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RESEARCH PAPER

Effect of different nitrogen levels through *Neem* coated urea and calcium sprays on leaf and soil NPK and Ca status and phytotoxicity in peach

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Abstract : A two year investigation was conducted at Krishi Vigyan Kendra (ICAR- VPKAS), Kafligair- Bageshwar during 2016 and 2017 in peach cv. RED JUNE with ten treatments *viz*., 375 g N per tree + 0.5 % $CaCl_2$ (T_1), 375 g N $tree^{-1}$ + 1.0 % $CaCl_2$ (T_2), 375 g N $tree^{-1}$ + 1.5 % $CaCl_2$ (T_3), 500 g N $tree^{-1}$ + 0.5 % $CaCl_2$ (T_4), 500 g N $tree^{-1}$ + 1.0 % $CaCl_2$ (T_5), 500 g N $tree^{-1}$ + 1.5 % $CaCl_2$ (T_6), 625 g N $tree^{-1}$ + 0.5 % $CaCl_2$ (T_7), 625 g N $tree^{-1}$ + 1.0 % $CaCl_2$ (T_8), 625 g N $tree^{-1}$ + 1.5 % $CaCl_2$ (T_9), 500g N $tree^{-1}$ + Water spray (T_{10} control). The source of nitrogen fertilization was neem coated urea. The experimental findings revealed that maximum leaf nitrogen content was estimated under T_9 (3.721% and 3.838% in 2016 and 2017, respectively), while maximum leaf phosphorus content was estimated under T_1 (0.450%) in first and T_3 (0.456%) in second year. During both the years, the maximum leaf potassium content was estimated under T_2 (2.096% and 2.110% in 2016 and 2017, respectively). The highest leaf calcium content was estimated under T_3 (1.735% in 2016 and 1.744% in 2017). Irrespective of nitrogen fertilization levels, highest calcium chloride concentration (1.5%) resulted in phytotoxicity which was evident by marginal leaf scorching. Significant differences for available soil nitrogen were found, while other studied nutrients did not differ significantly.

Key Words : Nitrogen levels, *Neem* coated urea, Calcium chloride, Leaf, Soil nutrient status

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INTRODUCTION

Peach [*Prunus persica* (L.) Batsch] is widely cultivated stone fruit crop of temperate regions of the world extending from 10° N and 49° S latitude where strong light, clear skies, long seasons and warm temperature prevails mainly in low and mid hills with altitudinal range of 1000-2000 m above mean sea level (Ghosh, 2001). This fruit crop is believed to be originated in an area near the city Xian, China and recorded to be grown as far back as 2000 BC (Kumar *et al*., 2015). From China it moved to west through sea route via India and mid east and also through the silk route via Persia

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(Janik, 2003). Presently, in India, peach is being cultivated in an area of 18.00 thousand hectare, with a production and productivity of 107.00 thousand MT and 5.94 MT/ ha, respectively (Horticultural Statistics at a Glance 2017).

Mineral nutrition has definite role on different plant processes. Among various essential minerals, response of peach to nitrogen fertilization is dramatic. Nitrogen can affect vegetative and reproductive aspects of fruit trees. Moreover, it was reported that supply of nitrogen also influences the availability of other plant nutrients in fruit trees (Singh *et al*., 2009; Gill and Gill, 2016). This in turn may affect the proper plant physiological processes and tree performance. Urea is the major nitrogen fertilizer in India and from January 2015, Government of India has made it mandatory for the domestic urea manufactures to produce "*Neem* coated urea" upto a minimum of 75 per cent of their total production of subsidized urea from 35 per cent earlier and allowed them to go upto 100 per cent (http:/thehindubusinessline.com). The information concerning the effect of *Neem* coated urea on major leaf and soil nutrient concentration is almost absent for peach in Indian scenario. Therefore, it is noteworthy to study the influence of different nitrogen levels through *Neem* coated urea on status of major plant nutrients in peach. Moreover, Sprays with calcium have been reported to be effective in extending shelf life of many fruits by maintaining firmness, minimizing respiration, tissue breakdown and thus, reducing the fruit loss (Shirzad *et al.,* 2011; Bhat *et al*., 2011). But the information pertaining to the effects of theses calcium sprays on major leaf and soil nutrients is almost lacking in Indian context. Nevertheless, the safe concentrations for calcium chloride without any phytotoxicity symptom need to be standardized. Therefore, with these objectives the study was conducted and being presented vide infra.

