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Correlation amongst yield and quality attributes of guava fruit in response to foliar feeding of zinc and iron in Vertisols of Jhalawar district

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Abstract
Correlation studies among yield and quality of guava fruit to zinc and iron status of leaf. The yield and quality attributes viz. number of fruits per plant, fruit length, fruit diameter, fruit weight, fruit volume, estimated yield per plant, estimated yield q/ha., total soluble solids, total sugars, reducing sugars, non-reducing sugars, seed cavity, ascorbic acid, pulp weight and total phenols exhibited significant and positive correlation with Zn and Fe concentration of guava leaves. However, specific gravity, acidity percentage, number of seeds per fruit and seed weight attributes exhibited significant and negative correlation with Zn and Fe concentration of guava cv.L-49 leaves. Correlation studies are very useful and important tool to interpret the trend and positive inter-relationships amongst morphological, biochemical and nutrient status of guava trees.

Keywords: Iotal soluble solids, fruit weight, reducing sugar, pulp weight, total phenols

Introduction
Guava (*Psidium guajava* L.) is one of the most common and popular fruit grown in tropical and sub-tropical niches of India and it belongs to the family Myrtaceae. It is the fourth most important fruit in area after mango, banana and citrus and in production after banana, mango and citrus. It is classified under genus *Psidium* which contains 150 species but only *Psidium guajava* is exploited commercially. It is cultivated in India since early 17th century. Due to its wider edapho-climatic adaptability in diverse soils and diverse agro-climatic regions, low cost of the cultivation, prolific bearing and being highly remunerative with nutraceutical values and biomass, it has gained tremendous popularity among the fruit growers. Zinc being a supporting micronutrient and is actively required for enhancement of tryptophan synthesis. Zinc is an essential micro-nutrient involved in key enzymatic reactions and acts as co-factor for number of essential enzymes. Zinc plays a pivotal role in regulating the protein and carbohydrate metabolism. Likewise, zinc also increases the chlorophyll content of leaves and essential for enzyme activities like catalase, peroxidase and cytochrome chlorophyll oxidase. Iron plays a key role in crucial metabolic processes such as DNA synthesis, respiration and oxidation-reduction reaction in the plant system. The critical importance of iron and its role in the plant metabolism cannot be under estimated. Plants needs sufficient iron to produce chlorophyll and to activate several enzymes including those involved in the oxidation reduction processes of photosynthesis and respiration. Zinc and iron concentrations within range of 50-100 ppm are often quoted as satisfactory leaf analysis values for guava crop for sustaining augmentation in growth and productivity of guava trees.

Materials and Methods
The experiment entitled correlation studies among yield and quality of guava cv. L-49 fruits in response to foliar feeding of zinc and iron status of leaf was conducted during the June, 2019 to December, 2019, at the Fruit Instructional Farm, Department of Fruit Science, College of Horticulture and Forestry, Jhalawar. The foliar application of zinc and iron with 16 treatments: To (Control), T_1 ($ZnSO_4$ 0.20%), T_2 ($ZnSO_4$ 0.40%), T_3 ($ZnSO_4$ 0.60%), T_4 ($FeSO_4$ 0.20%), T_5FeSO_4 (0.40%), T_6FeSO_4 (0.60%), T_7 ($ZnSO_4$ 0.20% + $FeSO_4$ 0.20%), T_8 ($ZnSO_4$ 0.20% + $FeSO_4$ 0.40%), T_9 ($ZnSO_4$ 0.20% + $FeSO_4$ 0.60%), T_{10} ($ZnSO_4$ 0.40% + $FeSO_4$ 0.20%), T_{11} ($ZnSO_4$ 0.40% + $FeSO_4$ 0.20%), T_{12} ($ZnSO_4$ 0.40% + $FeSO_4$ 0.60%), T_{13} ($ZnSO_4$ 0.60% +

