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Effect of foliar application of magnesium and certain micronutrients on vegetative growth parameters of guava cv. Hisar surkha

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Abstract
The experiment was carried out during winter season of two successive years i.e., 2020-21 and 2021-2022 on guava cv. Hisar Surkha to improve the vegetative growth by foliar application of boron, magnesium and iron @ 0.25% and 0.50% in combination, with control. Experiment was conducted at the experimental orchard of CCS Haryana Agricultural University, Hisar, Haryana during year. In this study 63 guava cv. Hisar surkha trees planted at a spacing of 6×6 m were subjected to foliar sprays of boron, magnesium and iron at the time of fruit set and again after one month to study the effect of foliar sprays of boron, magnesium and iron on yield and quality of guava. The experiment was carried out in Randomized Block Design with 21 treatments and 3 replications. The foliar sprays of boron, magnesium and iron significantly influenced vegetative characters of guava. Growth characters i.e. plant height, plant spread, canopy volume, length of lateral branches, length of terminal branches, leaf area and leaf area index were found to be maximum under the treatment T_{21} [$FeSO_4$ (0.5%) + H_3BO_3 (0.5%) + $MgSO_4$ (0.5%)]. However, stem girth was non-significantly influenced by the nutrient sprays.

Keywords: Growth, guava, boron, iron and magnesium

Introduction
The word Guava (*Psidium guajava* L.) was apparently derives from the Greek word "psizo" which basically means "to feed on pap". The species name comes from the Spanish word "guayaba" meaning "guava tree" (Morton, 1987)[7]. The genus *Psidium* belongs to the family Myrtaceae and is believed to be originated in Tropical America. It is popularly known as "Apple of tropics" and "poor man Apple" (Nakasone and Paull, 1998) [8]. India, Brazil and Mexico are the major guava producing countries in the world (Singh, 2009) [12]. Guava was introduced in India by Portuguese in the early seventeenth century.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) [11]. It is occupying fifth place in terms of area (2.87 lakh ha) and production, (43.07 lakh MT) respectively, in India (NHB, 2020) [11]. The leading guava producing states are Maharashtra, Madhya Pradesh, Uttar Pradesh, Bihar, Andhra Pradesh, West Bengal, Punjab and Gujarat.It is a major fruit crop of Haryana also. Haryana has a production of 2.61 lakh MT of Guava fruit from 0.15 lakh ha area (Hortharyana, 2021) [4]. Foliar fertilization is an important tool for the sustainable and productive management of crops. The nutritional status of a plant can have a significant effect on response to foliar fertilizer applications. Foliar fertilization has been widely adopted in modern crop management where it is used to ensure optimal crop performance when nutrient supply from the soil is inadequate or uncertain. Foliar fertilizers offer specific advantages over soil fertilizers when plant demand for nutrients exceeds the capacity for root nutrient uptake; when elemental mobility within the plant limits delivery to tissues; and when environmental conditions limit the effectiveness or prevent the application of nutrients to the soil. In many high-value production systems, foliar fertilizers are marketed as 'insurance' to minimize the potential impacts of unpredictable nutrient deficiencies. So keeping this in mind, this study was planned.

Material and Methods
The present investigation was carried out in the experimental orchard of the Department of Horticulture, Chaudhary Charan Singh Haryana Agricultural University, Hisar. A field experiment was conducted on 14 year old guava cv. Hisar Surkha trees planted at 6m × 6m spacing. A total of sixty three uniformly grown plants were selected randomly and maintained under uniform conditions of orchard management during the study period.

Treatment details are given in table 1. All the agronomic practices carried out during the experiment werefollowed as per the recommended package of practices.The experiment was laid down in a randomized block design with three replications. Plant height and was measured at the time of harvesting each year with the help of a graduated measuring pole from ground level to the tip of the highest shoot. The tree volume was calculated by the formula of Westwood *et al.* (1963)[14].Tree stem were marked with paint at 15 cm above ground level for recording the stem diameter at a particular portion. Stem diameter was measured with the help of vernier calipers at the marked point.Length of lateral and terminal shootswas measured with measuring tape at the end of growing season.Leaves from 3rd and 4th positions from the apex of the shoot from random branches from each plant were taken and their area was measured with the help of digital leaf area meter. Leaf area index was calculated by dividing total leaf area to total ground area covered.