MATERIAL AND METHODS

The present study was conducted at Krishi Vigyan Kendra (ICAR- VPKAS, Almora) Kafligair- Bageshwar (Uttarakhand) in two consecutive years *i.e.*, 2016 and 2017. The experimental site is situated in the mid Himalayas between 29º45'07" N latitude and 79º44'03" E longitude at an altitude of 1245 meters above the mean sea level which represents the humid sub- temperate climate with average annual rainfall of 1256 mm. The experiment was conducted peach cv. RED JUNE trees, raised on seedling rootstocks and planted in 2010 with planting spacing of 3m x 3m.

The experiment was conducted in Randomized Block Design with three replications and ten treatments. The treatments comprised three levels of nitrogen fertilization (375 g, 500 g and 625 g per tree through *Neem* coated urea) along with three concentrations (0.5 %, 1.0 % and 1.5 %) of calcium chloride for foliar spray, and a control (500 g N per tree through *Neem* coated urea along with water spray). Thus there were ten treatments *viz*., 375 g N per tree + 0.5 % $CaCl_2$ (T_1), 375 g N tree^{-1} + 1.0 % $CaCl_2$ (T_2), 375 g N tree^{-1} + 1.5 % $CaCl_2$ (T_3), 500 g N tree^{-1} + 0.5 % $CaCl_2$ (T_4), 500 g N tree^{-1} + 1.0 % $CaCl_2$ (T_5), 500 g N tree^{-1} + 1.5 % $CaCl_2$ (T_6), 625 g N tree^{-1} + 0.5 % $CaCl_2$ (T_7), 625 g N tree^{-1} + 1.0 % $CaCl_2$ (T_8), 625 g N tree^{-1} + 1.5 % $CaCl_2$ (T_9), 500g N tree^{-1} + Water spray (T_{10} control). Foliar sprays of calcium chloride were given thrice, first at petal fall stage, second at 25 days after Ist spray and third at 25 days after IInd spray. Common doses of FYM (40 kg/tree), P_2O_5 (250 g/tree) and K_2O (500 g/tree) were also applied uniformly in each tree. Source of N, P_2O_5 and K_2O were *Neem* coated urea, single super phosphate and muriate of potash, respectively. Whole quantity of FYM, P_2O_5 and K_2O were applied in December. Half of the N was applied in mid February about three weeks before flowering and remaining half in last week of March after fruit set.

The leaf and soil nutrient studies were conducted with following methods;

Leaf nutrient studies :

Leaf sampling :

Twenty five to thirty mid shoot leaves from all around the canopy were sampled in second week of July as suggested by Chadha (2011).

Preparation of leaf sample for analysis :

Washing :

The leaves were first washed properly with distilled water and then by 0.1 N HCl solution, followed by washing with de-ionized water thrice.

Drying :

Washed leaf samples were kept on blotting paper to soak off the excess water. After that the samples were dried in the oven at 60-70^{0}C for 40-45 hours to get a constant dry weight.

Grinding and storage :

The dried leaf samples were ground in Willey's Mill to powder form and then passed through a 40 mesh sieve to obtain a finely ground sample. These samples were labeled and stored in air tight glass tubes till analysis. Before analysis, the stored samples were further dried at a temperature of 65°C for 12 hours. These samples were then analyzed for N, P, K and Ca content.

Nitrogen :

0.5 g well prepared leaf samples were taken in Kjeldahl flask and digested in conc. H_2SO_4 with salt mixture of K_2SO_4: $CuSO_4$: Si (10:1:10). During distillation, liberated ammonia is collected in Boric acid – Bromocresol green-Methylene blue mixed indicator and then titrated with N/10 H_2SO_4 (Jackson, 1958). The estimation procedure was performed in Foss N Autoanalyser, Kjeltec- 2300. The titre value was converted into total nitrogen percentage by applying the following;

$$\text{Nitrogen (\%)} = (T - B) \times N \times \frac{1.4}{S}$$

where,

T = ml titre value for sample

B = ml titre value for blank

N = Normality of standard acid

S = Sample weight (g)

Phosphorus, potassium and calcium :

Digestion :

Well prepared leaf samples (0.5g) of each replication and treatment were taken in digestion tubes and 3 ml concentrated nitric and 2 ml hydrogen peroxide was added. Digestion was done in microwave digester (Classic Mars 6) at 420^{0}C for 2 hours. The digestion extract was then filtered through Whatman filter paper No. 42 filter paper in 50 ml volumetric flask and made up the volume by distilled water. The digest was used for the estimation of phosphorus, potassium and calcium.