$FeSO_4$ 0.20%), T_{14} ($ZnSO_4$ 0.60% + $FeSO_4$ 0.40%), T_{15} ($ZnSO_4$ 0.60% + $FeSO_4$ 0.60%). The experiment was laid down in randomized block design with four replications. The present investigations were undertaken at Fruit Instructional Farm, College of Horticulture and Forestry, Jhalawar on nine years old plants of guava cv. L- 49 planted at spacing of 6 X 6 meter under square system of planting. The total number of plants included in the experiment was 64. All the selected guava plants were selected on the basis of desired uniformity in growth and vigour. All the treatments were applied in two sprays, first spray 25th June and second spray 25th July, 2019. Correlation analysis was done after completion of all plant growth, yield and biochemical parameters with standard methods and subsequently data were analyzed for multiple correlations as suggested by Panse and Sukhatme (1985) [1].

Results and Discussion

Correlation among yield parameters to zinc and iron status of guava leaf cv. L-49:

Correlation among yield parameters to zinc and iron status of guava leaf cv. L-49 are presented in table 1. The attribute number of fruit per plant exhibited significant and positive correlation with fruit length (r = 0.812**), fruit diameter (r = 0.913**), fruit weight (r = 0.935**), fruit volume (r = 0.915**), estimated yield per plant (r = 0.954**) and estimated yield q/hectare (r = 0.954**). Fruit length exhibited significant and positive correlation with various attribute including number of fruit / plant (r = 0.812**), fruit diameter (r = 0.772**), fruit weight (r = 0.813**), fruit volume (r = 0.829 **), estimated yield per plant (r = 0.818**) and estimated yield q / hectare (r = 0.818**). However, fruit length exhibited significant and negative correlation with specific gravity (r = -0.520*). Fruit diameter exhibited significant and positive correlation with number of fruit per plant (r = 0.913**), fruit length (r = 0.772**), fruit weight (r = 0.977**), fruit volume (r = 0.965**), estimated yield per plant (r = 0.978**) and estimated yield q/hectare (r = 0.978**). Fruit weight exhibited significant and positive correlation with number of fruit per plant (r = 0.935**), fruit length (r = 0.813**), fruit diameter (r = 0.977**), fruit volume (r = 0.986**), estimated yield per plant (r = 0.998**) and estimated yield q/hectare (r = 0.998**).Fruit volume exhibited significant and positive correlation with number of fruit per plant (r = 0.915**), fruit length (r = 0.829**), fruit diameter (r = 0.965**), fruit weight (r = 0.986**), estimated yield per plant (r = 0.984**) and estimated yield q/hectare (r = 0.984**).Specific gravity exhibited significant and negative correlation with fruit length (r = -0.520*). Estimated yield per plant exhibited significant and positive correlation with number of fruit per plant (r = 0.954**), fruit length (r = 0.818**), fruit diameter (r = 0.978**), fruit weight (r = 0.998**), fruit volume (r = 0.984**) and estimated yield q/hectare (r = 1.000**). Estimated yield q/hectare exhibited significant and positive correlation with number of fruit per plant (r = 0.954**), fruit length (r = 0.818**), fruit diameter (r = 0.978**), fruit weight (r = 0.998**), fruit volume (r = 0.984**) and estimated yield per plant (r = 1.000**).

Correlation among quality of guava fruit to zinc and iron status of leaf cv. L-49

