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Foliar Applications of Calcium, Magnesium and Iron Influence Yield and Quality of Guava cv. Sardar

Jitendra Kumar[1]*, Alka Arya[2], Manpreet Singh[1], Shailesh Tripathi[1] and Rajesh Kumar[1]

[1]Department of Horticulture, [2]Department of Soil Science, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand – 263145, India

**Corresponding author*

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A B S T R A C T

The present experiment was conducted to evaluate the effect of foliar sprays of calcium, magnesium and iron to guava trees for rainy season crop. The yield on per hectare basis and total sugar content from fresh fruits was estimated by standard procedures. Study showed that fruit yield and total sugars content increased significantly with foliar application of calcium, magnesium and iron.

Introduction

Guava (*Psidium guajava* L.) is one of the most important fruit crops in the world. It belongs to the family myrtaceae. Guava has the chromosome count of 2n=22. It is grown in tropical, sub-tropical and some parts of arid regions in the world. The guava originated in tropical America, probably in an area extending from Mexico to Peru (Chandler, 1958). It is a very rich source of vitamin-C, carbohydrates, iron and fat, and contains a fair amount of calcium and phosphorous as well, which enhance its nutritional values (Kumar *et al.*, 2017). India is leading producers of guava in the world. Other major guava producing countries in the world are China, Thailand, Mexico, Indonesia, Pakistan and Brazil. In India, guava is cultivated in an area of 265 thousand hectares with production of 4054 thousand MT and productivity of 15.29 MT/ha (Horticultural Statistics, 2018). Major guava producing states in India are Madhya Pradesh, Uttar Pradesh, Bihar, Andhra Pradesh and Maharashtra.

Availability of guava fruits is throughout the year. Although, the yield of rainy season crop is much higher as compared to the winter season crop but the quality of fruits is relatively very poor (Kumar *et al.*, 2015) might be due to loss of nutrients leach in heavy rains. Foliar fertilization could be considerably lucrative when soil nutrient management practices are limiting. Foliar fertilization is an important tool for the sustainable and productive management of crops (Fernandez *et al.,* 2013). Improvement in yield and quality of fruits by foliar application of calcium, magnesium and iron has already been well documented by previous workers (Kumar *et al.*, 2017; Shi *et al.*, 2018; Chater and Garner, 2019). Calcium is required for cell elongation and cell division (Burstrom, 1968). Magnesium has important role in photosynthesis as it is primary constituent of chlorophyll (Hao and Papadopoulos, 2004). Iron has important role in activating biosynthesis of chlorophyll, biosynthesis of cytochromes and transfer of electrons in biological oxidation (Neuweiler *et al.*, 1996). These plant nutrients are directly or indirectly involved in biosynthesis and activation of many enzymes which require in different biochemical processes essential for plant metabolism. Keeping in view these points, the study has been conducted to evaluate the effect of foliar sprays of calcium, magnesium and iron for improving yield and fruit quality of guava.

Materials and Methods

The present investigation was carried out at Horticultural Research Centre, Patharchatta, Department of Horticulture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Udham Singh Nagar (Uttarakhand) during year 2016-17 and 2017-18. Pantnagar is situated in the foot hills of Himalaya at an altitude of 243.84 meters above the mean sea level and lies between 29ºN latitude and 79.3ºE longitude. The region is characterized by humid subtropical climate with maximum temperature ranging from 30°C to 43ºC in summer and minimum ranging from 0 to 9 ºC in winter. The summers are hot and dry, winters are cold and rains are heavy (average rainfall 1400 mm). Monsoon occurs from the third week of June to the middle of September. July and August are the wettest months in the year (mean 350-425 mm rainfall). Frost can be expected from the last week of December to middle of February. Occasionally, light rains are expected during winter (Figure 1). The soil of *Tarai* region have been developed from calcareous, medium to coarse textured materials under predominant influence of tall vegetation and moderate to well drained conditions. The soil of the experimental plot has been classified as series VI (sandy loam under the order Mollisol) of Patharchatta. Soil is moderately dark in colour, well drained and developed from loamy alluvial sediments averaging 0.6 to 1.0 meter thick over loamy sand, sand or gravel (Deshpande *et al.*, 1971).

