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Determination of Nutrient Content of Guava Cv. 'Pant Prabhat' Affected by Different Canopy Heights and Planting Densities

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study was conducted to determine the changes in nutrient composition of both affected by canopy heights, planting densities, and their interactions in comparison with both rainy and winter seasons. The experiment was composed of 4 different canopy heights [1.25m (H1), 1.5m (H2), 1.75m (H3), and unpruned (H4)] and 3 planting densities [5555 (D1), 3333 (D2), and (D3) 4444 plants ha-1] with total 12 treatment combinations laid out in factorial RBD was conducted. Fruits from the winter season were high in the nutrient content than in the rainy season. Canopy height H1 (1.75 m) recorded the maximum N, P, K, Zn, Cu, Fe and Mn (1.43%, 0.40%, 1.22%, 2.31 ppm, 2.28 ppm, 2.50 ppm and 1.31 ppm) in the winter season while, in the rainy season, maximum (0.88%, 0.35%, 0.98%, 2.07 ppm, 1.92 ppm, 2.14 ppm, 1.05 ppm) canopy height H3 (1.75m). Planting density D2 (3333 plant ha^{-1}) recorded the maximum nutrient content for both seasons. It is therefore concluded canopy height H1 (1.25m) with planting density D2 (3333 plant ha^{-1}) is best for producing fruits with high nutrient content for the winter crops.

Keywords: Canopy heights; planting densities; nutrient content; guava; interactions.

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1. INTRODUCTION

Guava (*Psidium guajava* L.) is an important fruit crop of tropical and subtropical regions of India but due to its hardy nature, it is also adapted to low rainfall areas. Guava is well-known as "super fruit" because of its richness in natural fiber, vitamins, minerals, polyphenols and antioxidants attributing to the building block of health [1]. It is the 3rd most important fruit crop rich in vitamin C, followed by camu-camu and aonla. The nutrient content of the fruit also has a significant contribution to eliminating the nutritive disorders and strengthening the health economy of the plant.

The nutrient content of the fruits is often dependent upon the physical status of the plant which is maintained by the proper management of the canopy as it makes a balance between the vegetative and reproductive growth and the number of plants also has a major contribution towards it. Canopy management is a sustainable practice in guava cultivation as it is pruning sensitive crops and current season bearers [2,3]. Canopy management provides ample scope for accommodating the maximum plant population per area. Without proper pruning, it is difficult for the proper functioning of the physiological activity of the plants as the transport of nutrients within the plants is bi-directional, hence affecting the nutritional content of the plant.

In Northern India, guava comes to flowering 2 times a year, i.e., summer (Apr-May) and rainy (Jul-Aug), and sometimes occasional flowering is seen in Oct. The summer flowering produces fruits in the rainy and rainy crops in the winter season. In Tarai conditions of India, maximum production (90%) was achieved from rainy crop while only 8-10% from winter season crop [4,5]. Although rainy season crops were inferior in quality as compared to the winter season, the nutrient content of both the season crop is not known. As canopy management influence the physical status of the plant so the effect on nutrient content of the fruits also. Therefore, here the experiment was undertaken to study different levels of canopy heights and planting density affecting the nutrient content of fruits as fruits are the ultimate product.

2. MATERIALS AND METHODS

The experiment was conducted at Horticulture Research Centre, Patharchatta, Department of Horticulture of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, on 7-year-old uniform trees of guava cv. 'Pant Prabhat'. The experimental site is characterized by a humid subtropical climate with the availability of high humidity during both the summer and winter seasons. The experiment was laid out in Factorial Randomized Block Design with four replications. In the present study, four canopy heights [1.25m (H1),1.5m (H2), 1.75m (H3) by pruning and lastly, plants without pruning treated as control (H4)] were maintained in an open canopy system and three planting densities [5000 plants ha^{-1} spaced at 2×1m (D1), 3333 plants ha^{-1} spaced at 2×1.5m (D2) and 4444 plants ha^{-1} spaced at 1.5×1.5m (D3)]. There were 2 sets of plants with each pruning height and planting densities, 1 set was chosen for rainy and another for winter season crop. Pruning was performed on the selected plants during the 2nd week of January and the 1st week of May to maintain targeted canopy heights.