Correlation among yield parameters to zinc and iron status of guava leaf cv. L-49 are presented in table 2. The attribute total soluble solids exhibited significantly and positive correlation with total sugar (r = 0.997 **), reducing sugar (r = 0.900**), non-reducing sugar (r = 0.990**), seed cavity diameter (r = 0.698**), ascorbic acid (r = 0.838**), pulp weight (r = 0.721**), total phenols (r =0.796**), final Zn value (r = 0.738**) and final Fe value (r = 0.784**). However, total soluble solids exhibited significant and negative correlation with number of seeds per fruit (r = -0.796**) seed weight (r = -0.719**). Acidity exhibited significantly and positive correlation with number of seed per fruit (r = 0.570*) and seed weight (r = 0.697**). However, exhibited significantly and negative correlation with pulp weight (r = -0.602*)**.** Total sugar exhibited significantly and positive correlation with reducing sugar (r = 0.992**), non-reducing sugar (r = 0.992**), seed cavity diameter (r = 0.686**), ascorbic acid (r = 0.844**), pulp weight (r = 0.722**), total phenols (r =0.792**), final Zn value (r = 0.727**) and final Fe value (r = 0.776**). However, total sugar exhibited significant and negative correlation with number of seeds per fruit (r = -0.804**) seed weight (r = -0.737**). Reducing sugar exhibited significantly and positive correlation with total sugar (r = 0.992**), non-reducing sugar (r = 0.969**), seed cavity diameter (r = 0.743**), ascorbic acid (r = 0.878**), pulp weight (r = 0.781**), total phenols (r =0.839**), final Zn value (r = 0.779**) and final Fe value (r = 0.821**). However, reducing sugar exhibited significant and negative correlation with number of seeds per fruit (r = -0.853 **) seed weight (r = -0.784 **). Non-reducing sugar exhibited significantly and positive correlation with total sugar (r = 0.992**), reducing sugar (r = 0.969**), seed cavity diameter (r = 0.615*), ascorbic acid (r = 0.794**), pulp weight (r = 0.647**), total phenols (r =0.730**), final Zn value (r = 0.659**) and final Fe value (r = 0.715**). However, non–reducing exhibited significant and negative correlation with number of seeds per fruit (r = -0.742**) seed weight (r = -0.676**).Seed cavity exhibited significantly and positive correlation with total sugar (r = 0.686**), reducing sugar (r = 0.743**), non-reducing sugar (r = 0.615*), ascorbic acid (r = 0.774**), pulp weight (r = 0.935**), total phenols (r =0.920**), final Zn value (r = 0.933**) and final Fe value (r = 0.951**). However, seed cavity exhibited significant and negative correlation with number of seeds per fruit (r = -0.629 **) seed weight (r = -0.613*).Number of seed per fruit significantly and positive correlation with seed weight (r = 0.930**). However, number of seed per fruit exhibited significant and negative correlation with total sugar (r = -0.804 **), reducing sugar (r = -0.853**), non-reducing sugar (r = -0.742**), seed cavity diameter (r = -0.629**), ascorbic acid (r = -0.833**), pulp weight (r = -0.775**), total phenols (r = -0.767**), final Zn value (r = -0.709**) and final Fe value (r = -0.716**)**.**Seed weight significantly and positive correlation with number of seed per fruit (r = 0.930**). However, seed weight exhibited significant and negative correlation with total sugar (r = -0.737 **), reducing sugar (r = -0.784**), non-reducing sugar (r = -0.676**), seed cavity diameter (r = -0.613**), ascorbic acid (r = -0.797**), pulp weight (r = -0.803**), total phenols (r = -0.766**), final Zn value (r = -0.644**) and final Fe value (r = -0.675**)**.** Ascorbic acid exhibited significantly and positive correlation with total sugar (r = 0.844**), reducing sugar (r = 0.878**), non-reducing sugar (r = 0.794*), seed cavity diameter (r = 0.774**), pulp weight (r = 0.826**), total phenols (r =0.825**), final Zn value (r = 0.812**) and final Fe value (r = 0.833**). However, ascorbic acid exhibited significant and negative correlation with number of seeds per fruit (r = -0.833 **) seed weight (r = -0.797**).Pulp weight exhibited

