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Effect of integrated nutrient management on quality attributes of guava varieties in the Rajnandgaon District of Chhattishgarh Plain

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Abstract
The field experiment entitled **"Effect of Integrated Nutrient Management on Quality Attributes of Guava Varieties in the Rajnandgaon District of Chhattisgarh Plains"** was conducted during the Mrig Bahar season of 2019–20 at the Horticulture Farm, Bharregaon, under Pt. K.L. Shukla College of Horticulture and Research Station, Rajnandgaon, Chhattisgarh. The experiment was laid out in a Factorial Randomized Block Design (FRBD), comprising 24 treatment combinations with three replications. The study involved two factors: four guava varieties and six levels of Integrated Nutrient Management (INM). Among the different treatment combinations, V_3N_3 (Shweta + 75% RDF + 10 kg FYM + 2.5 kg vermicompost + 50 g Azotobacter) recorded superior results for most of the fruit quality parameters, including total soluble solids (13.84 °Brix), ascorbic acid content (246.71 mg/100 g) and total sugar content (9.16%).

Keywords: Integrated Nutrient Management, Guava varieties, Fruit quality parameters, Chhattisgarh Plains, *Psidium guajava* L.

Introduction

Guava (*Psidium guajava* L.), belonging to the family Myrtaceae, is an important tropical and subtropical fruit crop widely cultivated in India, including Chhattisgarh. It has been cultivated in India since the 17th century and ranks as the fourth most important fruit crop after mango, banana and citrus. India has approximately 2.51 lakh hectares under guava cultivation, with an annual production of about 40.83 lakh tonnes. Guava contributes nearly 4.5% of the total fruit-growing area and 3.3% of the country's total fruit production (Anonymous, 2015) [1].

Owing to its excellent nutritional composition, guava is often referred to as the "apple of the tropics." The fruit pulp is particularly rich in vitamin C (75–260 mg per 100 g), along with appreciable amounts of thiamine (0.03–0.07 mg per 100 g) and riboflavin (0.02–0.04 mg per 100 g) (Singh *et al.*, 2003). It is also a valuable source of essential minerals, including phosphorus (22.5–40.0 mg per 100 g), calcium (10.0–30.0 mg per 100 g) and iron (0.60–1.39 mg per 100 g) (Singh *et al.*, 2003). Furthermore, guava contains a considerable amount of pectin (0.5–1.8%), making it suitable for processing into jelly and various other value-added products (Adsule *et al.*, 1995) [1].

Maintaining soil health and improving fruit productivity and quality are important aspects of sustainable guava cultivation. Research findings indicate that the integrated application of organic manures, inorganic fertilizers and biofertilizers can improve soil productivity, enhance nutrient availability and contribute to higher crop yields and better fruit quality (Singh *et al.*, 2011) [2].

Materials and Methods

An experiment entitled **"Effect of Integrated Nutrient Management on Quality Attributes of Guava Varieties in the Rajnandgaon District of Chhattisgarh Plains"** was conducted during the 2019–20 season at the Horticultural Farm, Bharregaon, under Pt. K.L. Shukla College of Horticulture and Research Station, Rajnandgaon, Chhattisgarh.

The experiment comprised 24 treatment combinations involving four guava varieties and six levels of Integrated Nutrient Management (INM), with three replications. The treatments included organic manures (farmyard manure and vermicompost), inorganic fertilizers and biofertilizers. The observations on various fruit quality parameters were recorded using standard analytical procedures, as described below.

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1. Total soluble solids (°Brix)

Total soluble solids (TSS) were determined using a hand refractometer (0–32 °Brix), following the procedure recommended by A.O.A.C. (2012). For estimation, fruits from each treatment were crushed and homogenized to obtain a uniform pulp sample. The juice was extracted through muslin cloth, and a drop of the filtered juice was placed on the prism surface of the refractometer. The instrument was directed towards a light source, and the reading was recorded at room temperature. The results were expressed in degrees Brix (°Brix).

2. Ascorbic acid (mg/100 g)

Ascorbic acid content was estimated by the 2,6-dichlorophenol-indophenol dye titration method, following Ranganna (1977) [3].