The guava cv. Sardar was used as experimental material for the present investigation. Its fruits are large, roundish ovate in shape, skin primrose yellow and pulp white, very sweet and tasty. The total soluble solids (TSS) and vitamin C contents are high. The trees are vigorous. Ten year old 63 uniform trees of guava cv. Sardar comprised the plant materials. These plants were planted in a hedge row system of planting at 8 × 4 m^2 distance. All the trees were maintained under uniform cultural operations throughout the period of experiment.

The experiment was laid out under completely Randomized Block Design given by Cochran and Cox (1992). The experiment consisted of 21 treatments (Table 1) which are replicated 3 times. Application of calcium chloride, magnesium sulphate and ferrous sulphate was given to the 10 years aged healthy and uniform trees of guava cv. Sardar. The foliar application of plant nutrients was given as liquid sprays by using knapsack sprayer. Foliar sprays of nutrients were given two times; first just after fruit set and second one month after first spray. The data on the fruit yield per tree was recorded by weighing all the fruits in each treatment, replication wise at the time of harvesting by using the electric balance of 20 kg capacity and calculated on the basis of number of plants per hectare in tons. Total sugars were estimated as described by Ranganna (1986). The significance of variance among the treatments was analyzed by applying the 'F-test' (Fisher, 1935) and critical difference at five percent level was calculated to compare the mean values of treatments for all the characters.

Results and Discussion

Perusal of the data regarding to effect of calcium, magnesium and iron sprays on yield of guava reveals that yield was significantly influenced by the application of calcium, magnesium and iron during both the years 2016 and 2017, and with pooled (Table 2, Figure 2). During 2016-17, the data pertaining to yield of guava showed that maximum yield (13.49 t/ha) was recorded with the treatment T_{21} [$FeSO_4$ (0.6%) + $CaCl_2$ (0.6%) + $MgSO_4$ (0.6%)] followed by T_{20} (11.64 t/ha). Whereas, minimum yield (9.23 t/ha) was observed under the treatment T_1 (control) which was statistically at par with T_2, T_3, T_4, T_5, T_6, T_7, T_8, T_{11}, T_{14}, T_{15}, T_{16} and T_{19}. However, rest of the treatments had significantly higher yield.

During 2017-18, maximum yield (14.06 t/ha) was recorded under the treatment T_{21} [$FeSO_4$ (0.6%) + $CaCl_2$ (0.6%) + $MgSO_4$ (0.6%)] which was statistically at par with T_{20}. However, rest of the treatments had significantly lower yield. Whereas, minimum yield (8.71 t/ha) was observed with the treatment T_1 (control). Analysis of pooled means of both the years 2016-17 and 2017-18 indicates that maximum yield (13.78 t/ha) was recorded with the treatment T_{21}. Whereas, minimum yield (8.97 t/ha) was observed with the treatment T_1 (control).

Magnesium has been reported to have important role in increasing overall plant growth and yield due to its stimulatory effect on plant metabolism (Devlin, 1966). Also the growth and yield might have been augmented due to higher synthesis of nucleic acid. Magnesium also participates in enzymatic activities involved in protein synthesis and cell multiplication. The increase in the yield in magnesium treated plants may be on account of maximum availability of plant metabolism (Bangali *et al.*, 1993). The present study is in line with the findings of Majer (2004) who reported that the application of magnesium increased fruit yield in grapevine. According to Chaturvedi *et al.*, (2005), iron in combination with zinc has been reported to increase the yield of strawberry. Bhoyar and Ramdevputra (2016) noticed that 0.5% ferrous sulphate application recorded maximum yield in guava cv. Sardar than zinc and borax. Iron deficiency causes decreases in fruit yield and quality peach (Almaliotis *et al.*, 1995). According to Zaiter *et al.*, (1993), significant increases in yield of strawberry cultivars were obtained when they were sprayed with iron. Similar findings have also been reported in pear by Alvarez-Fernandez *et al.*, (2011), by El-Kassas (1984) in citrus, by Yadav *et al.*, (2013) in peach and by Jagtap *et al.*, (2013) in acid lime.

