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Nutritional status of Santa Rosa Japanese plum as affected by nitrogen and boron under rainfed conditions of Kashmir

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ABSTRACT

Present experiment was carried out in a seven year old private plum orchard near SKUAST-Kashmir, Shalimar Campus, Srinagar during 2012 and 2013, to examine the response to nitrogenous fertilizer and boron on nutritional status of soil, leaf and fruit of plum cv. Santa Rosa. Urea @ 500 g (N_1), $CaNO_3$ @ 1450 g (N_2), N_1 + 50 g boron (N_3) and N_2 + 50 g boron (N_4) were applied at T_1 = Full dose in spring, T_2 = Full dose after harvest and T_3 = $^3/_4$ dose in spring and $^1/_4$ dose after harvest. Observations were recorded on nutritional status of soil, leaf and fruit. N_1T_1 treatment combination scored maximum values for nitrogen (359.79 %), potassium (326.27 %), iron (53.33 ppm), copper (1.79 ppm), zinc (1.64 ppm) and manganese (41.50 ppm) while N_2T_2 and N_2T_1 treatment recorded maximum values for phosphorous (21.28 %) and calcium (37.37 %), respectively. Maximum nitrogen (2.57 %), magnesium (0.50 %), Iron (260.39 ppm) and copper (8.95 ppm) content was recorded in leaves of N_1T_1 treatment however, N_2T_2 treatment recorded maximum phosphorus (0.27 %). Potassium (3.26 %), zinc (33.61 ppm) and manganese (73.18 ppm) scored higher values in N_2T_1 treatment combination. Macro nutrient content in fruits viz. nitrogen (1.38 %), phosphorous (1.38 %) and potassium (2.37 %) was maximum in N_1T_1, while maximum calcium (0.92 %) in N_2T_1 and magnesium (0.36 %) in N_3T_1. Similarly, maximum micro-nutrient contents in fruit *viz.* zinc (18.82 ppm), manganese (47.16 ppm), copper (9.32 ppm) and iron (9.20 ppm) were recorded under the treatment combinations of N_2T_1. Both sources of nitrogen and boron can be considered as best fertilizer in plum orchards for improving the mineral nutrient status of leaf, fruit and soil.

Key words: *Prunus salicina*, micronutrient, fertilizers.

INTRODUCTION

Plum is an important stone fruit crop of temperate region, stands next to peach in economic importance and is used both as fresh and in preserved form. Among different species of plum, *Prunus salicina* is more vigorous, productive, precocious in bearing and disease resistant than the *Prunus domestica*. Area under plum cultivation in Jammu and Kashmir is 4038 hectares with an annual production of 10112 MT (Anonymous, 2). In Jammu and Kashmir, still Santa Rosa is a leading commercial cultivar of Japanese plum known for its fair quality, aroma and characteristic flavor. Nutrients are essential for high productivity and good quality of different fruit crops. Supplying of the nutrients to the fruit plants from different fertilizers in a balanced form is critical for achieving consistent production and high quality fruits.

Nitrogen is usually applied annually to fruit crops and for which various sources are available such as nitrate, ammonium or in combination of both whereas the calcium nitrate or urea is commonly used nitrogen fertilizer for fruit crops. Boron is an essential trace element required for abundant yield and high quality fruit. High amount of boron in plum tree must be applied during flowering because boron plays an important role in pollen production its germination, pollen tube growth and cell division (Wang *et al.*, 14). But boron fertilization in fruit trees and especially in plum trees is seldom applied in Kashmir.