significantly and positive correlation with total sugar (r = 0.722 **), reducing sugar (r = 0.781**), non-reducing sugar (r = 0.647*), seed cavity diameter (r = 0.935**), ascorbic acid (r = 0.826**), total phenols (r =0.967**), final Zn value (r = 0.903**) and final Fe value (r = 0.945**). However, pulp weight exhibited significant and negative correlation with number of seeds per fruit (r = -0.775 **) seed weight (r = -0.803**). Total phenols exhibited significantly and positive correlation with total sugar (r = 0.792**), reducing sugar (r = 0.839**), non-reducing sugar (r = 0.730*), seed cavity diameter (r = 0.920**), ascorbic acid (r = 0.825**) pulp weight (r = 0.967**), final Zn value (r = 0.922**) and final Fe value (r = 0.962**). However, total phenols exhibited significant and negative correlation with number of seeds per fruit (r = -0.767**) seed weight (r = -0.766**).Final Zn value exhibited significantly and positive correlation with total sugar (r = 0.727**), reducing sugar (r = 0.779**), non-reducing sugar (r = 0.659*), seed cavity diameter (r = 0.933**), ascorbic acid (r = 0.812**) pulp weight (r = 0.903**), totals phenols (r = 0.922**) and final Fe value (r = 0.980**). However, final Zn value exhibited significant and negative correlation with number of seeds per fruit (r = -0.709**) seed weight (r = -0.644**). Final Fe value exhibited significantly and positive correlation with total sugar (r = 0.776**), reducing sugar (r = 0.821**), non-reducing sugar (r = 0.715*), seed cavity diameter (r = 0.951**), ascorbic acid (r = 0.833**) pulp weight (r = 0.945**), total phenols (r = 0.962**) and final Zn value (r = 0.980**) However, final Fe value exhibited significant and negative correlation with number of seeds per fruit (r = -0.716**) seed weight (r = -0.675**).

Table 1: Correlation among yield parameters to zinc and iron status of guava leaf cv. L-49

	Number of fruits/plant	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Fruit volume (ml)	Specific gravity (g/cc)	Estimated yield/plant (kg)	Estimated q/hectare
Number of fruits/plant	1							
Fruit length (cm)	.812**	1						
Fruit diameter (cm)	.913**	.772**	1					
Fruit weight (g)	.935**	.813**	.977**	1				
Fruit volume (ml)	.915**	.829**	.965**	.986**	1			
Specific gravity (g/cc)	-.333	-.520*	-.346	-.362	-.412	1		
Estimated yield/plant (kg)	.954**	.818**	.978**	.998**	.984**	-.350	1	
Estimated q/hectare	.954**	.818**	.978**	.998**	.984**	-.349	1.000**	1

* Correlation is significant at the 0.05 level

** Correlation is significant at the 0.01 level

Table 2: Correlation among quality of fruit to zinc and iron status of guava leaf cv. L-49

	Total soluble solids (^{0}brix)	**Acidity (%)**	**Total sugar (%)**	**Reducing sugar (%)**	**Non-reducing sugar (%)**	**Seed cavity diameter (cm)**	**No. of seeds/fruit**	**Seed weight (g)**	**Ascorbic acid (mg/100g pulp)**	**Pulp weight (g)**	**Total phenols (mg GAE/100g)**	**Final values Zn (ppm)**	**Final values Fe (ppm)**
1	1												
2	-.390	1											
3	.997**	-.404	1										
4	.990**	-.432	.992**	1									
5	.990**	-.369	.992**	.969**	1								
6	.698**	-.427	.686**	.743**	.615*	1							
7	-.796**	.570*	-.804**	-.853**	-.742**	-.629**	1						
8	-.719**	.697**	-.737**	-.784**	-.676**	-.613*	.930**	1					
9	.838**	-.496	.844**	.878**	.794**	.774**	-.833**	-.797**	1				
10	.721**	-.602*	.722**	.781**	.647**	.935**	-.775**	-.803**	.826**	1			
11	.796**	-.470	.792**	.839**	.730**	.920**	-.767**	-.766**	.825**	.967**	1		
12	.738**	-.354	.727**	.779**	.659**	.933**	-.709**	-.644**	.812**	.903**	.922**	1	
13	.784**	-.412	.776**	.821**	.715**	.951**	-.716**	-.675**	.833**	.945**	.962**	.980**	1

1-Total soluble solids, 2- Acidity, 3- Total sugars, 4-Reducing sugars, 5- Non reducing sugars, 6- Seed cavity diameters, 7- No. of seed/fruit, 8-Seed weight, 9- Ascorbic acid, 10-Pulp weight, 11- Total phenols, 12- Final zinc value, 13- Final iron value

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