For sampling 10 fully matured fruits were collected from all directions of the plant, cut into small pieces and dried at 70°C for 40-45 hrs in a hot air oven to get a constant dry weight. The powder was prepared by grinding and sieved through a 40 mesh sieve to obtain a finely ground powder, which was used for nutrient analysis. The nitrogen content of the fruits was determined by the Kjeldahl method and phosphorus by the vanado-molebdate colour reaction method. Potassium content was estimated by a microprocessor-based flame photometer (Systronic flame photometer, Ahmedabad, India) by using a specific filter (K filter) and LPG flame. The micro-nutrients (Zn, Cu, Fe and Mn) contents were determined by the use of an atomic absorption spectrophotometer [6].

The data were analyzed statistically using a two-way analysis of variance, followed by Turkey's Honest Significant Difference (HSD) test available in SAS software version 9.3 (SAS Institute, Cary, NC, USA). *P values* ≤ 0.05 were considered significant.

3. RESULTS AND DISCUSSION

The macro-nutrient content of the fruits was significantly affected by canopy heights, planting densities and their interactions with both rainy and winter season crops (Table 1). The winter season crop was observed for its supremacy over the rainy crop in macro-nutrient content. The maximum N, and K content (0.88%, 0.35% and 0.98%) was recorded in canopy height H3

(1.75 m) while the least value were documented in control (0.52%, 0.28% and 0.64%) respectively in rainy season crop. In contrast, canopy height H1 (1.25 m) was noted for its maximum N, P and K (1.43%, 0.40% and 1.22%) in fruits of the winter season crop. Similarly, the lowest value for N, P and K was observed for control. The highest nitrogen content in the pruned plants than the unpruned might be due to the fact of increasing amino acids and amino sugars, due to increased photosynthesis than that of control owing to the vegetative growth and old leaves. Similarly, the role of nitrogen in the uptake of phosphorus and potassium content of the fruits due to the chain reaction among the components again resulted in improving quality of the fruits with higher in P and K in pruned plants than that control. Similar results were reported by [7] in which they reported maximum N, P and K content in lightly pruned plants than that of control, in mango.

Macro-nutrient content followed a consistent result with planting density for both the season crop. The value for macro-nutrient followed an inflation-deflation principle with the value recorded highest at lowest planting density, decreasing on increasing the density, again observed to rise with the increase in density. The highest N, P and K (0.75%, 0.31% and 0.84%) (1.32%, 0.35%, 1.04%) were noted in D2 (3333 plants ha^{-1}) for both rainy and winter season crops respectively and the lowest value was observed in control. This might be due to the lower planting densities resulting in increased absorption of nutrients within the plants, ultimately increasing the nutrient content of the fruits. The contrasting reports were given by [8] in corn that the minimum amount of nutrient uptake was observed in lowest and highest plant densities while the maximum was recorded in moderate planting densities.

The winter season recorded the highest N and K value (1.50% and 1.35%) in treatment combination H1D2 while P content (0.41%) was noted as maximum in H1D1. For rainy crops, maximum N and P (0.96%, 0.36%) were noted in H3D2 while K content (1.08%) was documented as maximum in H3D1.

The micro-nutrient (Zn, Cu, Fe and Mn) content of the fruits was significantly affected by canopy heights, planting densities and their interactions (Table 2). In the rainy season crop, the maximum Zn, Cu, Fe and Mn (2.07 ppm, 1.92 ppm, 2.14 ppm and 1.05 ppm) were observed at canopy height H3 (1.75 m) while in the winter season, the maximum (2.31 ppm, 2.28 ppm, 2.50 ppm and 1.31 ppm) were recorded in canopy height H1 (1.25 m) significantly differing from others. The minimum value for micro-nutrients was documented in control (H4) for both seasons. Similar results on Zn, cu, Fe and Mn content of fruits was in confirmation by [9] who reported 0.23 mg, 0.26 mg, 0.23 mg, 0.15 mg 100 g^{-1} of zinc content in guava fruit. The results were in line with [10]. Improvement in fruit quality high in micro-nutrients attributed to improvement in different physiological, hormonal and biochemical processes within the plants which were due to pruning resulting in new initiation of shoots and leaves increasing the efficiency of these processes.