The data on total sugars mentioned in Table 2 and Figure 3 showed that total sugars were significantly influenced by the application of calcium, magnesium and iron during both the years 2016-17 and 2017-18, and with pooled. During 2016-17, maximum total sugars (6.94%) was recorded with the treatment T_{21} [$FeSO_4$ (0.6%) + $CaCl_2$ (0.6%) + $MgSO_4$ (0.6%)] which was statistically at par with the treatments T_9, T_{10}, T_{12}, T_{13}, T_{17}, T_{18} and T_{20}. However, rest of the treatments had significantly lower total sugars. Whereas, minimum total sugars (4.65%) was observed with the treatment T_1 (control).

Table.1 Details of the treatments

Treatments	Details
T_1	Control
T_2	$CaCl_2$ (0.3%) + $MgSO_4$ (0.3%)
T_3	$CaCl_2$ (0.3%) + $MgSO_4$ (0.6%)
T_4	$CaCl_2$ (0.6%) + $MgSO_4$ (0.3%)
T_5	$CaCl_2$ (0.6%) + $MgSO_4$ (0.6%)
T_6	$FeSO_4$ (0.3%) + $MgSO_4$ (0.3%)
T_7	$FeSO_4$ (0.3%) + $MgSO_4$ (0.6%)
T_8	$FeSO_4$ (0.3%) + $CaCl_2$ (0.3%)
T_9	$FeSO_4$ (0.3%) + $CaCl_2$ (0.3%) + $MgSO_4$ (0.3%)
T_{10}	$FeSO_4$ (0.3%) + $CaCl_2$ (0.3%) + $MgSO_4$ (0.6%)
T_{11}	$FeSO_4$ (0.3%) + $CaCl_2$ (0.6%)
T_{12}	$FeSO_4$ (0.3%) + $CaCl_2$ (0.6%) + $MgSO_4$ (0.3%)
T_{13}	$FeSO_4$ (0.3%) + $CaCl_2$ (0.6%) + $MgSO_4$ (0.6%)
T_{14}	$FeSO_4$ (0.6%) + $MgSO_4$ (0.3%)
T_{15}	$FeSO_4$ (0.6%) + $MgSO_4$ (0.6%)
T_{16}	$FeSO_4$ (0.6%) + $CaCl_2$ (0.3%)
T_{17}	$FeSO_4$ (0.6%) + $CaCl_2$ (0.3%) + $MgSO_4$ (0.3%)
T_{18}	$FeSO_4$ (0.6%) + $CaCl_2$ (0.3%) + $MgSO_4$ (0.6%)
T_{19}	$FeSO_4$ (0.6%) + $CaCl_2$ (0.6%)
T_{20}	$FeSO_4$ (0.6%) + $CaCl_2$ (0.6%) + $MgSO_4$ (0.3%)
T_{21}	$FeSO_4$ (0.6%) + $CaCl_2$ (0.6%) + $MgSO_4$ (0.6%)

Table.2 Effect of calcium, magnesium and iron on yield (t/ha) of guava cv. Sardar

Treatments	Yield (t/ha)			Total Sugars (%)		
	2016	2017	Pooled	2016	2017	Pooled
T_1	9.23	8.71	8.97	4.65	4.64	4.65
T_2	10.65	11.38	11.01	5.01	5.01	5.01
T_3	10.32	11.26	10.79	5.13	5.23	5.18
T_4	10.74	11.36	11.05	5.15	5.28	5.21
T_5	9.99	10.82	10.41	5.26	5.89	5.58
T_6	11.08	11.60	11.34	5.03	5.10	5.07
T_7	10.08	11.05	10.57	5.16	5.30	5.24
T_8	10.03	11.07	10.54	5.07	5.15	5.11
T_9	11.32	12.13	11.73	6.23	6.35	6.29
T_{10}	11.33	12.16	11.74	6.49	6.43	6.46
T_{11}	10.45	10.76	10.60	5.18	5.35	5.27
T_{12}	11.06	11.63	11.35	6.56	6.44	6.50
T_{13}	11.10	11.82	11.46	6.73	6.67	6.70
T_{14}	10.27	10.62	10.45	5.18	5.41	5.29
T_{15}	10.17	10.69	10.43	5.28	6.04	5.66
T_{16}	10.32	10.94	10.63	5.20	5.63	5.42
T_{17}	10.92	11.80	11.36	6.63	6.58	6.60
T_{18}	11.10	11.62	11.36	6.77	6.79	6.78
T_{19}	10.13	10.68	10.40	5.38	6.23	5.80
T_{20}	11.64	12.47	12.05	6.89	6.89	6.89
T_{21}	13.49	14.06	13.78	6.94	7.00	6.97
C.D. at 5% level of significance	1.78	1.88	1.26	1.00	1.04	0.64
SEm±	0.62	0.66	0.44	0.35	0.36	0.23

