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RESPONSE OF 'PANT PRABHAT' GUAVA TREES TO FOLIAR SPRAYS OF ZINC, BORON, CALCIUM AND POTASSIUM AT DIFFERENT PLANT GROWTH STAGES

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ABSTRACT

The experiment comprised foliar sprays of boron, zinc, calcium and potassium at two stages, *viz.*, at fruit set or two weeks after fruit set on guava plant. The foliar fertilization showed an increasing trend towards plant height (12.17% with 0.03% Zn two weeks after fruit set), fruit weight (150g with 0.03% B two weeks after fruit set), volume (147.67 with 0.03% B two weeks after fruit set) and yield (52.50 kg/tree with 0.01% Zn two weeks after fruit set). Similarly, pulp : seed ratio (94.88 with 0.5% K two weeks after fruit set), TSS (11.50^{0}Brix with 0.5% K on fruit set) and total sugars (7.36% with 0.5% K two weeks after fruit set) also increased by foliar fertilization while it showed a trend towards decresing per cent fruit drop (5.90% with 0.03% Zn two weeks after fruit set) and acidity content (0.26% with 0.5% K two weeks after fruit set). The seed hardness (11.48 kg with 0.01% B on fruit set) showed non uniform pattern. The stage of growth also affected the growth, yield and quality of guava fruits. Results indicated that foliar fertilization when done two weeks after fruit set influenced plant growth and fruit quality.

INTRODUCTION

Guava is a member of myrtaceae family, sometimes known as "Super fruit" because it is embedded with immense nutritive values which have several health benefits. It is the fourth most important fruit of India, with an area, production and productivity of 2.360 Mha, 3.198 MT and 13.6 MT/ha, respectively (Anonymous, 2013). It is rich in pectin, vitamin C which is 2-5 times more than fresh orange juice. The effects of macro and micronutrient deficiencies are visible in terms of stunted growth, low yield, dieback and even may result in plant death. Moreover, foliar application of these nutrients may produce better results. Foliar fertilization of nutrients has advantage of low application rates, uniform distribution of fertilizer materials and quick response to applied nutrients. Application of nutrients through foliage can be from 10 to 20 times more effective than soil application (Zaman and Schumann, 2006). The fruit quality of rainy season guava is poor which can be improved by better nutrient scheduling and amount through foliar application. The similar kind of studies has also been reported by Bisen *et al.*, 2014 on guava and Lalithya *et al.*, 2014 on sapota.In this experiment an effort has been made to achieve the objectives of determining effective dose of foliar application as well as the more appropriate growth stage for improving quality and yield of this important fruit crop.

MATERIALS AND METHODS

Present experiment was carried out at Horticultural Research Centre, G.B. Pant University of Agriculture and Technology, Pantnagar (Uttarakhand), India, during the year 2013-14 on 8 years old guava cv. Pant Prabhat for rainy season crop. The experiment was laid out in Randomized Block Design to study the effect of foliar spray of boron, zinc, calcium and potassium at different stages of plant growth on physico-chemical and vegetative characters of fruit and plant, respectively. The treatments comprised T_1 [B (0.01 %) on fruit set], T_2 [B (0.03 %) on fruit set],T_3 [B (0.01 %) two weeks after fruit set], T_4 [B (0.03 %) two weeks after fruit set], T_5 [Zn (0.01 %) on fruit set], T_6 [Zn (0.03 %) on fruit set], T_7 [Zn (0.01 %) two weeks after fruit set], T_8 [(0.03 %) two weeks after fruit set], T_9 [Ca (0.2 %) on fruit set], T_{10} [Ca (0.5 %) on fruit set],T_{11} [Ca (0.2 %) two weeks after fruit set], T_{12} [Ca (0.5 %) two weeks after fruit set], T_{13} [K (0.2 %) on fruit set], T_{14} [K (0.5 %) on fruit set], T_{15} [K (0.2 %) two weeks after fruit set] and T_{16} [K (0.5 %) two weeks after fruit set].Treatment 17 was taken as control and remained untreated during the course of experiment. Zinc sulphate (55 % Zn), calcium nitrate (19.5 % Ca), potassium chloride (60 % K) and borax (11 % B) were taken as sources of boron, zinc, calcium and potassium, respectively. Growth and yield parameters were estimated as; per cent increase in plant height (%) and plant girth (%), length of lateral and terminal shoots of new growth, yield (kg/tree), fruit weight (g), fruit volume (ml) by water displacement method and specific gravity (weight/ volume). Fruit drop (%) was calculated by multiplying number of fruit retained at harvest by 100 and divided by number of fruits at the time of the treatment application. Seed hardness was measured with the help of pressure tester in kilogram. Total soluble solid (TSS) was determined with the help of digital refractometer. Total sugar, reducing sugar, non-reducing sugar and acidity were estimated by standard method described in AOAC (1980). The data was statistically analysed by method of analysis of variance using RBD as described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The data regarding per cent increase in tree height (Table 1) showed that treatments affected tree height significantly. Maximum seasonal growth in tree height (12.23 %) was recorded in T_6 followed by $T_8$where as minimum variation in tree height was observed (7.08 %) in T_{17}. Zinc is required for the synthesis of tryptophan, which is a precursor of auxin (Skoog, 1940) which might have resulted in increase in apical growth. Present findings are in close conformity with the results of Razzaq *et al.* (2013) in Kinnow mandarin. Neilsen and Hogue (1983) reported elevated shoot growth in 'McIntosh' apple seedlings treated with one foliar spray containing zinc.

