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Growth attributes of guava (*Psidium guajava* L.) cv. Hisar Safeda as effected by soil application of zinc sulphate and ferrous sulphate

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Abstract
The work was undertaken to see the effect of soil application of zinc sulphate (zero, 30, 60 and 90 g/plant) and ferrous sulphate (zero, 10, 20 and 30 g/plant) on the growth parameters of 8 years old plants of guava cv. Hisar Safeda planted at 6m × 2m spacing. Application of 90 g zinc sulphate per plant showed maximum increase in plant height, plant spread (both directions) as well as stem girth, while shoot length was found maximum with 60 g zinc sulphate. Maximum plant height, stem girth and plant spread (E-W) was succeeded under 20 g ferrous sulphate treatment, whereas shoot length and increase in plant spread (N-S) was found maximum with 10 g ferrous sulphate application, which was at par with 30 g ferrous sulphate.

Keywords: Soil application, zinc sulphate, ferrous sulphate, guava, growth

Introduction
Guava (*Psidium guajava* L.) belongs to the family Myrtaceae and has originated in Tropical America. It was introduced in India by Portuguese in the early seventeenth century. Guava has good taste, pleasant flavour, high nutritive value and is rich source of vitamin C (Siddiqui *et al*., 2005) [1]. It is also considered as remunerative fruit as it gives good returns without much care and input. It is hardy in nature and bears plentiful even on marginal lands. In terms of area and production, guava is the fifth most important fruit crop of India after mango, banana, citrus and papaya (Saxena and Rao, 2017) [2]. In India, it has occupied an area of 254.9 thousand hectare with annual production and productivity of 4047.8 thousand metric tons and 15.87 MT per hectare respectively. The area under guava in Haryana is 12.08 thousand hectare with 137.02 thousand tones production and 11.34 tonnes per hectare productivity (Anonymous, 2017) [3]. Sonipat, Karnal, Mewat, Hisar and Yamunanagar are the major guava producing districts of Haryana. It can be cultivated in assorted type of soils ranging from heavy clay to very light sandy soil and performs well in wide soil pH range of 4.5-8.2. The roots of the guava tree uptake majority of the nutrients from upper 25 cm soil depth. Thus, the surface soil should be fertile enough such that it provides essential nutrients for promoting the new growth (Chadha, 2001) [4]. Fertilizers containing only macronutrients like N, P and K are mainly used by farmers. Thus, problem regarding deficiency of micronutrients is being faced. Among these micronutrients, zinc and iron are most important. The present stuudy was conducted to determine the effect of zinc sulphate and ferrous sulphate on growth attributes of guava (*Psidium guajava* L.) cv. Hisar Safeda.

Material methodology
Experiment was conducted on 8 years old guava plants planted at 6m × 2m spacing in the orchard of the Department of Horticulture, CCS Haryana Agricultural University, Hisar. There were 16 combinations of four levels each of zinc sulphate (zero, 30, 60 and 90 g/plant) and ferrous sulphate (zero, 10, 20 and 30 g/plant). Half dose of zinc and iron was applied in February and rest half in August in the soil. The experiment was designed in randomized block with three replications of each. Forty eight uniform plants were selected for the experiment and plants were maintained under uniform orchard management conditions and all the agronomic practices were carried out as per package of practices. Standard prescribed methods were used for recording growth parameters.