Table 1. Effect of canopy heights, planting densities and their interactions on macro-nutrient (N, P and K) content of the fruits

Canopy heights/ planting densities	**N (%)**		**P (%)**		**K (%)**	
Canopy heights	**Rainy**	**Winter**	**Rainy**	**Winter**	**Rainy**	**Winter**
1.25 m (H1)	0.79^{b}	1.43^{a}	0.30^{b}	0.40^{a}	0.78^{b}	1.22^{a}
1.5 m (H2)	0.60^{c}	1.28^{b}	0.29^{c}	0.33^{b}	0.76^{b}	1.02^{b}
1.75 m (H3)	0.88^{a}	1.20^{c}	0.35^{a}	0.31^{c}	0.98^{a}	0.94^{c}
Unpruned (H4)	0.52^{d}	1.09^{d}	0.28^{c}	0.30^{d}	0.64^{c}	0.74^{d}
LSD≤0.05	0.04	0.04	0.01	0.01	0.05	0.05
Density (Plants/ha)						
5000 (D1)	0.69^{b}	1.26^{b}	0.30^{ba}	0.33^{b}	0.80^{a}	0.99^{b}
3333 (D2)	0.75^{a}	1.32^{a}	0.31^{a}	0.35^{a}	0.84^{a}	1.04^{a}
4444 (D3)	0.66^{c}	1.20^{c}	0.30^{b}	0.33^{b}	0.72^{b}	0.91^{c}
LSD≤0.05	0.03	0.03	0.01	0.01	0.05	0.04

Mean values in each column and for each canopy height, density or canopy height × density combination followed by different lower-case letters were significantly different at P ≤ 0.05 by Turkey's HSD test

Table 2. Effect of canopy heights, planting densities and their interactions on micro-nutrient (Zn, Cu, Fe and Mn) content of the fruits

Canopy heights/ planting densities	Zn (ppm)		Cu (ppm)		Fe (ppm)		Mn (ppm)	
Canopy heights	**Rainy**	**Winter**	**Rainy**	**Winter**	**Rainy**	**Winter**	**Rainy**	**Winter**
1.25 m (H1)	1.58^{b}	2.31^{a}	1.33^{b}	2.28^{a}	1.61^{b}	2.50^{a}	0.75^{b}	1.31^{a}
1.5 m (H2)	1.29^{cb}	2.11^{b}	1.19^{c}	2.13^{b}	1.38^{c}	2.35^{b}	0.67^{c}	1.21^{b}
1.75 m (H3)	2.07^{a}	2.02^{c}	1.92^{a}	1.90^{c}	2.14^{a}	2.14^{c}	1.05^{a}	1.12^{c}
Unpruned (H4)	1.12^{c}	1.71^{d}	0.99^{d}	1.81^{d}	1.29^{d}	2.05^{d}	0.28^{d}	0.93^{d}
LSD≤0.05	0.30	0.02	0.08	0.04	0.09	0.04	0.06	0.03
Density (Plants/ha)								
5000 (D1)	1.55^{a}	2.04^{b}	1.36^{b}	2.04^{b}	1.60^{b}	2.26^{b}	0.66^{b}	1.15^{b}
3333 (D2)	1.56^{a}	2.14^{a}	1.44^{a}	2.12^{a}	1.71^{a}	2.36^{a}	0.77^{a}	1.24^{a}
4444 (D3)	1.43^{a}	1.93^{c}	1.28^{c}	1.94^{c}	1.51^{c}	2.16^{c}	0.63^{b}	1.05^{c}
LSD≤0.05	0.26	0.01	0.07	0.03	0.08	0.04	0.06	0.02

Mean values in each column and for each canopy height, density or canopy height × density combination followed by different lower-case letters were significantly different at P ≤ 0.05 by Turkey's HSD test