Proper fertilization depends on analytical results instead of routine application of fertilizers every year irrespectively of the plants need from which money can be saved and the quality of the fruit will improve. Chemical analysis of soil and leaf samples provide details that helps us to choose the most appropriate fertilizers to be used. Data from analysis of soil is not used for the same purposes as that from leaf analysis. Soil analysis is best used before planting. However, in planted blocks soil analysis still gives useful background information, especially if salt problems or problems associated with low or high pH are suspected. After establishment of orchard leaf analysis gives better guide to the fruit nutrient status than soil. Leaf analysis after 120 days after full bloom can be very useful tool for plum nutritional diagnosis (Singh-Sidhu and Kaundal, 13). Determination of nutritional needs for efficient production of high quality fruits of plum is an important aspect of nutrient management for the orchardist. The present study was conducted to determine the effect of nitrogenous

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and boron fertilizers, their dose and timing on the soil, leaf and fruits of Santa Rosa plum under rainfed conditions of Kashmir valley.

MATERIALS AND METHODS

Experimental site and soil health

The experiment was carried out at farmer's field for two successive seasons 2012 and 2013 near SKUAST-Kashmir, Shalimar, Srinagar (J & K). The experimental orchard was situated at an altitude of 1685 m amsl which lying between 34°75' N latitude and 74°50' E longitude. Most of the precipitation received from October to April and rest is erratically distributed. The total rainfall and evapotranspiration during the experimentation period was 251.4 mm & 449.4 mm and 4.01 mm & 7.23 mm during 2012 and 2013, respectively. Winters are severe extending from December to March and the temperature often goes below freezing point (- 4.57°C) during this period. The analysis of soil indicated that the soil of the experimental site was clay-loam having pH (6.52), organic carbon (1.32 %), electrical conductivity (0.20 dSm^{-1}), available N, P, K Ca, Mg, B, Fe, Zn, Cu, Mn was 110 ppm, 10.40 ppm, 120.50 ppm, 23.5 ppm, 17.0 ppm, 1.97 ppm, 42 ppm, 1.15 ppm, 1.65 ppm, 35.65 ppm, respectively.

Material involved

The study was carried out on seven years old plum trees cv. Santa Rosa under rainfed conditions grown on private plum orchard. Thirty six healthy trees of Santa Rosa plum were selected on the basis of uniform size, age and vigour. The selected plants were labeled and grouped into three replications and twelve treatments combinations. Trees were kept under a rigid schedule of uniform cultural operation including irrigation, fertilization, insect-pests and disease control during the entire period of investigation. The following treatment combinations were made

Source of fertilizers	Time of fertilizer application		
	T_1	T_2	T_3
N_1	N_1T_1	N_1T_2	N_1T_3
N_2	N_2T_1	N_2T_2	N_2T_3
N_3	N_3T_1	N_3T_2	N_3T_3
N_4	N_4T_1	N_4T_2	N_4T_3

The fertilizers were applied from various sources of fertilizers *viz.*, N_1 = Urea (500 g), N_2 = Calcium nitrate (1450 g), N_3 = Urea (500 g) + 50 g Boron, N_4 = Calcium nitrate (1450 g) + 50 g Boron and at different times *viz.* T_1 = Full dose in spring, T_2 = Full dose after harvest, T_3 = ¾ dose in spring and ¼ dose after harvest.

Observations recorded

Observations were recorded on nutritional status of soil, leaf and fruit.

Soil nutrient status

Composite soil samples from 0-15 cm and 15-30 cm depth were collected during the month of June, mixed and dried in shade, grounded, sieved through 2 mm plastic sieve and stored in cloth bags (Ali and Narayan, 1). Nitrogen (kg/ha) was estimated by Alkaline Potassium Permanganate Method. Phosphorus (kg/ha) was determined by Stannous Chloride reduced Ammonium Molybdate Method using Olsen's Extractant and determined on UV-Spectrophotometer Model GS5701V at 660 nm wave length (Estefan *et al.*, 4). Potassium (kg/ha), exchangeable calcium (ppm) and magnesium (ppm) were extracted with neutral normal ammonium acetate procedure and potassium was estimated on Flame Photometer (Estefan *et al.*, 4) while calcium, magnesium, iron, zinc, copper and manganese were determined on Atomic Absorption Spectrophotometer and expressed in ppm (Ali and Narayan, 1).