Results

Per cent increase in plant height

The data expressed in Table 1 shows that plant height showed significant increase with zinc sulphate application. Application of 90 g zinc sulphate per plant showed maximum increase in plant height (10.34%), which was significantly higher than all other treatments except 60 g zinc sulphate application per plant, while minimum increase in plant height (9.68%) was shown by plants under control treatment. Increase in plant height may be due to zinc being involved in formation of tryptophan, which acts as precursor for auxin production that might have resulted in increase in apical growth. The results find conformity with the outcome of Yadav *et al.* (2007) [5] in Sweet orange cv. Jaffa. They observed that soil application of zinc sulphate @ 250 g per plant led to maximum increase in height. Similar results were obtained by Kumar *et al.* (2015) [6] in 'Pant Prabhat' guava and Baloda (1999) [7] in Kinnow mandarin. Ferrous sulphate treatments also showed significant increase in plant height. Maximum increase in height (10.31%) was shown by plants supplied with 20 g ferrous sulphate per plant, which was at par with 30 g ferrous sulphate and significantly higher than all other treatments and minimum (9.78%) was recorded in control treatment. This might be because iron plays an important role in the activation of chlorophyll and in the synthesis of many proteins such as different cytochromes, which participate in different functions in the plant metabolism. The results are in line with the outcome of Yadav *et al.*(2014)[8] who revealed significant increase in plant height of pomegranate with application of ferrous sulphate @ 0.2 per cent and 0.4 per cent. The interaction effect of different doses of zinc sulphate and ferrous sulphate for per cent increase in plant height was found to be non-significant.

Table 1: Effect of zinc sulphate and ferrous sulphate on per cent increase in plant height of guava cv. Hisar Safeda

$ZnSO_4$ (g/plant)	$FeSO_4$ (g/plant)				
	Zero	10	20	30	**Mean**
Zero	9.27	9.61	9.93	9.90	9.68
30	9.70	10.01	10.29	10.27	10.07
60	10.07	10.27	10.50	10.44	10.32
90	10.09	10.27	10.53	10.46	10.34
Mean	9.78	10.04	10.31	10.27	
CD at 5%	Zn= 0.17, Fe= 0.17, Zn × Fe= NS				

Per cent increase in stem girth

It is evident from the data presented in Table 2 that zinc sulphate had significant effect on per cent increase in stem girth. Maximum per cent increase in stem girth (11.67%) was observed in plants with 90 g zinc sulphate application which was at par with 60 g zinc sulphate and significantly higher than all other treatments and minimum (11.19%) was noted under control treatment. The results are in contradiction with the findings of Kumar *et al.* (2015) [6] in 'Pant Prabhat' guava that stem girth was not significantly affected with application of zinc. Similarly, non-significant results were obtained by Bahadur *et al.* (1998) [9] in mango and Walworth and Pond (2009) [10] in 'Wichita' pecan trees. Ferrous sulphate application also showed significant impact on stem girth. Maximum per cent increase in stem girth (11.65 %) was shown with 20 g ferrous sulphate per plant, which was significantly higher than all other treatments except 30 g ferrous sulphate and minimum (11.17%) was shown by control treatment. The interaction effect of zinc sulphate and ferrous sulphate regarding per cent increase in stem girth could not attain the level of significance.

Table 2: Effect of zinc sulphate and ferrous sulphate on percent increase in stem girth of guava cv. Hisar Safeda

$ZnSO_4$ (g/plant)	$FeSO_4$ (g/plant)				
	Zero	10	20	30	**Mean**
Zero	10.92	11.13	11.36	11.33	**11.19**
30	11.14	11.34	11.55	11.51	**11.38**
60	11.29	11.61	11.83	11.80	**11.63**
90	11.32	11.64	11.87	11.83	**11.67**
Mean	11.17	11.43	11.65	11.62	
CD at 5%	Zn= 0.17, Fe= 0.17, Zn × Fe= NS				

Per cent increase in plant spread

The data presented in Table 3&4 revealed that zinc sulphate showed significant increase in plant spread in N-S as well as E-W direction. Maximum increase in plant spread in N-S direction (6.51%) as well as in E-W direction (7.63%) was found with 90 g zinc sulphate, which was at par with 60 g zinc sulphate and significantly higher than all other treatments. Minimum increase was shown by control treatment, both in N -S direction (6.12%) and in E -W direction (7.24%). Zinc is reported to promote synthesis of tryptophan which serves as precursor for auxin synthesis. Therefore, zinc sulphate might have enhanced the spread of plants. These findings are in close agreement with the results of Yadav *et al.*(2007)[5] who stated that maximum plant spread (10.78%) in Sweet orange cv. Jaffa was recorded with application of zinc sulphate @ 250 g per plant. Similar results were obtained by Yadav *et al.*(2014)[8] in pomegranate and Baloda (1999)[7] in Kinnow mandarin. Per cent increase in plant spread was also significantly affected by ferrous sulphate application. Maximum increase in plant spread in N-S direction (6.50%) was observed with application of 30 g ferrous sulphate, which was at par with 10 g ferrous sulphate treatment and significantly higher than all other treatments. While in E-W direction, maximum increase in plant spread (7.64%) was observed with 20 g ferrous sulphate treatment, which was closely followed by 30 g ferrous sulphate and significantly higher than all other treatments. Minimum increase in plant spread (6.04%) in N-S direction as well as in E-W direction (7.21%) was observed with control treatment. This may be due to increase in plant metabolism by iron *via* activation of chlorophyll. Earlier such findings were reported by Yadav *et al.*(2014)[8] in pomegranate where they observed significant increase in plant spread over control with application of ferrous sulphate @ 0.2 and 0.4 per cent. No significant effect was observed with interaction of different zinc sulphate and ferrous sulphate on plant spread.