Phosphorus :

The total phosphorus was determined by Vanadomolybdophosphoric yellow colour method as described by Jackson (1958). 'Reagent A' and 'Reagent B' were prepared separately. For 'Reagent A' 25 g ammonium molybdate was dissolved in 400 ml distilled water. 'Reagent B' was made by dissolving 1.25 g ammonium metavanadate in 300 ml of boiling water. 'Reagent B' is cooled and then 250 ml concentrated nitric acid was added and allowed to cool again to room temperature. Finally 'Reagent A' is poured in 'Reagent B' and the mixture is diluted to 1 litre. This 'Reagent (A+B)' was used as working reagent.

5 ml aliquot of digested leaf sample was taken in a 50 ml volumetric flask then 10 ml 'Reagent (A+B)' was added and volume was made upto the mark. It was incubated for 30 min at room temperature and then absorbance was recorded at 420 nm using Spectrophotometry (Spectrascan, UV 2600). Similarly, absorbance was also taken for blank and standard solutions. The phosphorus content (ppm) in test solutions was obtained by plotting the absorbance values of test samples on standard curve. It was then converted in total leaf phosphorus content (%) by using the following formula;

$$\text{P (\%)} = \frac{\text{P (ppm) x Volume made up after digestion x Dilution}}{\text{Weight of sample x Volume of aliquot x 10000}}$$

Potassium :

The digested solution was again diluted to five times. For this 5ml aliquots were diluted to 25 ml. This diluted extract was then atomized in a flame photometer (Systronics Flame Photometer 128) as per the description made by Tondon (1993). K (ppm) values present in the test solutions were determined that were converted into total leaf potassium content (%) by applying the following formula;

$$\text{K (\%)} = \frac{\text{K (ppm) x Volume made up after digestion x Dilution}}{\text{Weight of sample x Volume of aliquot x 10000}}$$

Calcium :

Calcium determination was done by atomic absorption spectrophotometry (Double AS). Before analyzing, 1 ml digested solution was further diluted to 200 ml and then calcium concentration (ppm) in the test solution was recorded by Perkin Elmer AAS Analyst 400. This calcium concentration of test solution was converted into total leaf calcium content (%) by using the following formula;

$$\text{Ca (\%)} = \frac{\text{Ca (ppm) x Volume made up after digestion x Dilution}}{\text{Weight of sample x Volume of aliquot x 10000}}$$

Phytotoxicity (Scorched leaves %):

It was a symptom of chloride toxicity due to over doses of calcium chloride. For calculating the scorched leaves (%), number of total leaves and number of scorched leaves on ten selected shoots from each tree were recorded and their sum was calculated, finally the values were converted into percentage by applying the following formula;

$$\text{Scorched leaves (Percentage)} = \frac{\text{Scorched leaves}}{\text{Total leaves}} \times 100$$

Soil nutrient studies :

Soil samples representing 0-30 cm depth were collected from each tree basin with the help of screw auger after harvest in July, 2016 and 2017. The samples were dried in shade, ground and passed through 2 mm sieve and stored in muslin bags. Estimation methods for available N, P, K and Ca are being described as follows;

Available nitrogen :

The available nitrogen in soil was determined by alkaline potassium permangnate method as given by Subbiah and Asija (1956). Properly prepared soil sample (3 g) was taken in the distillation tube and 15 ml 0.32% $KMnO_4$ was added. It was put in the Foss N Autoanalyser, Kjeltec- 2300 that expressed titre reading in ml for the standard acid used. This titre reading was converted into available nitrogen (kg ha^{-1}) in soil by multiplying it with the factor value of 1045.