Preparation of 3% metaphosphoric acid solution

Three grams of metaphosphoric acid (HPO_3) were dissolved in distilled water, and the final volume was made up to 100 ml to obtain a 3% solution.

Preparation of standard ascorbic acid solution

One hundred milligrams of L-ascorbic acid were accurately weighed and dissolved in 3% metaphosphoric acid. The volume was made up to the required volume using the same acid solution to prepare the standard ascorbic acid solution. The solution was subsequently diluted as required for standardization.

Preparation of dye solution

Approximately 150 ml of distilled water was brought to boiling, and 42 mg of sodium bicarbonate was added. After cooling, 52 mg of the sodium salt of 2,6-dichlorophenol-indophenol was dissolved in the solution. The prepared dye solution was stored in a refrigerator until further use.

Standardization of dye solution

Five millilitres each of the standard ascorbic acid solution and 3% metaphosphoric acid were taken using a microburette. The mixture was titrated against the standard dye solution until a light pink colour persisted for approximately 15 seconds. The dye factor was calculated using the following formula:

$$\text{Dye factor} = \frac{\text{Amount of ascorbic acid (mg)}}{\text{Volume of dye consumed (ml)}}$$

Preparation of fruit sample

Ten millilitres of fruit juice were mixed with 3% metaphosphoric acid and filtered to obtain a clear extract for analysis.

Estimation of ascorbic acid

A 10 ml aliquot of the prepared extract was titrated against the standardized dye solution until a light pink colour persisted for approximately 15 seconds. The titre value was recorded, and ascorbic acid content was calculated using the following formula:

$$\text{Ascorbic acid (mg/100 g)} = \frac{(T \times D \times V \times 100)}{(A \times W)}$$

Where:

- T = Volume of dye consumed for sample titration (ml)
- D = Dye factor (mg/ml)
- V = Total volume of the extract (ml)
- A = Volume of aliquot taken for titration (ml)
- W = Weight of fruit sample (g)

3. Titratable acidity (%)

Titratable acidity was determined by the titration method recommended by A.O.A.C. (2012). A known quantity of filtered fruit juice was diluted with distilled water and titrated against standard 0.1 N sodium hydroxide (NaOH) solution using phenolphthalein as an indicator. The end point was indicated by the appearance of a light pink colour that persisted for approximately 15 seconds. The acidity was calculated and expressed as a percentage.

4. Total sugars (%)

Total sugar content was estimated by the Fehling's solution titration method. A measured quantity of fruit juice (20 ml) was taken in a beaker, followed by the addition of 5 ml of concentrated hydrochloric acid (HCl). The mixture was heated in a boiling water bath for approximately five minutes to hydrolyse non-reducing sugars into reducing sugars. After cooling, the solution was neutralized using sodium carbonate. The hydrolysed sample was then transferred into a 100 ml volumetric flask, and the volume was made up to the mark with distilled water.

The prepared solution was transferred into a burette and titrated against a mixture of Fehling's solutions A and B, following the procedure used for reducing sugar estimation. The total sugar content was calculated and expressed as a percentage.

5. Preparation of fruit sample for sugar estimation

For sugar estimation, approximately 2 g of fresh guava pulp was crushed and mixed thoroughly with 20 ml of ethanol. The mixture was filtered through muslin cloth to obtain a uniform extract. The filtrate was subsequently diluted with distilled water, and the final volume was made up to 100 ml. This prepared extract was used for the estimation of sugar constituents.

6. Reducing sugars (%)

Reducing sugar content was estimated by the Nelson modification of Somogyi's method (Somogyi, 1952) [4], using arsenomolybdate colour-forming reagent and copper reagents A and B.

One millilitre of appropriately diluted fruit juice (100-fold dilution) was mixed with 1 ml of copper reagent, prepared by mixing 24 parts of copper reagent A with one part of copper reagent B. The reaction mixture was heated in a boiling water bath and subsequently cooled. The arsenomolybdate colour-forming reagent was then added, and the resulting colour intensity was measured spectrophotometrically at 620 nm using a Spectronic-20 spectrophotometer.

The reducing sugar concentration was determined by comparing the absorbance values with a standard calibration curve prepared using glucose. The results were calculated and expressed as a percentage of reducing sugars.