The maximum percent increase (14.26%) in stem girth (Table 1) was recorded in T_7 followed by 14.12 % in T_3 whereas minimum (8.29 %) stem girth increase was observed in T_{17} (control). However, data regarding variation among different treatments on stem girth was found to be non-significant during the whole period of study. This might be due to the very small period of study (one season) *i.e.* from application of treatment till harvest. Data (Table 1) showed that the difference for terminal and lateral shoot length was non-significant in different treatments. Data indicated that maximum terminal shoot length (23.70 cm) of new growth was recorded in T_{15} whereas minimum terminal shoot length (12.37 cm) was recorded in T_{14}. Maximum lateral shoot length (24.18 cm) was recorded in T_{15} whereas minimum lateral shoot length (13.74 cm) was recorded in T_{14}. The increase in terminal and lateral shoot lengths in the potassium treated plants may be due to the action of potassium in translocation of photosynthates to newly emerged shoots.

All the treatments reduced per cent fruit drop (Table 1) and minimum fruit drop (5.90 %) was recorded in T_8 whereas maximum fruit drop (25.26 %) was observed in T_{17} (control). Per cent fruit drop varied significantly among different treatments. The highest reduction in fruit drop in plants sprayed with 0.03 % zinc might be probably due to auxin metabolizing role of zinc which perhaps antagonized the effect of ethylene and delayed synthesis of abscission layer. These results are in close conformity with the findings of Awasthi *et al.* (1975) in litchi. Fruit weight varied significantly among different treatments (Table 1). Significantly, higher fruit weight (150.00 g) was recorded in T_4 whereas minimum fruit weight (80.00 g) was observed in T_{17}. The increase in fruit weight with application of boron might be due to increased cell division and expansion. Appreciable improvement in fruit weight by boron application has also been reported by Dutta (2004) in mango.

The data (Table 1) indicated that significantly higher fruit volume (147.67 ml) was recorded in T_4whereas minimum fruit volume (83.00 ml) was recorded in T_{17}. Present results are in conformity with the findings of Ullah *et al.* 2012 in Kinnow mandarin that application of boron increased fruit volume significantly. It is evident from the data (Table 1) that effect of different treatments on specific gravity was non-significant. However, maximum (1.09) specific gravity was recorded in T_{16} whereas minimum specific gravity (0.97) was found in T_{17}.