Available phosphorus :

The available phosphorus in soil was extracted by Olsen's extract and estimated spectrophotometrically as described by Tondon (1993). Properly prepared soil sample (2.5 g) was taken in a conical flask in which 25 ml Oleson's extract (0.5 M $NaHCO_3$) was poured. 1 spatula P free charcoal was also added in this mixture. The mixture was put on the shaker for 15 min and then filtered (Whatman filter paper No. 1). 5 ml filtrate was taken in a 25 ml volumetric flask and 1 drop para nitro phenol was added that led to yellow colour development. Then 2.5 M H_2SO_4 was added drop by drop till yellow colour disappeared. Now 4 ml mixture of 'Reagent A' (6 g ammonium molybdate in 125 ml distil water) and 'Reagent B' (1.454 mg antimony potassium tartarate in 50 ml distil water + few particles of ascorbic acid) was poured in it and made the volume upto the mark. After 15 minute take the absorbance using Spectrophotometry (Spectrascan, UV 2600) at 660 nm. Similarly, absorbance was also taken for blank and standard solutions. The phosphorus content (ppm) in test solutions was obtained by plotting the absorbance values of test samples on standard curve. It was then converted into available phosphorus (kg ha^{-1}) in soil by multiplying it with the factor value of 112.

Available potassium :

Following the method explained by Tondon (1993), 5 g adequately prepared soil sample was taken in a volumetric flask and 25 ml 1 N ammonium acetate was added. This mixture was placed on the shaker for 15 min and then filtered through Whatman filter paper No.1. This filtrate was atomized in a flame photometer (Systronics Flame Photometer 128) with the wavelength dial set at 768 nm and the transmission set at 100 per cent for the top standard solution of KCl containing 1000 ppm (K). Standard potassium curve was obtained from different concentrations of potassium chloride. Thus K (ppm) values present in the test solutions were determined that were converted into available potassium content (kg ha^{-1}) in soil by applying the following formula;

$$\text{K (kg ha}^{-1}\text{)} = \text{K (ppm)} \times \text{Dilution factor} \times 2.24$$

Available calcium :

The extraction procedure for available calcium was similar to available potassium. After extraction the filtrate was used to determine calcium by atomic absorption spectrophotometry (Double AS). Before analyzing, 1 ml extract was further diluted to 200 ml and then calcium concentration (ppm) in the test solution was recorded by Perkin Elmer AAS Analyst 400. This calcium concentration of test solution was converted into available soil calcium content (%) by using the following formula;

$$\text{Ca (\%)} = \frac{\text{Ca (ppm)} \times \text{Volume made up after digestion} \times \text{Dilution}}{\text{Weight of sample} \times \text{Volume of aliquot} \times 10000}$$

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Leaf nutrient studies:

It is evident from Table 1 that the applied treatments resulted in significant variation for leaf nitrogen, phosphorus, potassium and calcium content of peach cv. RED JUNE. In first year of the experiment *i.e.*, 2016, the leaf nitrogen content varied from 3.721% to 2.687%. The maximum leaf nitrogen content was estimated under

T_9 which was statistically at par to T_7 (3.666) and T_8 (3.633). The minimum was found under T_3 which differed non significantly with T_1 (2.734%) and T_2 (2.774%). In second year of the study *i.e.*, 2017, the maximum leaf nitrogen content was observed under T_9 (3.838%) followed by the statistically at par values of T_7 (3.793) and T_8 (3.731%). In the same year, the minimum leaf nitrogen content was recorded under T_2 (2.839%) which varied non significantly with T_1 (2.819%) and T_3 (2.799%).

In 2016, the maximum leaf phosphorus content was estimated under T_1 (0.450%) which differed non significantly with T_2 (0.419%) and T_3 (0.417%), whereas in the same year the minimum leaf phosphorus was obtained under T_8 (0.205%) which was statistically at par with T_7 (0.216%) and T_9 (0.238%). The second year observations (2017) showed that the highest leaf phosphorus content (0.456%) recorded under T_3 varied non significantly with T_1 (0.427%) and T_2 (0.425%), whereas, the lowest was found under T_8 (0.225%) which had non significant differences with T_7 (0.258%) and T_9 (0.233%).

In first year of the experiment (2016), the maximum leaf potassium content was estimated under T_2 (2.096%) which was closely followed by the statistically at par values of 2.013% and 1.987% recorded under T_1 and T_3, respectively. In the same year, the minimum leaf potassium content was found under T_7 (1.317%) which varied non significantly with T_8 (1.340%) and T_9 (1.350%). In second year of the experiment (2017), the leaf potassium content ranged from 2.110% to 1.333%. The maximum was recorded under T_2, while, the minimum was found under T_7.