Leaf and fruit nutrient status

For mineral nutrition analysis, both leaf (collected on 15 July) and mature fruits were first washed with tap water followed by labolene wash and finally with distilled water and dried on newspapers for overnight and then transferred to oven for drying at (60°C). Then the samples were crushed in stainless steel blender and stored in polythene bags for analysis. Nitrogen was estimated by Micro-Kjeldhal method (Estefan *et al.*, 4) and was calculated in per cent.

$$N (\%) = \frac{\text{Titration recording of sample} \times \text{Titration recording of blank} \times \text{Normality of HCl} \times 14}{\text{Sample weight} \times 1000} \times 100$$

Phosphorous was determined by Vanado-Molybdo phosphoric yellow colour method and the colour intensity was measured at 440 nm in double beam ultra visible spectrophotometer. Potassium was estimated by flame photometer method using flame photometer 130 (systronics). Ca, Mg and other micronutrients were analyzed with the help of atomic absorption spectrophotometer (Estefan *et al.*, 4).

Statistical analysis

The data generated from these investigations were appropriately computed, tabulated and pooled data of two years were analyzed by applying Randomized Block Design Factorial (RBD). The level of significance was tested for different variable at 5 per cent (Gomez and Gomez, 7). Data were analysed using analysis of variance OPSTAT, HAU, Hisar, Haryana (India).

RESULTS AND DISCUSSION

Data presented in Table 1-2 reveals that soil nutrient contents were markedly influenced by various treatments. The highest (359.79 %) and lowest (340.00 %) values for soil nitrogen content was recorded under the treatment combinations of N_1T_1 (full dose of urea in spring) and N_4T_3 (¾ dose of Calcium nitrate + 50 g borax in spring and ¼ dose after harvest), respectively (Table 1). Urea + lime significantly increased the available nitrogen content in the soil, while calcium ammonium nitrate resulted in the lower concentration of available nitrogen in the soil, which may probably be due to the NH_4^+ fixation capacities in the soil. Calcium ammonium nitrate also increases the exchangeable calcium content in the soil which may be responsible for low levels of nitrogen retention in the soil (Pooja, 10).

Full dose of calcium nitrate when applied after harvest (N_2T_2) registered maximum (21.28 %) and N_3T_3 (¾ dose of Urea + 50 g borax in spring and ¼ dose after harvest) registered minimum (18.07 %) values for soil phosphorous content (Table 1). Maximum (326.27 %) soil potassium content was obtained when full dose of Urea was applied in spring (N_1T_1), whereas minimum (306.23 %) soil potassium content was registered in N_4T_3 (¾ dose of Calcium nitrate + 50 g borax in spring and ¼ dose after harvest) treatment combination. Prasad *et al.*, (11) reported that calcium nitrate significantly increased soil potassium content in pear, respectively. Soil calcium content was recorded maximum (37.37 %) in N_2T_1 treatment combination and minimum (18.54 %) was obtained in N_3T_2. Soil calcium content was significantly influenced by various sources of nitrogenous fertilizer and recorded maximum calcium

Table 1. Effect of nitrogenous fertilization and boron on soil nutrient content (N, P, K and Ca) of Santa Rosa.

Source of fertilizer	Time of fertilizer application											
	Nitrogen (%)			Phosphorous (%)			Potassium (%)			Calcium (%)		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
N_1	359.79	352.65	344.16	19.32	18.95	18.61	326.27	316.57	316.41	23.54	20.88	21.24
N_2	353.61	347.98	342.97	21.28	21.53	21.17	312.89	310.39	308.22	37.37	36.03	34.88
N_3	356.58	350.68	343.00	19.07	18.49	18.07	323.40	317.24	312.89	20.71	18.54	20.38
N_4	349.49	343.00	340.00	19.33	18.47	18.78	310.74	307.57	306.23	30.55	28.54	27.38
$CD_{(0.05)}$												
N		0.66			0.32			0.98			0.62	
T		1.63			0.78			2.41			0.15	
N × T		2.31			0.11			3.40			0.21	

N_1 = Urea, N_2 = Calcium nitrate, N_3 = Urea + 50 g Boron, N_4 = Calcium nitrate + 50 g Boron
T_1 = Full dose in spring, T_2 = Full dose after harvest, T_3 = $^3/_4$ dose in spring and $^1/_4$ dose after harvest

Table 2. Effect of nitrogenous fertilization and boron on soil nutrient content (Zn, Fe, Cu and Mn) of plum Santa Rosa.