I have reorganized your Results and Discussion section into thesis-style scientific writing, removed the repeated portion and improved the interpretation of the findings. I have retained your reported treatment values and variety codes.

One important issue: the ascorbic acid value for N_3 is written as **136.50 mg/100 g**, whereas the variety values and N_4 value are above 200 mg/100 g. I have flagged this for verification rather than silently changing it.

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Results and Discussion

The results obtained from the investigation on the effect of Integrated Nutrient Management (INM) on quality attributes of different guava varieties are presented and discussed below. 1. Total Soluble Solids (°Brix) A significant variation in total soluble solids (TSS) was observed among the different guava varieties. Among the varieties, V_3 (Shweta) recorded the highest TSS content (13.00 °Brix), followed by V_4 (Lalit) with 12.85 °Brix. The lowest TSS content (12.73 °Brix) was recorded in V_1 (Allahabad Safeda). Different INM treatments also exerted a significant influence on TSS content. Among the nutrient management treatments, N_3 (75% RDF + 10 kg FYM + 2.5 kg vermicompost + 50 g Azotobacter) recorded the highest TSS (13.73 °Brix), followed by N_4 (75% RDF + 10 kg FYM + 2.5 kg vermicompost + 50 g *Azospirillum*), which recorded 13.30 °Brix. The lowest TSS content (11.94 °Brix) was observed in N_0 (Control). 2. Ascorbic Acid (mg/100 g) Significant differences in ascorbic acid content were observed among the different guava varieties. V_3 (Shweta) recorded the highest ascorbic acid content (230.54 mg/100 g), followed by V_4 (Lalit), which recorded 226.31 mg/100 g. The lowest ascorbic acid content (216.91 mg/100 g) was observed in V_1 (Allahabad Safeda). The different INM treatments also had a significant effect on ascorbic acid content. The highest ascorbic acid content was recorded in N_3 (75% RDF + 10 kg FYM + 2.5 kg vermicompost + 50 g Azotobacter), followed by N_4 (75% RDF + 10 kg FYM + 2.5 kg vermicompost + 50 g *Azospirillum*), which recorded 227.85 mg/100 g. The lowest ascorbic acid content (208.88 mg/100 g) was recorded in N_0 (Control). 3. Titratable Acidity (%) Significant variation in titratable acidity was observed among the different guava varieties. V_4 (Lalit) recorded the highest acidity (0.529%), followed by V_3 (Shweta), with an acidity of 0.510%. The lowest acidity (0.498%) was recorded in V_2 (L-49). A significant influence of INM treatments on fruit acidity was also observed. The highest acidity (0.563%) was recorded in N_0 (Control), followed by N_1 (100% RDF), which recorded 0.541%. In contrast, the lowest acidity (0.422%) was observed in N_3 (75% RDF + 10 kg FYM + 2.5 kg vermicompost + 50 g Azotobacter). 4. Total Sugars (%) A significant variation in total sugar content was observed among the different guava varieties. V_3 (Shweta) recorded the highest total sugar content (8.74%), followed by V_4 (Lalit), with 8.58%. The lowest total sugar content (8.40%) was recorded in V_1 (Allahabad Safeda). Different INM treatments also significantly influenced the total sugar content of guava fruits. The highest total sugar content (8.98%) was recorded in N_3 (75% RDF + 10 kg FYM + 2.5 kg vermicompost + 50 g Azotobacter), followed by N_4 (75% RDF + 10 kg FYM + 2.5 kg vermicompost + 50 g *Azospirillum*), which recorded 8.74%. The lowest total sugar content (8.23%) was observed in N_0 (Control). 5. Reducing Sugars (%) Significant differences in reducing sugar content were observed among the different guava varieties. V_4 (Lalit) recorded the highest reducing sugar content (4.49%), followed by V_1 (Allahabad Safeda), with 4.46%. The lowest reducing sugar content (4.39%) was recorded in V_3 (Shweta). A significant effect of different INM treatments was also observed on reducing sugar content. Among the treatments, N_3 (75% RDF + 10 kg FYM + 2.5 kg vermicompost + 50 g Azotobacter) recorded the highest reducing sugar content (4.71%), followed by N_5 (75% RDF + 10 kg FYM + 2.5 kg vermicompost + 50 g VAM), with 4.57%. The lowest reducing sugar content (4.26%) was recorded in N_0 (Control), as presented in Table 1