Table 1: Details of treatments

Treatments no.	Treatments details
T_1	Control
T_2	Boric acid (0.25%) + Magnesium sulphate (0.25%)
T_3	Boric acid (0.25%) + Magnesium sulphate (0.5%)
T_4	Boric acid (0.5%) + Magnesium sulphate (0.25%)
T_5	Boric acid (0.5%) + Magnesium sulphate (0.5%)
T_6	Ferrous sulphate (0.25%) + Magnesium sulphate (0.25%)
T_7	Ferrous sulphate (0.25%) + Magnesium sulphate (0.5%)
T_8	Ferrous sulphate (0.25%) + Boric acid (0.25%)
T_9	Ferrous sulphate (0.25%) + Boric acid (0.25%) + Magnesium sulphate (0.25%)
T_{10}	Ferrous sulphate (0.25%) + Boric acid (0.25%) + Magnesium sulphate (0.5%)
T_{11}	Ferrous sulphate (0.25%) + Boric acid (0.5%)
T_{12}	Ferrous sulphate (0.25%) + Boric acid (0.5%) + Magnesium sulphate (0.25%)
T_{13}	Ferrous sulphate (0.25%) + Boric acid (0.5%) + Magnesium sulphate (0.5%)
T_{14}	Ferrous sulphate (0.5%) + Magnesium sulphate (0.25%)
T_{15}	Ferrous sulphate (0.5%) + Magnesium sulphate (0.5%)
T_{16}	Ferrous sulphate (0.5%) + Boric acid (0.25%)
T_{17}	Ferrous sulphate (0.5%) + Boric acid (0.25%) + Magnesium sulphate (0.25%)
T_{18}	Ferrous sulphate (0.5%) + Boric acid (0.25%) + Magnesium sulphate (0.5%)
T_{19}	Ferrous sulphate (0.5%) + Boric acid (0.5%)
T_{20}	Ferrous sulphate (0.5%) + Boric acid (0.5%) + Magnesium sulphate (0.25%)
T_{21}	Ferrous sulphate (0.5%) + Boric acid (0.5%) + Magnesium sulphate (0.5%)

Note: Recommended dose of fertilizers for 14 year old plants of guava is 75 kg FYM + 1.5 kg Urea + 1.25 kg Super phosphate + 0.5 kg Potassium sulphate.

Results and Discussion

Perusal of pooled data of both the years 2020-21and 2021-22 also showed that maximum plant height (5.73 m) was recorded with the treatment T_{21} which was statistically at par with the treatments T_{18} and T_{20} (table 2). However, rest of the treatments had significantly lower plant height. Whereas, minimum plant height (4.27 m) was observed with the treatment T_1 (control). Maximum plant spread (5.83 m) was recorded with the treatment T_{21} which was statistically at par with the treatments T_{18} (table 2). However, rest of the treatments had significantly lower plant spread. Whereas, minimum plant spread (4.32 m) was observed with the treatment T_1 (control). Maximum tree volume(102.76 m^3) was recorded with the treatment T_{21} which was statistically at par with the treatments T_{18} (table 2). However, rest of the treatments had significantly lower tree volume. Whereas, minimum tree volume(42.02 m^3) was observed with the treatment T_1 (control). Stem girth was non-significantly influenced by the application of boron, magnesium and iron during both the years 2020-21and 2021-22, and with pooled (table 2).

Table 2: Effect of boron, magnesium and iron on Plant Height, Plant spread, Tree volume, Stem girth of guava cv. Hisar surkha

	Plant Height (m)			Plant spread (m)			Tree volume (m^3)			Stem girth (cm)		
Treatments no.	2020-21	2021-22	Pooled mean	2020-21	2021-22	Pooled mean	2020-21	2021-22	Pooled mean	2020-21	2021-22	Pooled mean
T_1	4.02	4.52	4.27	4.07	4.57	4.32	34.78	49.25	42.02	20.07	20.12	20.09
T_2	4.07	4.58	4.33	4.13	4.58	4.35	36.31	50.20	43.25	20.10	20.15	20.13
T_3	4.34	4.87	4.60	4.41	5.00	4.71	44.17	63.53	53.85	20.36	20.44	20.40
T_4	4.25	4.75	4.50	4.33	4.83	4.58	41.77	57.98	49.88	20.22	20.29	20.25
T_5	4.45	5.04	4.75	4.56	5.04	4.80	48.47	67.23	57.85	20.55	20.63	20.59
T_6	4.23	4.68	4.46	4.27	4.74	4.51	40.45	54.98	47.72	20.17	20.24	20.20
T_7	4.69	5.15	4.92	4.72	5.15	4.94	54.76	71.59	63.17	20.65	20.76	20.71
T_8	4.13	4.62	4.38	4.18	4.68	4.43	37.68	53.08	45.38	20.12	20.17	20.14
T_9	4.84	5.39	5.11	4.89	5.43	5.16	60.68	83.31	71.99	20.92	21.05	20.98
T_{10}	4.97	5.63	5.30	5.05	5.63	5.34	66.37	93.67	80.02	21.13	21.26	21.20
T_{11}	4.29	4.80	4.55	4.37	4.90	4.64	42.85	60.18	51.52	20.28	20.35	20.32
T_{12}	4.93	5.47	5.20	4.98	5.53	5.26	64.10	87.57	75.83	21.02	21.15	21.08
T_{13}	5.17	5.71	5.44	5.23	5.87	5.55	73.99	102.8	88.41	21.39	21.58	21.49