Source of fertilizer	Time of fertilizer application											
	Iron (ppm)			Copper (ppm)			Zinc (ppm)			Manganese (ppm)		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
N_1	53.33	50.93	49.88	1.79	1.78	1.78	1.64	1.60	1.59	41.50	38.58	37.77
N_2	52.61	49.10	48.10	1.69	1.68	1.67	1.58	1.56	1.53	40.27	39.13	37.00
N_3	51.81	49.24	48.83	1.78	1.64	1.65	1.63	1.57	1.54	40.41	38.06	36.80
N_4	51.48	48.29	47.82	1.68	1.67	1.67	1.52	1.55	1.53	38.57	37.00	36.10
$CD_{(0.05)}$												
N		0.70			0.98			0.10			0.54	
T		1.71			0.84			0.26			1.33	
N × T		2.42			46.06			0.36			1.88	

N_1 = Urea, N_2 = Calcium nitrate, N_3 = Urea + 50 g Boron, N_4 = Calcium nitrate + 50 g Boron
T_1 = Full dose in spring, T_2 = Full dose after harvest, T_3 = $^3/_4$ dose in spring and $^1/_4$ dose after harvest

content in soil under the treatment of calcium nitrate (Prasad et al., 11).

Maximum iron (53.33 ppm) and copper (1.79 ppm) content in soil was registered in treatment combinations of N_1T_1 (full dose of Urea in spring) (Table 2). Minimum value (47.82 ppm) for soil iron content was recorded in N_4T_3 treatment combination whereas minimum (1.64 ppm) soil copper content was recorded in N_3T_2. Increasing level of nitrogen application, increased available N, P, Fe, Zn, Cu and exchangeable Mg and Ca content in Santa Rosa plum orchards (Raese and Drake 12). Treatment combination of N_1T_1 registered maximum values for zinc (1.64 ppm) and manganese (41.50 ppm) content in soil, however, minimum values for zinc (1.52 ppm) and manganese (36.10 ppm) content in soil were recorded in N_4T_3 treatment. Increasing level of nitrogen application also increased available micronutrients especially Zn and Mn contents in plum orchard (Singh-Sidhu and Kaundal, 13).

Pooled data of two years presented in Table 3-4 reveals that status of macro nutrient in leaf showed markedly influence under various treatments. The maximum leaf nitrogen content (2.57 %) was recorded in N_1T_1 (urea 500 g full dose in spring) however, treatment N_4T_3 registered minimum values for leaf nitrogen content (2.30 %) (Table 3). Since nitrogen is a dominating nutritional factor in the growth and development of the plants as it affects vegetative growth, flowering, fruit set, yield and particularly leaf nutrient status (Chatzitheodorou *et al.* 3) so the higher level of nitrogen in leaves as a result of urea sprays may be attributed to the fact that on hydrolysis urea release NH_4^+ for nitrogen uptake by the plants.

Maximum values for leaf phosphorus (0.27 %) were recorded in N_2T_2 (full dose of calcium nitrate

Table 3. Effect of nitrogenous fertilization and boron on leaf nutrient content (N, P, K nd Mg) of plum Santa Rosa.