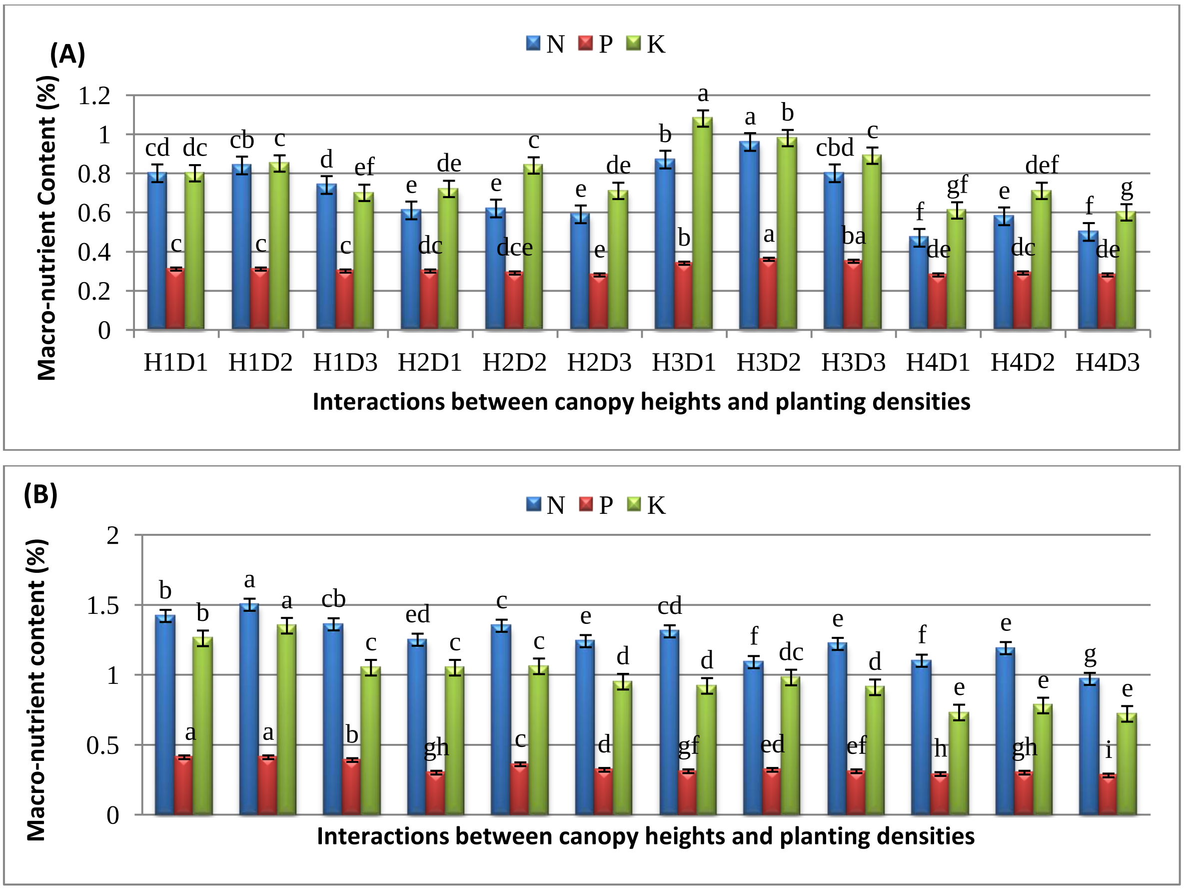
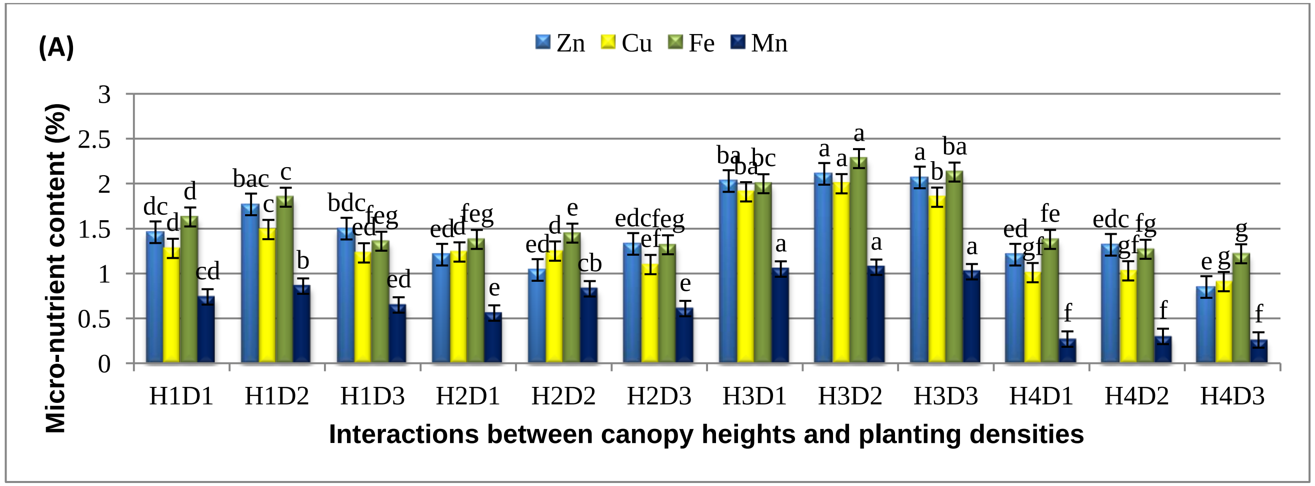