T_{14}	4.75	5.19	4.97	4.77	5.33	5.05	56.52	77.11	66.82	20.76	20.87	20.82
T_{15}	4.78	5.29	5.04	4.91	5.38	5.15	60.42	80.22	70.32	20.85	20.96	20.90
T_{16}	4.38	4.91	4.64	4.53	4.95	4.74	47.05	62.97	55.01	20.45	20.53	20.49
T_{17}	5.06	5.69	5.38	5.14	5.70	5.42	69.98	96.93	83.46	21.28	21.41	21.35
T_{18}	5.33	5.86	5.59	5.40	6.12	5.76	81.36	114.7	98.05	21.66	21.85	21.75
T_{19}	4.54	5.14	4.84	4.70	5.13	4.92	52.58	70.79	61.68	20.57	20.68	20.62
T_{20}	5.22	5.78	5.50	5.27	5.97	5.62	75.87	107.9	91.91	21.49	21.68	21.58
T_{21}	5.48	5.98	5.73	5.50	6.15	5.83	86.87	118.6	102.7	21.74	21.93	21.84
CD at 5%	0.28	0.34	0.24	0.29	0.22	0.17	7.42	5.51	4.83	NS	NS	NS

Maximum length of lateral branches (22.78 cm) was recorded with the treatment T_{21} [H_3BO_3 (0.5%) + $FeSO_4$ (0.5%) + $MgSO_4$ (0.5%)] which was statistically at par with T_{13}, T_{17}, T_{18} and T_{20} (table 3). However, rest of the treatments had significantly lower value of length of lateral branches. Whereas, minimum length of lateral branches (14.18 cm) was observed with the treatment T_1 (Control). Maximum length of terminal branches (20.07 cm) was recorded with the treatment T_{21} [H_3BO_3 (0.5%) + $FeSO_4$ (0.5%) + $MgSO_4$ (0.5%)] which was statistically at par with T_{18} and T_{20}. However, rest of the treatments had significantly lower value of length of terminal branches. Whereas, minimum length of terminal branches (11.29 cm) was observed with the treatment T_1 (Control) (table 3). Highest leaf area per leaf (88.92 cm^2) was found in the treatment T_{21} [H_3BO_3 (0.5%) + $FeSO_4$ (0.5%) + $MgSO_4$ (0.5%)] which was statistically at par with T_{18} (table 3). However, rest of the treatments had significantly lower value of leaf area. Whereas, minimum leaf area (69.12 cm^2) was observed with the treatment T_1 (Control). Maximum leaf area index (3.39) was recorded with the treatment T_{21} [H_3BO_3 (0.5%) + $FeSO_4$ (0.5%) + $MgSO_4$ (0.5%)] which was statistically at par with T_{18} (table 3). However, rest of the treatments had significantly lower value of leaf area index. Whereas, minimum leaf area index (2.77) was observed with the treatment T_1 (Control).