Fig.1 Monthly average weather data during 2016 and 2017

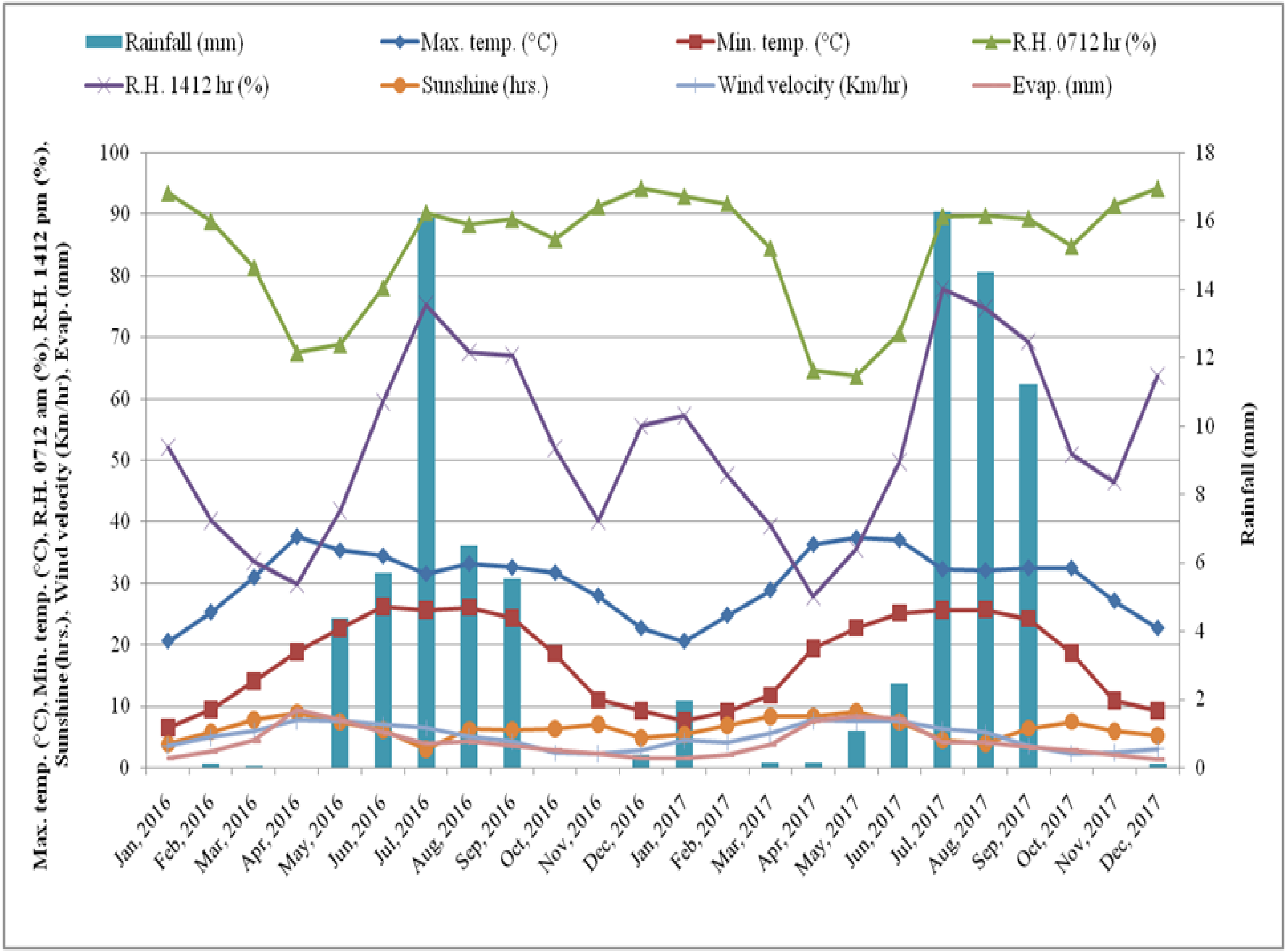


Fig.2 Effect of calcium, magnesium