Table 3: Effect of zinc sulphate and ferrous sulphate on per cent increase in plant spread (%) [N-S] of guava cv. Hisar Safeda

$ZnSO_4$ (g/plant)	$FeSO_4$ (g/plant)				
	Zero	10	20	30	**Mean**
Zero	5.85	6.26	6.06	6.29	**6.12**
30	5.99	6.36	6.19	6.40	**6.23**
60	6.09	6.60	6.41	6.63	**6.43**
90	6.25	6.65	6.44	6.68	**6.51**
Mean	6.04	6.47	6.28	6.50	
CD at 5%	Zn= 0.10, Fe= 0.10, Zn × Fe= NS				

Table 4: Effect of zinc sulphate and ferrous sulphate on per cent increase in plant spread (%) [E-W] of guava cv. Hisar Safeda

$ZnSO_4$ (g/plant)	$FeSO_4$ (g/plant)				
	Zero	10	20	30	**Mean**
Zero	6.97	7.18	7.41	7.38	7.24
30	7.18	7.38	7.59	7.55	7.42
60	7.33	7.53	7.75	7.72	7.58
90	7.37	7.56	7.80	7.77	7.63
Mean	7.21	7.41	7.64	7.60	
CD at 5%	Zn= 0.10, Fe= 0.10, Zn × Fe= NS				

Shoot length

It is quite evident from the data presented in Table 5 that shoot length was significantly affected with zinc sulphate. Application of 60 g zinc sulphate per plant resulted in maximum shoot length (29.14 cm), which was significantly higher than all other treatments, while minimum shoot length (25.83 cm) was obtained under control treatment. The results of the present investigation are in accordance with the findings of Shivanandam *et al.* (2007) [11] who found that soil application of $ZnSO_4$ @ 1 kg per tree during second week of September + foliar application of $ZnSO_4$ @ 0.6 per cent during second week of October and second foliar application of $ZnSO_4$ @ 0.6 per cent after 50 days recorded significantly the highest length of new shoot in mango hybrids and varieties. Similar results were obtained by Prabhu and Singaram (2001) [12] in grapes, whereas, contradictory results were obtained by Wojcik (2007) [13] in apple that total length of current season shoots per tree did not depend on Zn fertilization. The effect of ferrous sulphate on shoot length was also significant. Maximum shoot length (28.52 cm) was observed in plants treated with 10 g ferrous sulphate per plant, which was significantly higher than all other treatments except 30 g ferrous sulphate, while minimum shoot length (26.55 cm) was found in control treatment. The interaction between zinc sulphate and ferrous sulphate was found to be non-significant.

Table 5: Effect of zinc sulphate and ferrous sulphate on shoot length (cm) of guava cv. Hisar Safeda

$ZnSO_4$ (g/plant)	$FeSO_4$ (g/plant)				
	Zero	10	20	30	**Mean**
Zero	24.77	26.77	25.67	26.13	25.83
30	26.07	28.07	26.97	27.37	27.12
60	28.13	30.07	29.00	29.37	29.14
90	27.23	29.17	28.13	28.47	28.25
Mean	26.55	28.52	27.44	27.83	
CD at 5%	Zn= 0.69, Fe= 0.69, Zn × Fe= NS				

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