In the first year of study *i.e.*, 2016 the maximum leaf calcium content was estimated under T_3 (1.735%) which was statistically at par with T_2 (1.724%). In the same year, the minimum leaf calcium content of 0.971% was found with control (T_{10}) which was significantly lower than all other treatments. Similar to the results of first year, in 2017 also, the maximum leaf calcium content was found under T_3 (1.744%) which varied non significantly with T_2 (1.732%). Treatment T_{10} remained significantly lower than all other treatments in second year also and contained 0.979% leaf calcium content.

It may be concluded from the results described above that different nitrogen regimes through *Neem* coated urea and foliar application of calcium chloride had marked effect on leaf nutrient status. In general, there was a steady and significant increase in leaf nitrogen content with increased nitrogen fertilization levels. But leaf phosphorus, potassium and calcium showed a decline with higher nitrogen regimes. Calcium chloride sprays could not impart significant changes in studied leaf nutrient contents, except for calcium.

Supply and intake of nitrogen is inter- related to the availability of other nutrients (Chadha, 2011). Similar to our findings, significant increase in leaf nitrogen content of peach with higher nitrogen fertilization levels were also reported by Olmstead *et al*. (2015). In agreement with our upshot, Almaliotis *et al*. (1997) also reported that increasing levels of nitrogen led to increase the leaf nitrogen content and simultaneously decreased leaf phosphorus and calcium concentrations; however, his findings for potassium were in contrary to present results. Gill and Gill (2016) also documented an increase in leaf potassium and decrease in calcium concentration with higher nitrogen fertilization doses in pear. The present findings regarding leaf nitrogen, phosphorus and potassium concentrations are also in harmony with Arora *et al*. (1999) in peach and (Singh *et al*., 2009) in apple.

The significant effect of foliar application of calcium chloride on leaf calcium content only might be due to the surface absorption of this nutrient which possibly did not affect the uptake of other nutrients. The significantly lower leaf calcium content at 0.5 per cent calcium chloride than higher concentrations might be because of less availability of this nutrient for absorption which apparently became static above 1.0 per cent concentration. Brunetto *et al*. (2008) also reported that foliar application of calcium chloride in peach did not affect leaf nitrogen and potassium content, though leaf calcium content increased. Similarly, Sotiropoulos *et al*. (2010) also found increased leaf calcium content through the application of various commercially available calcium containing products and at the same time no significant effect on leaf nitrogen and potassium concentrations was observed. However, contradictory results were found by Ganal (2005) and Khalifa *et al*. (2009) in apple who reported significant influence of calcium chloride sprays on concentration of other nutrients also. These dissimilarities in findings might be due to the differences in agro-climatic factors. Moreover, here different nitrogen regimes were also imposed which had more pronounced effect on nutrient availability that might possibly make the effect of calcium chloride sprays negligible for other nutrients except calcium.

Phytotoxicity (Scorched leaves %):

During the course of study, symptoms of chloride toxicity as marginal leaf scorching were observed in some of the plants, however the fruits were not affected. The data pertaining to these observations (Table 1 and Plate 1) showed that irrespective of nitrogen regimes the leaf scorching was noticed in those treatments which received calcium chloride sprays at highest concentration *i.e.*, 1.5%. In the first as well as in second year the maximum leaf scorching was observed under T_9 (14.933% in 2016 and 14.433% in 2017) which was statistically at par with T_6 and T_3, while no sign of scorching was experienced under other treatments.

The leaf scorching at the highest calcium chloride concentration (1.5%) might be due to the increased chloride level which possibly proved phyotoxic for the leaves. Autio and Bramlage (2014) also observed leaf scorching in apple with calcium chloride spray and associated it with inaccurate sprayer calibration. Similarly, Amiri *et al*. (2009) reported leaf injury in grapevine at highest (2 %) concentration of calcium chloride sprays, at the same time the berries were not affected. The threshold concentration of calcium chloride to cause leaf injuries might depend on plant species and agro-climatic factors possibly due to the variation in defensive mechanism of plants and absorption of nutrients.