and iron on yield (t/ha) of guava cv. Sardar

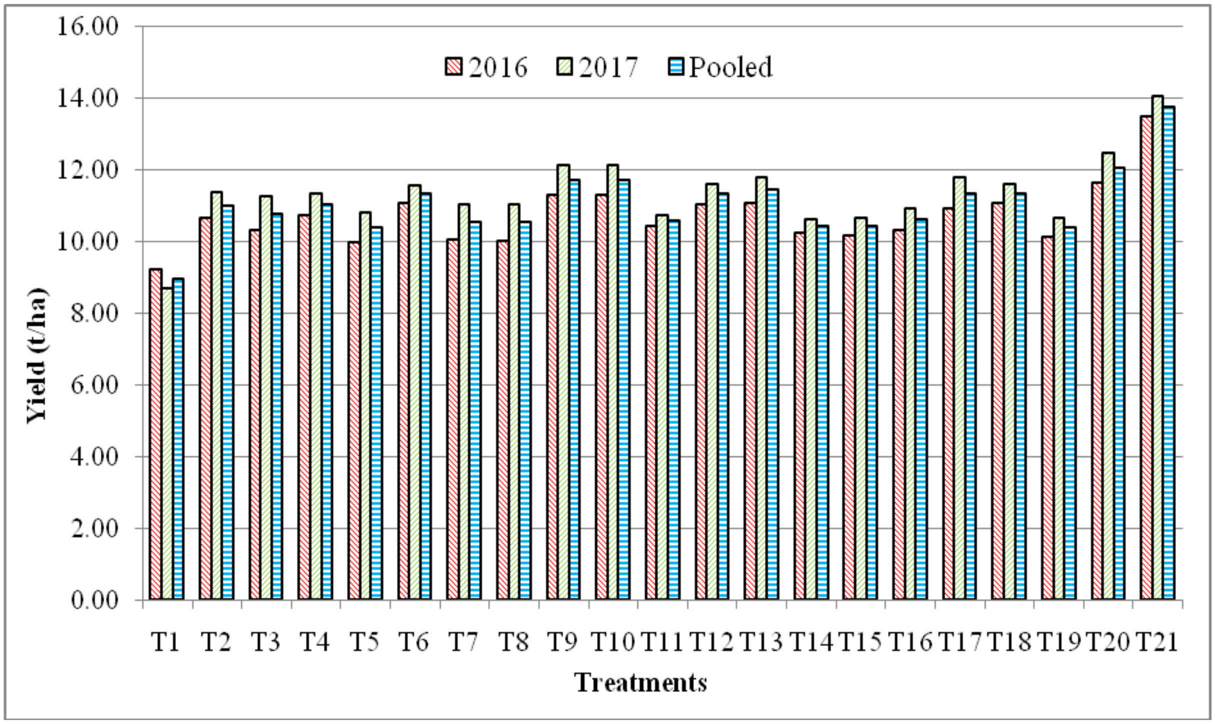
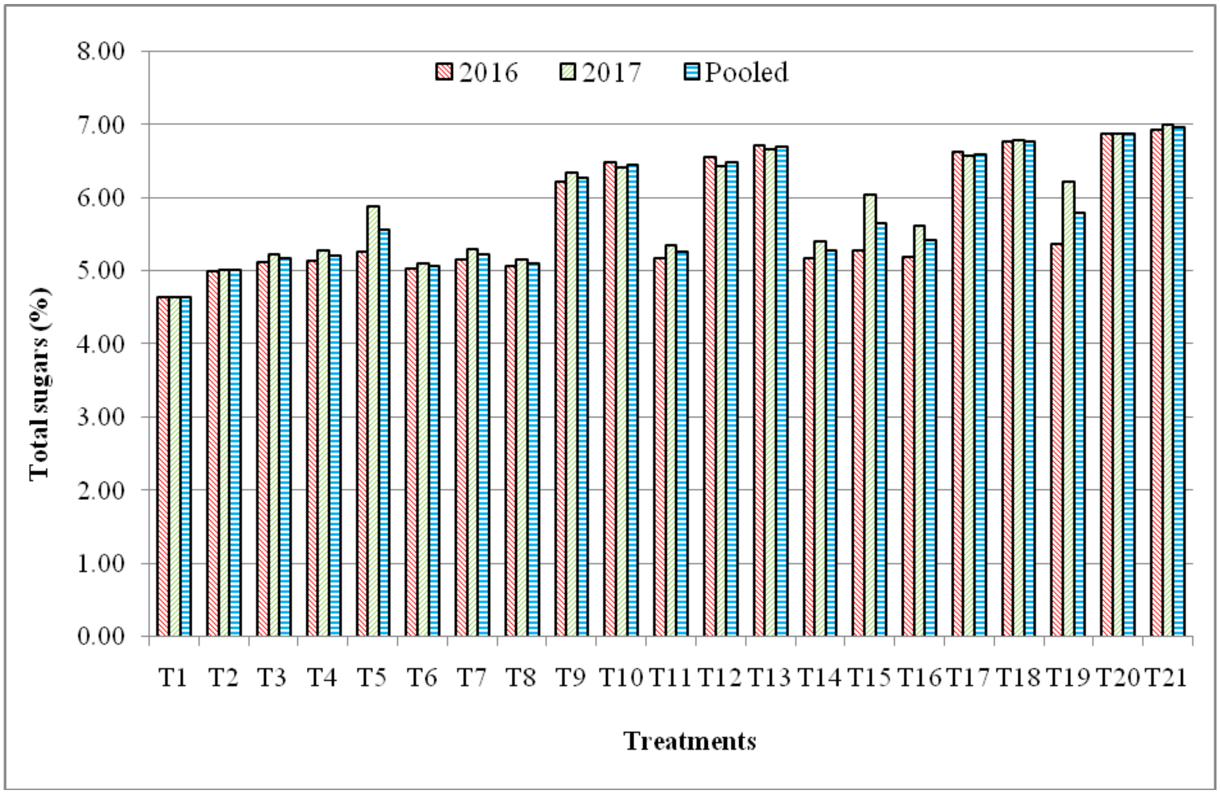