Source of fertilizer	Time of fertilizer application											
	Nitrogen (%)			Phosphorous (%)			Potassium (%)			Magnesium (%)		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
N_1	2.57	2.53	2.54	0.25	0.25	0.25	3.11	3.10	3.10	0.50	0.48	0.48
N_2	2.42	2.43	2.39	0.25	0.27	0.26	3.26	3.23	3.24	0.39	0.37	0.35
N_3	2.56	2.50	2.50	0.22	0.19	0.21	3.07	3.08	3.06	0.43	0.37	0.34
N_4	2.35	2.37	2.30	0.21	0.22	0.21	3.13	3.11	3.13	0.37	0.33	0.31
CD $_{(0.05)}$												
N		NS			0.79			0.10			0.21	
T		NS			0.19			0.25			0.18	
N × T		6.91			0.27			0.35			NS	

N_1 = Urea, N_2 = Calcium nitrate, N_3 = Urea + 50 g Boron, N_4 = Calcium nitrate + 50 g Boron
T_1 = Full dose in spring, T_2 = Full dose after harvest, T_3 = $^3/_4$ dose in spring and $^1/_4$ dose after harvest

Table 4. Effect of nitrogenous fertilization and boron on leaf nutrient content (Zn, Fe, Cu and Mn) of plum Santa Rosa.

Source of fertilizer	Time of fertilizer application											
	Zinc (ppm)			Iron (ppm)			Copper (ppm)			Manganese (ppm)		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
N_1	30.03	29.83	29.44	260.39	232.07	250.39	8.95	8.01	7.89	53.44	51.13	51.77
N_2	33.61	33.54	32.52	252.06	250.12	248.22	8.10	7.45	7.74	73.18	71.26	70.01
N_3	28.37	29.49	26.26	241.52	242.70	242.34	7.17	7.81	7.10	50.70	49.99	50.17
N_4	31.01	30.85	28.45	236.65	237.25	233.20	7.44	7.09	7.44	64.68	61.85	60.89
CD $_{(0.05)}$												
N		0.84			NS			0.55			1.13	
T		2.06			19.96			0.47			2.77	
N × T		2.91			28.23			1.82			3.92	

N_1 = Urea, N_2 = Calcium nitrate, N_3 = Urea + 50 g Boron, N_4 = Calcium nitrate + 50 g Boron
T_1 = Full dose in spring, T_2 = Full dose after harvest, T_3 = $^3/_4$ dose in spring and $^1/_4$ dose after harvest

after harvest), however, minimum (0.19 %) values were obtained under the treatment combination of N_3T_2 (full dose of urea + 50 g boron after harvest). Maximum (3.26 %) leaf potassium content was recorded under the fertilizer application of calcium nitrate 1450 g full dose in spring (N_2T_1) and minimum (3.06 %) was registered when Urea + 50 g borax was applied ¾ dose in spring and ¼ dose after harvest (N_3T_3) (Table 3). The lowest level of P and K in leaves could be attributed to the increased doses of nitrogen through urea and calcium nitrate. Phosphorus and potassium content of leaves decreased with increased dose of nitrogen application (Pooja, 10). However, factors responsible for a decrease in leaf phosphorus may be due to growth dilution of phosphorus (Goff, 6).

Two year pooled data showed that N_1T_1 (full dose of urea in spring) treatment combination registered maximum (0.50 %) magnesium content in leaves whereas minimum value (0.31 %) was obtained in N_4T_3 treatment combination (Table 3). This may be attributed to the fact that nitrogen is considered balance wheel for other nutrients and vegetative growth enhances with $Ca(NO_3)_2$, therefore, it increases uptake of other nutrients through transpiration pull. Leaf magnesium content increased with the Urea + lime @ 600 g N/tree in respect of plum cv. Santa Rosa (Pooja, 10) and Ganai (5) also found that leaf Ca, N, Mg and B were enhanced under $CaCl_2$ treatments in apple.