Soil nutrient studies:

The perusal of data presented in Table 2 reveals that application of different treatments resulted in

Calcium chloride @ 0.5% **Calcium chloride @ 1.0%** **Calcium chloride @ 1.5%**

Plate 1 : Phytotoxicity (Marginal leaf scorching)

Table 1: Effect of different nitrogen levels through *Neem* coated urea and calcium sprays on leaf nitrogen, phosphorus, potassium and calcium content (%) and on phytotoxicity (Scorched leaves (%) in peach cv. RED JUNE

Treatments	Treatment symbols	Leaf nitrogen content (%)		Leaf phosphorus content (%)		Leaf potassium content (%)		Leaf calcium content (%)		Phytotoxicity scorched leaves (%)	
		2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
375g N per tree + 0.5% Calcium chloride	T_1	2.734^{c}*	2.819^{c}*	0.450^{a}*	0.427^{a}*	2.013^{a}*	2.033^{a}*	1.595^{b}*	1.603^{b}*	0.000^{b}*	0.000^{b}*
375g N per tree + 1.0% Calcium chloride	T_2	2.774^{c}	2.799^{c}	0.419^{a}	0.425^{a}	2.096^{a}	2.110^{a}	1.724^{a}	1.732^{a}	0.000^{b}	0.000^{b}
375g N per tree + 1.5% Calcium chloride	T_3	2.687^{c}	2.839^{c}	0.417^{a}	0.456^{a}	1.987^{a}	2.043^{a}	1.735^{a}	1.744^{a}	14.667^{a}	14.267^{a}
500g N per tree + 0.5% Calcium chloride	T_4	3.226^{b}	3.282^{b}	0.336^{b}	0.360^{b}	1.705^{b}	1.718^{b}	1.271^{d}	1.281^{d}	0.000^{b}	0.000^{b}
500g N per tree + 1.0% Calcium chloride	T_5	3.140^{b}	3.224^{b}	0.349^{b}	0.366^{b}	1.784^{b}	1.796^{b}	1.374^{c}	1.382^{c}	0.000^{b}	0.000^{b}
500g N per tree + 1.5% Calcium chloride	T_6	3.191^{b}	3.286^{b}	0.345^{b}	0.353^{b}	1.710^{b}	1.723^{b}	1.386^{c}	1.395^{c}	14.800^{a}	14.367^{a}
625g N per tree + 0.5% Calcium chloride	T_7	3.666^{a}	3.793^{a}	0.216^{c}	0.258^{c}	1.317^{c}	1.333^{c}	1.133^{f}	1.146^{f}	0.000^{b}	0.000^{b}
625g N per tree + 1.0% Calcium chloride	T_8	3.633^{a}	3.731^{a}	0.205^{c}	0.225^{c}	1.340^{c}	1.363^{c}	1.168^{e}	1.171^{ef}	0.000^{b}	0.000^{b}
625g N per tree + 1.5% Calcium chloride	T_9	3.721^{a}	3.838^{a}	0.238^{c}	0.233^{c}	1.350^{c}	1.369^{c}	1.181^{e}	1.189^{e}	14.933^{a}	14.433^{a}
500g N per tree + Water spray (Control)	T_{10}	3.234^{b}	3.355^{b}	0.348^{b}	0.356^{b}	1.738^{b}	1.764^{b}	0.971^{g}	0.979^{g}	0.000^{b}	0.000^{b}
C.D. (P=0.05)		0.219	0.195	0.033	0.035	0.185	0.196	0.038	0.038	2.030	2.055
S.E.±		0.073	0.065	0.011	0.012	0.062	0.065	0.013	0.013	0.678	0.686

*Values within columns having common letter are statistically at par

Table 2 : Effect of different nitrogen levels through neem coated urea and calcium sprays on available nitrogen, phosphorus, potassium and calcium in soil (kg ha^{-1}) in peach cv. RED JUNE