Table 1. Factor A: Varieties: 4

V_1	AllahabadSafeda
V_2	L-49
V_3	Shweta
V_4	Lalit

Table 2. Factor- B: INM : 6 levels

N_0	Control
N_1	100%RDF
N_2	75%RDF+10 kgFYM+2.5kgvermicompost +50 gmTrichoderma
N_3	75%RDF+10 kgFYM+2.5kgvermicompost +50 gm Azotobacter
N_4	75%RDF+10 kgFYM+2.5kgvermicompost +50 gmAzospirillum
N_5	75%RDF+10kgFYM+ 2.5kgvermicompost +50 gm PSB

Table 3. Effect of varieties and INM on quality attributes of guava

Treatment		TSS°Brix	Ascorbicacid mg/100 g	Acidity(%)	Totalsugar(%)	Reducingsugar(%)
FactorA. Varieties (4Varieties)						
V_1	AllahabadSafeda	12.73	216.91	0.507	8.40	4.46
V_2	L-49	12.75	220.31	0.498	8.51	4.435
V_3	Shweta	**13.00**	**230.54**	**0.510**	**8.74**	4.39
V_4	Lalit	12.85	226.31	0.529	8.58	**4.49**
S. Em.		0.022	0.333	0.002	0.006	0.007
C.Dat5 %		0.064	0.408	0.006	0.017	0.021
FactorB. INM(6 Level)						
N_0	Control	11.94	208.88	0.563	8.23	4.26
N_1	100%RDF	12.35	220.42	0.541	8.34	4.34
N_2	75%RDF+10 kg FYM+ 2.5 kg vermicompost+50 gm *Trichoderma*	12.51	222.14	0.527	8.42	4.28
N_3	75%RDF+10 kg FYM+ 2.5 kg vermicompost+50 gm Azotobacter	**13.73**	**236.50**	**0.422**	**8.98**	**4.71**
N_4	75%RDF+10 kg FYM+ 2.5 kg vermicompost+50 gm *Azospirillum*	13.30	227.85	0.476	8.74	4.53
N_5	75%RDF+10kgFYM+ 2.5 kg vermicompost+50 gmPSB	13.17	225.34	0.491	8.63	4.57
S. Em.		0.027	0.408	0.003	0.007	0.009
C.Dat5 %		0.078	1.164	0.007	0.021	0.026

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Conclusion

Based on the results obtained from the present investigation, it can be concluded that guava varieties and different levels of Integrated Nutrient Management (INM) significantly influenced the quality attributes of guava fruits.

Among the four guava varieties, V_3 (Shweta) recorded the highest total soluble solids (13.00 °Brix), ascorbic acid content (230.54 mg/100 g) and total sugar content (8.741%). The lowest TSS (12.73 °Brix), ascorbic acid content and total sugar content (8.44%) were recorded in V_1 (Allahabad Safeda). However, the highest titratable acidity (0.529%) was observed in V_4 (Lalit), whereas the lowest acidity (0.498%) was recorded in V_2 (L-49). Regarding reducing sugar content, V_4 (Lalit) recorded the highest value (4.49%), while V_3 (Shweta) recorded the lowest value (4.39%).

The different INM treatments significantly influenced the major fruit quality parameters. Among the nutrient management treatments, N_3 (75% RDF + 10 kg FYM + 2.5 kg vermicompost + 50 g Azotobacter) was found to be the most effective treatment. It recorded the highest total soluble solids (13.735 °Brix), ascorbic acid content (236.50 mg/100 g) and total sugar content (8.982%). In contrast, the lowest TSS (11.94 °Brix), ascorbic acid content (208.883 mg/100 g) and total sugar content (8.403%) were recorded under N_0 (Control).

Overall, the combined application of 75% recommended dose of fertilizers (RDF), 10 kg farmyard manure (FYM), 2.5 kg vermicompost and 50 g Azotobacter (N_3) proved promising for improving the quality attributes of guava fruits under the agro-climatic conditions of the Chhattisgarh plains.

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