Zinc, iron, copper and manganese content were markedly influenced by various treatments during the studies (Table 4). The maximum (33.61 ppm) and minimum (26.26 ppm) leaf zinc was recorded under the treatment combination of N_2T_1 (full dose of calcium nitrate in spring) and N_3T_3 (¾ dose of Urea + 50 g borax in spring and ¼ dose after harvest). Maximum iron (260.39 ppm) and copper (8.95 ppm) content in leaves was recorded in the treatment combination of N_1T_1 where full dose of urea was applied in spring. Minimum values for iron content in leaves (233.20 ppm) was obtained in N_4T_3 (¾ dose of Calcium nitrate + 50 g borax in spring and ¼ dose after harvest) whereas, leaf copper was observed minimum (7.09 ppm) in N_4T_2 (full dose of Calcium nitrate + 50 g borax) treatment combination. Increased nitrogenous fertilizer application increased the uptake of copper and iron (Pooja, 10). Leaf manganese content with a maximum values (73.18 ppm) was registered in the treatment combination of N_2T_1 *i.e.* full dose of Calcium nitrate in spring while minimum (49.99 ppm) leaf manganese content was recorded when full dose of Urea + 50 g borax was applied after harvest (N_3T_2) (Table 4). Pooja (10) in Santa Rosa plum reported similar results.

Pooled data of two years showed significant results as influenced by various treatments with respect to nutrient contents of fruits (Table 5-6). Maximum nitrogen (1.38 %) was observed in treatment combination of N_1T_1 (full dose of urea in spring), whereas, minimum nitrogen (1.08 %) content of fruits was registered in N_4T_3 (¾ dose of Calcium nitrate + 50 g borax in spring and ¼ dose after harvest) (Table 5). The concentration of fruit nitrogen tends to be higher after application of nitrogenous fertilizers. Increasing nitrogen rates, increased the nitrogen composition in fruit peel and cortex from trees (Irshaad, 8). Treatment combination of N_1T_1 (full dose of urea in spring) registered maximum phosphorous (0.31 %) content in fruits, however, minimum phosphorous (0.16 %) was recorded in N_1T_3 treatment combination (Table 2). Ganai (5) also recorded a significant increase in phosphorous content under $CaCl_2$ treatment however, phosphorous

Table 5. Effect of nitrogenous fertilization & boron on fruit nutrient content (N, P, K, Mg and Ca) of plum Santa Rosa.

Source of fertilizer	Time of fertilizer application														
	Nitrogen (%)			Phosphorous (%)			Potassium (%)			Magnesium (%)			Calcium (%)		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
N_1	1.38	1.35	1.31	0.31	0.19	0.16	2.37	2.33	2.31	0.26	0.24	0.20	0.82	0.82	0.78
N_2	1.19	1.17	1.15	0.29	0.29	0.28	1.96	1.95	1.86	0.31	0.28	0.25	0.92	0.86	0.85
N_3	1.25	1.29	1.27	0.30	0.28	0.22	2.26	2.16	2.08	0.36	0.33	0.31	0.78	0.78	0.76
N_4	1.14	1.09	1.08	0.28	0.25	0.25	1.76	1.66	1.53	0.29	0.24	0.22	0.85	0.82	0.80
$CD_{(0.05)}$															
N		0.77			0.13			0.10			0.67			0.12	
T		0.18			0.34			0.25			0.16			0.31	
N × T		0.26			0.48			0.36			0.23			0.44	

N_1 = Urea, N_2 = Calcium nitrate, N_3 = Urea + 50 g Boron, N_4 = Calcium nitrate + 50 g Boron
T_1 = Full dose in spring, T_2 = Full dose after harvest, T_3 = $^3/_4$ dose in spring and $^1/_4$ dose after harvest

Table 6. Effect of nitrogenous fertilization and boron on fruit nutrient content (Zn, Fe, Cu and Mn) of plum Santa Rosa.

Source of fertilizer	Time of fertilizer application											
	Zinc (ppm)			Iron (ppm)			Copper (ppm)			Manganese (ppm)		
	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
N_1	18.31	16.64	14.95	31.25	31.06	30.87	7.29	7.21	7.14	7.15	7.13	7.10
N_2	18.82	18.15	17.82	47.16	46.18	46.50	9.32	9.25	9.17	9.20	9.14	9.15
N_3	17.31	15.64	15.15	26.54	24.34	26.15	6.15	6.14	6.08	6.12	6.09	6.06
N_4	18.13	17.96	16.98	36.71	36.17	34.12	8.28	8.27	8.20	8.14	8.17	8.13
$CD_{(0.05)}$												
N		0.36			NS			0.83			0.84	
T		0.88			1.96			0.20			0.20	
N × T		1.25			2.77			0.28			0.29	

N_1 = Urea, N_2 = Calcium nitrate, N_3 = Urea + 50 g Boron, N_4 = Calcium nitrate + 50 g Boron
T_1 = Full dose in spring, T_2 = Full dose after harvest, T_3 = $^3/_4$ dose in spring and $^1/_4$ dose after harvest

content remained unaltered under different calcium treatments.