Treatments	Treatment symbols	Available nitrogen in soil (kg ha^{-1})		Available phosphorus in soil (kg ha^{-1})		Available potassium in soil (kg ha^{-1})		Available calcium in soil (kg ha^{-1})	
		2016	2017	2016	2017	2016	2017	2016	2017
375g N per tree + 0.5% Calcium chloride	T_1	317.390^{c}*	319.550^{c}*	26.285^{a}*	27.510^{a}*	181.153^{a}*	181.653^{a}*	1.305^{a}*	1.296^{a}*
375g N per tree + 1.0% Calcium chloride	T_2	315.137^{c}	316.647^{c}	25.930^{a}	27.770^{a}	181.930^{a}	181.047^{a}	1.262^{a}	1.306^{a}
375g N per tree + 1.5% Calcium chloride	T_3	316.823^{c}	318.230^{c}	25.413^{a}	27.453^{a}	181.343^{a}	181.763^{a}	1.290^{a}	1.325^{a}
500g N per tree + 0.5% Calcium chloride	T_4	332.590^{b}	333.307^{b}	26.053^{a}	26.180^{a}	181.217^{a}	180.220^{a}	1.281^{a}	1.309^{a}
500g N per tree + 1.0% Calcium chloride	T_5	330.080^{b}	330.680^{b}	26.287^{a}	26.420^{a}	181.030^{a}	180.067^{a}	1.289^{a}	1.330^{a}
500g N per tree + 1.5% Calcium chloride	T_6	331.933^{b}	331.857^{b}	26.393^{a}	26.227^{a}	181.740^{a}	180.300^{a}	1.299^{a}	1.331^{a}
625g N per tree + 0.5% Calcium chloride	T_7	345.137^{a}	346.307^{a}	25.603^{a}	26.073^{a}	180.580^{a}	180.270^{a}	1.267^{a}	1.319^{a}
625g N per tree + 1.0% Calcium chloride	T_8	347.547^{a}	349.583^{a}	26.083^{a}	26.193^{a}	180.383^{a}	181.363^{a}	1.292^{a}	1.324^{a}
625g N per tree + 1.5% Calcium chloride	T_9	346.697^{a}	347.057^{a}	25.537^{a}	26.957^{a}	180.897^{a}	180.323^{a}	1.265^{a}	1.314^{a}
500g N per tree + Water spray (Control)	T_{10}	331.997^{b}	332.910^{b}	26.327^{a}	26.563^{a}	181.433^{a}	181.587^{a}	1.278^{a}	1.307^{a}
C.D. (P=0.05)		8.595	6.607	NS	NS	NS	NS	NS	NS
S.E. $\pm$		2.871	2.207	0.816	0.568	1.081	0.791	0.034	0.015

*Values within columns having common letter are statistically at par NS=Non-significant

significant variation for available nitrogen in soil during both the years of study. In first year (2016), the maximum available nitrogen in soil was estimated under T_8 (347.547 kg ha^{-1}) that was statistically at par with T_9 (346.697 kg ha^{-1}) and T_7 (345.137 kg ha^{-1}). In the same year, the minimum value of 315.137 kg ha^{-1} was recorded with T_2 and it varied non significantly with T_1 (317.390 kg ha^{-1}) and T_3 (316.823 kg ha^{-1}). In second year of the experiment, T_8 again possessed the highest available soil nitrogen (349.583 kg ha^{-1}) which was statistically at par to T_9 (347.057 kg ha^{-1}) and T_7 (346.307 kg ha^{-1}). At the same time, the lowest available soil nitrogen was estimated under T_2 (316.647 kg ha^{-1}) which had non significant variation with T_1 (319.550 kg ha^{-1}) and T_3 (318.230 kg ha^{-1}). It is also apparent from the data presented in Table 2 that different nitrogen regimes as well as calcium chloride sprays could not influence the available phosphorus, potassium and calcium in soil significantly during two years of study.

It is manifested from the results described for available soil nutrient status that the applied treatments had significant effect on available soil nitrogen only, whereas the status of other studied nutrient was not affected considerably. Irrespective of calcium chloride sprays, the significant and continuous increase in available soil nitrogen was experienced with increase in nitrogen doses. This might be due to the increased availability of this nutrient in soil under higher nitrogen regimes, whereas the foliarly applied calcium chloride was possibly not involved in changing the soil fertility status. Squires (2013) also documented that soil nitrate concentrations generally increased with greater nitrogen inputs, however soil phosphates were very variable within treatments and did not follow any trend. Our present findings are also in agreement with the previous reports of Garhwal *et al*. (2014) in Kinnow mandarin, Saha *et al*. (2015) in rice and Silva *et al*. (2016) in grapevine.

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