Significant variation (Table 2) was recorded among different treatments on pulp to seed ratio. Pulp : seed ratio was significantly highest (94.88) in T_{16} followed by T_{15} whereas minimum (53.41) value was recorded in T_{17}. However, boron and potassium both are attributed to translocation of photosynthates, which might have led to increased growth and better quality of fruit. Numerous literature revealed that boron has a major role in reproductive growth and higher grain and seed production, potassium may be responsible for the allocation of more photosynthates to the fruits leading to

Table 1: Effect of foliar spray of different nutrients on vegetative and fruit-physical characters of guava cv. Pant Prabhat

Treatment		%increase in plant height	%increase in stem girth	Shoot growth (cm) Terminal	Lateral	Fruit Drop (%)	Weight (g)	Volume (mL)	Specific gravity
T_1	B (0.01%) on fruit set	8.23	11.78	13.72	16.93	20.51	125.00	122.33	1.03
T_2	B (0.03%) on fruit set	9.90	13.68	21.69	17.40	18.68	108.30	100.67	1.08
T_3	B (0.01%) two weeks after fruit set	8.56	14.12	17.63	16.55	17.35	125.00	130.67	0.97
T_4	B (0.03%) two weeks after fruit set	7.57	11.97	21.10	19.73	16.98	150.00	147.67	1.02
T_5	Zn (0.01%) on fruit set	9.98	11.09	16.33	14.00	16.89	107.33	102.33	1.05
T_6	Zn (0.03%) on fruit set	12.23	13.61	17.83	20.47	15.87	108.30	104.00	1.04
T_7	Zn (0.01%) two weeks after fruit set	9.46	14.26	18.40	16.61	14.79	128.67	118.00	1.09
T_8	Zn (0.03%) two weeks after fruit set	12.17	12.14	22.28	17.50	5.90	126.60	116.33	1.09
T_9	Ca (0.2%) on fruit set	10.85	11.09	20.67	16.40	12.67	91.60	89.00	1.03
T_{10}	Ca (0.5%) on fruit set	10.41	13.48	17.40	16.73	14.81	91.60	86.67	1.06
T_{11}	Ca (0.2%) two weeks after fruit set	10.41	13.78	19.51	19.40	14.99	98.30	101.33	0.97
T_{12}	Ca (0.5%) two weeks after fruit set	10.34	13.17	18.59	17.87	13.65	116.60	112.00	1.04
T_{13}	K (0.2%) on fruit set	9.64	12.16	20.60	15.90	21.89	100.00	99.33	1.01
T_{14}	K (0.5%) on fruit set	12.09	13.41	12.37	13.74	19.57	126.60	117.67	1.08
T_{15}	K (0.2%) two weeks after fruit set	10.22	12.24	23.70	24.18	10.44	116.60	117.00	1.00
T_{16}	K (0.5%) two weeks after fruit set	10.26	13.95	19.61	16.87	10.07	116.60	106.67	1.09
T_{17}	Control	7.08	8.29	22.13	21.07	25.26	80.00	83.00	0.97
	CD at 5%	2.42	NS	NS	NS	6.78	16.31	14.59	NS
	SEm ±	0.84	1.24	2.21	1.89	2.35	5.66	5.06	0.04

Table 2: Effect of foliar spray of different nutrients on physico-chemical properties and yield of guava cv. Pant Prabhat

Treatment		Yield (kg/tree)	Pulp : seed	Seed hardness (kg)	TSS (°B)	Acidity (%)	Sugar (%) Reducing	Non-reducing	Total
T_1	B (0.01%) on fruit set	27.17	67.31	11.48	7.00	0.41	3.69	2.75	6.44
T_2	B (0.03%) on fruit set	21.50	87.59	6.88	8.00	0.28	4.10	1.85	5.95
T_3	B (0.01%) two weeks after fruit set	28.50	55.76	8.04	8.10	0.47	4.91	1.82	6.73
T_4	B (0.03%) two weeks after fruit set	19.50	65.09	5.96	8.20	0.30	4.89	2.29	7.18
T_5	Zn (0.01%) on fruit set	17.00	55.91	8.92	8.20	0.32	4.91	1.82	6.73
T_6	Zn (0.03%) on fruit set	17.67	66.99	7.72	8.90	0.28	4.89	1.81	6.70
T_7	Zn (0.01%) two weeks after fruit set	52.50	83.55	5.72	7.80	0.28	4.79	1.91	6.70
T_8	Zn (0.03%) two weeks after fruit set	34.67	91.43	6.72	9.20	0.30	4.89	2.23	7.11
T_9	Ca (0.2%) on fruit set	22.50	55.12	7.08	7.50	0.28	4.57	2.13	6.70
T_{10}	Ca (0.5%) on fruit set	18.17	61.95	6.28	8.30	0.28	4.19	2.67	6.86
T_{11}	Ca (0.2%) two weeks after fruit set	20.17	70.44	7.12	8.60	0.41	3.92	2.14	6.07
T_{12}	Ca (0.5%) two weeks after fruit set	22.00	65.15	8.72	8.20	0.34	4.37	2.22	6.59
T_{13}	K (0.2%) on fruit set	52.32	55.85	8.16	7.20	0.30	3.81	2.25	6.06
T_{14}	K (0.5%) on fruit set	31.32	86.56	5.92	11.50	0.36	3.70	3.46	7.16
T_{15}	K (0.2%) two weeks after fruit set	24.50	88.00	7.96	8.80	0.30	3.34	3.37	6.71
T_{16}	K (0.5%) two weeks after fruit set	19.82	94.88	5.40	9.30	0.26	3.86	3.50	7.36
T_{17}	Control	16.50	53.41	6.96	6.90	0.49	3.24	1.79	5.03
	CD at 5%	8.81	12.53	3.06	1.02	0.09	0.59	0.79	0.53
	SEm ±	3.06	4.35	1.06	0.36	0.03	0.21	0.27	0.18