Table 3: Effect of boron, magnesium and iron on Length of lateral shoots, terminal shoots, Leaf area, Leaf area index of guava cv. Hisar surkha

	Length of lateral shoots (cm)			**Length of terminal shoots (cm)**			**Leaf area (cm^2)**			**Leaf area index**		
Treatments no.	**2020-21**	**2021-22**	**Pooled mean**	**2020-21**	**2021-22**	**Pooled mean**	**2020-21**	**2021-22**	**Pooled mean**	**2020-21**	**2021-22**	**Pooled mean**
T_1	14.04	14.3	14.18	10.74	11.84	11.29	68.07	70.17	69.12	2.76	2.79	2.77
T_2	14.67	15.0	14.83	10.80	12.00	11.40	70.74	71.21	70.98	2.78	2.81	2.79
T_3	16.07	17.1	16.57	12.20	14.06	13.13	73.70	74.27	73.98	2.91	3.02	2.97
T_4	15.20	16.0	15.58	11.13	12.75	11.94	72.20	73.00	72.60	2.87	2.91	2.89
T_5	16.94	17.8	17.39	12.84	14.87	13.86	75.06	75.67	75.37	3.03	3.08	3.06
T_6	14.97	15.0	14.97	11.07	12.50	11.78	71.45	72.05	71.75	2.85	2.88	2.87
T_7	17.67	19.0	18.32	13.83	15.93	14.88	77.52	77.69	77.61	3.09	3.15	3.12
T_8	14.73	15.1	14.92	10.93	12.20	11.57	71.03	71.28	71.16	2.81	2.83	2.82
T_9	18.98	20.3	19.64	14.82	17.68	16.25	81.01	82.34	81.67	3.18	3.24	3.21
T_{10}	19.75	21.1	20.42	15.87	19.10	17.49	81.77	83.44	82.61	3.24	3.28	3.26
T_{11}	15.81	16.2	16.01	11.63	13.48	12.56	72.81	73.48	73.14	2.88	2.96	2.92
T_{12}	19.06	20.4	19.74	15.60	18.39	17.00	81.42	82.49	81.95	3.20	3.26	3.23
T_{13}	20.53	21.7	21.10	17.23	19.78	18.51	84.97	85.27	85.12	3.28	3.35	3.32
T_{14}	17.99	19.3	18.67	14.09	16.58	15.33	78.60	79.20	78.90	3.12	3.19	3.16
T_{15}	18.47	20.2	19.31	14.27	17.23	15.75	80.37	81.37	80.87	3.16	3.21	3.19
T_{16}	16.49	17.4	16.95	12.27	14.38	13.32	74.62	75.42	75.02	2.97	3.05	3.01
T_{17}	20.35	21.5	20.91	16.63	19.53	18.08	82.27	83.70	82.98	3.26	3.32	3.29
T_{18}	21.33	22.6	21.98	18.30	20.98	19.64	86.67	88.20	87.43	3.34	3.40	3.37
T_{19}	17.33	18.8	18.07	13.30	15.53	14.41	76.62	76.72	76.67	3.05	3.12	3.09
T_{20}	20.83	22.2	21.52	17.60	20.57	19.08	85.67	86.00	85.83	3.31	3.37	3.34
T_{21}	21.73	23.8	22.78	18.60	21.53	20.07	88.33	89.50	88.92	3.36	3.42	3.39
CD at 5%	2.15	2.40	1.94	1.39	1.21	0.90	2.51	2.16	2.03	0.06	0.05	0.04

These findings are in line with earlier reports of Vikas and Verma (2020) [13], Kumawat *et al.* (2012) [5] and Lal *et al.* (2000) [6]who have shown that application of micronutrients alone or in combinations had significant effect on plant height, plant spread, canopy volume and stem girth in guava plant. The present results were in line with those obtained by El-Kassas (1984) [3] who found that foliar application of iron encouraged vegetative growth of Balady lime trees. They reported that foliar spray or soil application of iron tended to increase growth and yield of respective plants used in their studies. This maximum increase in growth attributes might be due to the favorable influence of application of micronutrients on growth characteristics because of their catalytic or stimulatory effect on most of the physiological and metabolic processes of plant. Iron is also necessary for vital plant metabolic functions such as chlorophyll synthesis, various enzymatic reactions, respiration and photosynthesis (Ram and Bose, 2000) [9]. Magnesium also plays an important role in synthesis of chlorophyll molecules which increases the photosynthesis and consequently plant growth (Hawkesford *et al.*, 2012) [4]. Boron are essential components of enzymes responsible for nitrogen and carbohydrates metabolism respectively, thereby resulting into increase in uptake of nitrogen by the plant which is ultimately going to increases the growth of plant. Micronutrients are known to accelerate the metabolic activities of plants, thereby mobilizing more amounts of photosynthates from source to sink thus it ultimately improves yield attributes like length of lateral branches, length of terminal branches, leaf area and leaf area index over control (Sau *et al.*, 2016) [10]

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