Fig.3 Effect of calcium, magnesium and iron on total sugars (%) of guava cv. Sardar



Data for the year 2017-18 showed that maximum total sugars (7.00%) was recorded with the treatment T_{21} [$FeSO_4$ (0.6%) + $CaCl_2$ (0.6%) + $MgSO_4$ (0.6%)] which was statistically at par with the treatments T_9, T_{10}, T_{12}, T_{13}, T_{15}, T_{17}, T_{18}, T_{19} and T_{20}. However, rest of the treatments had significantly lower total sugars. Whereas, minimum total sugars (4.64%) was recorded with the treatment T_1 (control). Analysis of the pooled data indicates that maximum total sugars (6.97%) was recorded with the treatment T_{21} [$FeSO_4$ (0.6%) + $CaCl_2$ (0.6%) + $MgSO_4$ (0.6%)] which was statistically at par with the treatments T_9, T_{10}, T_{12}, T_{13}, T_{17}, T_{18} and T_{20}. However, rest of the treatments had significantly lower total sugars. Whereas, minimum total sugars (4.65%) was observed with the treatment T_1 (control).

The increase in total sugars may be because of an increase in reducing sugars and non-reducing sugar resulting from conversion of starch into simple sugar. This conversion of starch into sugars is mediated by amylases and involvement of calcium ions in activation and regulation enzymes is documented by Bush *et al.,* (1989). The present results are in agreement with the findings of Bisen *et al.*, (2014), who reported that calcium alone or in combination increased total sugars when applied as pre-harvest foliar application on guava. According to Ghosh and Besra (2000), highest total sugar content was recorded when iron was sprayed along with zinc and boron in sweet orange. The investigation of Babu and Yadav (2005) also supported the present results as they noticed a significant increase in total sugars in Khasi mandarin when sprayed with 0.5 per cent each of magnesium, manganese and zinc.

The present study reveals that two times foliar application of 0.6 per cent each of calcium, magnesium and iron as calcium chloride, magnesium sulphate and ferrous sulphate respectively, just after fruit set and again after one month can improve fruit yield and quality of fruits in terms of enhanced total sugars content.

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