higher pulp content and ultimately the ratio of pulp to the seed increased.The data (Table 2) showed that seed hardness was significantly affected by different treatments. Maximum seed hardness (11.48 kg) was recorded in T_1 whereas minimum seed hardness (5.40 kg) was recorded in T_{16}. Increase in seed hardness may be ascribed to the action of boron in cell wall structure and membrane integrity as reported by Marschner(1995).

Significantly, higher TSS (11.50 ^{0}Brix) was observed in T_{14} whereas minimum TSS (6.90°Brix) was recorded in T_{17} (control) as presented in Table 2. Potassium has a prominent role in translocation of photo-assimilates; sugars and other soluble solids which are responsible for increased TSS. Present results regarding TSS are in accordance with the findings of Mandal *et al.* (2012) in guava.The titratable acidity was significantly reduced with the foliar application of various nutrients. Maximum titratable acidity (0.49 %) was recorded in T_{17} whereas minimum titratable acidity (0.26 %) was recorded in T_{16}. Lower acidity in fruits results due to higher accumulation of sugars, better translocation of sugars into fruit tissues and conversion of organic acids into sugars. Similar findings have also been reported by Beniwal *et al.* (1992) in grapes. The data on average total sugar reveal that the sugar content was significantly influenced by various treatments (Table 2). The highest total sugar (7.36 %) was recorded in the treatment T_{16} whereas minimum total sugar in fruits (5.03 %) was found in T_{17}.

Increase in total sugars with higher concentration of potassium application at the later stage of fruit development might be due to the fact that potassium is required for translocation of sugar (Kumar *et al.* 2006). The present results regarding increase in total sugar content of fruits are in accordance with the findings of Dutta and Banik (2007) in guava. The data regarding reducing sugar content of fruits (Table 2) indicate that there was significant variation in different treatments. The maximum reducing sugar (4.91 %) was recorded in the T_3. The Minimum reducing sugar content (3.24 %) was obtained in T_{17}. The positive effects of boron on reducing sugar are in agreement with the findings of Bhatt *et al.* (2012) in mango. Observations regarding non-reducing sugars of fruits, as revealed by Table 2 indicate that it was significantly influenced by various treatments. It is evident from the data that maximum non-reducing sugar (3.50%) was recorded in T_{16}. Whereas minimum non-reducing sugar (1.79 %) was observed in T_{17}. The possible reason for increase in non-reducing sugar content of fruits with the application of nutrients might be due to hydrolysis of polysaccharides to simpler form *i.e.*, mono and disaccharides and better transportation of nutrients to plant by potassium application as it plays animportant role in the transportation of assimilates and nutrients to the plant from leaves to their place of utilization, which increases availability of nutrients and eventually resulting in better quality of fruits. These results corroborate the earlier records of Kaur and Dhillon (2006) in guava.

From the present investigation it is revealed that foliar application is an instant and effective way of application of nutrients. Application through foliar spray of nutrients at critical stages of plant growth significantly influenced vegetative characters of plant as well as physico-chemical properties of fruits.

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