Fruit potassium content with maximum (2.37 %) and minimum (1.53 %) value was recorded in treatment combinations of N_1T_1 (full dose of Urea in spring) and N_4T_3 (¾ dose of Calcium nitrate + 50 g borax in spring and ¼ dose after harvest) (Table 5). Potassium was the most accumulated nutrient in fruits, followed by phosphorous and magnesium, regardless of the cultivar. Most potassium accumulation in apple and plum fruits (Nachtigall and Dechen, 9) may be due to the fact the potassium content is almost balanced in fruit due to the reason that K is not retrieved efficiently from the leaves to the fruits. Maximum (0.92 %) and minimum (0.76 %) fruit calcium was recorded with full dose of calcium nitrate in spring (N_2T_1) and ¾ dose of Urea + 50 g borax in spring and ¼ dose after harvest (N_3T_3). Foliar application of calcium both in summer and in autumn resulted in increased calcium concentration in fruit (Wojcik *et al.* 15). Treatment combination of N_3T_1 (full dose of Urea + 50 g borax) and N_1T_3 (¾ dose of Urea in spring and ¼ dose after harvest) recorded maximum (0.36 %) and minimum (0.20 %) values for magnesium content in fruits, respectively. Increasing nitrogen rates increased magnesium composition in fruit peel and cortex from trees on Granny Smith apple, however, leaf and fruit nitrogen and fruit magnesium concentrations were lowest for trees with the low nitrogen fertilizer rate and highest nitrogen and magnesium concentrations for trees with the lowest fruit quality from the higher nitrogen rates (Raese and Drake, 12).

Treatment combinations of N_2T_1 (full dose of calcium nitrate in spring) and N_1T_3 (¾ dose of Urea in spring and ¼ dose after harvest) observed maximum (18.82 ppm) and minimum (14.95 ppm) values for zinc contents in fruits (Table 6). Zinc levels in fruit peel and cortex were highest in fruit from trees receiving the low rates of nitrogen (Raese and Drake, 12). Since nitrogen is considered balance wheel for other nutrients and vegetative growth enhances with calcium nitrate therefore it increases uptake of other nutrients through transpiration pull however, a non-significant effect on leaf and fruit zinc content were also reported (Ganai, 5 and Irshaad, 8).

Maximum iron (47.16 ppm) and copper (9.32 ppm) content was observed in N_2T_1 (full dose in calcium nitrate in spring) treatment. Minimum fruit iron (24.34 ppm) content was registered in N_3T_2 (full dose urea + 50 g borax) treatment, however, minimum fruit copper (6.08 ppm) content was obtained in N_3T_3 (¾ dose of Urea + 50 g borax in spring and ¼ dose after harvest). Fruit manganese content was maximum (9.20 ppm) and minimum (6.06 ppm) registered by the treatment combinations of N_2T_1 (full dose in calcium nitrate in spring) and N_3T_3 (¾ dose of Urea + 50 g borax in spring and ¼ dose after harvest) (Table 6). Since the mineral content of leaves had a close association with mineral content of fruits as such higher concentration of Cu, Fe and Mn correspond with those of mineral content in fruits which acts as a sink for various elements. However, Ganai (5) observed a non-significant effect of calcium treatments on leaf and fruit Cu, Fe and Mn content.

Current research indicates that mineral nutrient content in leaf, fruit and soil were increased by the application of various nitrogenous and boron fertilizers which could move towards sink for enhancing the growth, yield and quality of the fruits.

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