Fig. 1. Effect of interaction between canopy heights and planting densities on N, P and K content (A) On rainy season fruit (B) On winter season fruit

Similarly, the different planting densities significantly influenced the micro-nutrient content of the fruits in both the rainy and winter seasons. The highest value for micro-nutrient (Zn, Cu, Fe and Mn) (2.14 ppm, 2.12 ppm, 2.36 ppm and 1.24 ppm) was documented in D2 (3333 plants ha^{-1}) for the winter season and the same value (1.56 ppm, 1.44 ppm, 1.71 ppm and 0.77 ppm) was observed relatively less in the rainy crop in D2 also while the lowest was noted in D3 (4444 plant ha^{-1}) for both rainy and winter season crops.



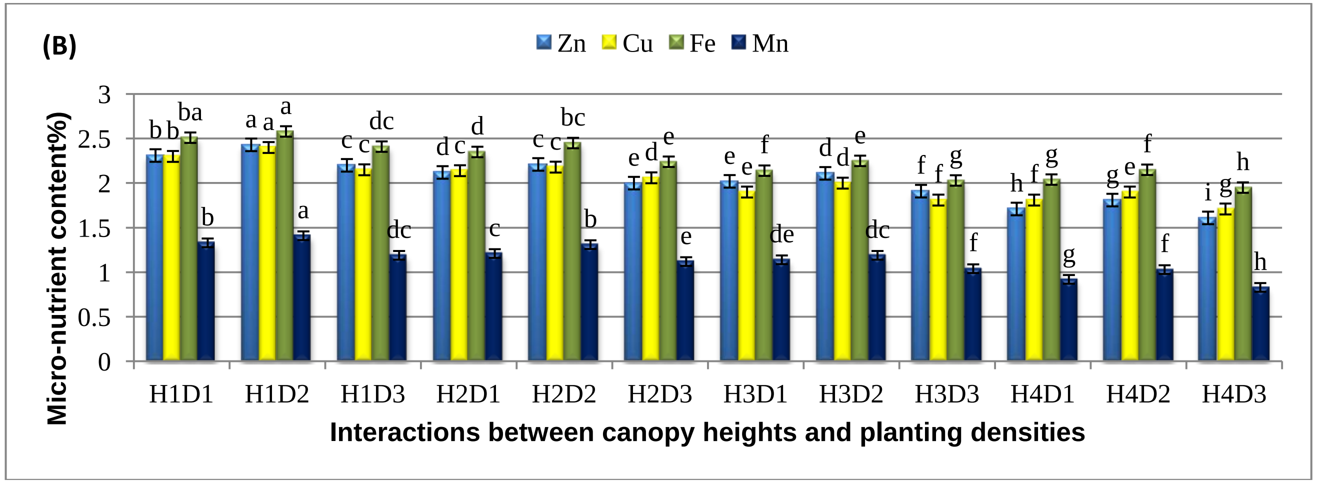


Fig. 2. Effect of interaction between canopy heights and planting densities on Zn, Cu, Fe and Mn content (A) On rainy season fruit (B) On winter season fruit

In interaction combination, the micro-nutrient content of fruits for the winter season surpasses over rainy crop combination. The maximum Zn, Cu, Fe and Mn content (2.43 ppm, 2.40 ppm, 2.58 ppm and 1.41 ppm) were noted in treatment combination H1D2 in winter season while the Zn, Cu, Fe and Mn (2.11 ppm, 2.00 ppm, 2.28 ppm and 1.07 ppm) were documented highest in H3D2 in rainy season crop. The minimum micro-nutrient for both seasons was noted in H4D3.

4. CONCLUSION

From the present experiment, it can be concluded that canopy heights, planting densities and their interactions have a significant effect on the nutrient content of guava fruits in both the rainy and winter season as affected by the different heights of pruning and number of plants or competition among them for resources. Winter season crop recorded for its supersede effect over rainy season crop in nutrient and mineral content of the fruits. So, from this, it can be concluded and recommended to follow the canopy height (H3) at 1.75m in the rainy season and (H1) 1.25 m in the rainy season with planting density D2 (3333 plants ha^{-1}) for the production of high-quality fruits wrapped with high nutrient content.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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