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Impact of Plant Bioregulators on Growth, Yield, Quality and Economic Feasibility of Guava (*Psidium guajava* L.) in Central Region of Punjab, India

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Authors' contributions

This work was carried out in collaboration among all authors. Authors SS and RS conceptualized the study. Authors RS, NC and Tanvi performed the methodology, did data collection and original data analysis. Authors SS, AS and RS did data presentation and wrote the paper. Authors AS and JS wrote, reviewed and edited the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Guava holds significant importance in India due to its high nutritional value, affordability, and ability to grow in diverse climatic conditions. It plays a vital role in the economy and is a major source of vitamins, especially vitamin C, for millions. A study conducted from 2022 to 2024 at the Department of Agriculture, Agriculture Research Farm, Mata Gujri College, Fatehgarh Sahib, Punjab, evaluated the effects of various plant growth regulators on guava. The experiment involved ten treatments; each replicated three times using a randomized block design. The treatments included: PBR_1 (NAA 50 ppm), PBR_2 (NAA 75 ppm), PBR_3 (NAA 100 ppm), PBR_4 (GA_3 50 ppm), PBR_5 (GA_3 100 ppm), PBR_6 (GA_3 150 ppm), PBR_7 (Triacontanol 25 ppm), PBR_8 (Triacontanol 50 ppm), PBR_9 (Triacontanol 75 ppm), and PBR_{10} (Control). Among the treatments, PBR_3 (NAA 100 ppm) produced the best results in terms of fruit volume (85.72 cm^3), minimum firmness (8.05), specific gravity (1.02%), ascorbic acid content (252.85mg/100g), total sugar content (10.73%) and TSS (10.86 ^{0}Brix) and minimum found in PBR_{10} (control). The highest net return of Rs. 454,237 and the best benefit-cost (B:C) ratio were also recorded for PBR_3 (NAA 100 ppm). Based on these findings, the use of plant growth regulators, particularly NAA 100 ppm, is recommended to enhance both the yield and quality of guava fruits.

Keywords: Bioregulators; firmness; growth regulator; triacontanol; yield.

1. INTRODUCTION

Guava is a globally significant fruit due to its rich nutritional profile, particularly its high vitamin C content, and adaptability to various climates. In India, guava is vital for both its economic contribution and as a highly affordable, nutritious fruit consumed by millions (Angulo-López et al., 2024). It plays a key role in improving public health and supporting rural livelihoods. The leading states of production in India are including Uttar Pradesh, Madhya Pradesh, Bihar, Punjab, Haryana, West Bengal, and Gujarat. With an annual production of 983.59 thousand tonnes, Uttar Pradesh is leading state followed by Madhya Pradesh (434.41 thousand tonnes) and Bihar (776.75 thousand tonnes) (NHB, 2023). With an area of 8.2 thousand hectares and an annual production of 183.4 thousand tonnes, guava is the second most productive fruit in Punjab, after citrus (NHB, 2023). Key districts for guava cultivation in Punjab include Patiala, Ludhiana, Jalandhar, Muktsar Sahib, Sangrur, and Bathinda. The fruit is used for the preparation of processed products like jams, jellies, and nectar. Guava jelly puree is very popular in its attractive purplish-red colour, pleasant taste, and aroma. Guava is a good source of pectin (0.78%) which is an important constituent of jelly (Salgado et al., 2024).

Despite its widespread appeal, a number of obstacles that have a detrimental influence on this guava cultivar's economic viability have prevented it from reaching its full production potential. Key issues faced by guava producers include poor fruit set, a high percentage of early fruit drop, improper fruit development, and the high perishability of the fruit (Singh and Singh, 2008). Promoting vegetative development and flowering necessitates the administration of plant growth regulators. Due to their beneficial effects on the fruit's physical, chemical, and reproductive properties, it has also been noted that employing these regulators can increase fruit set and yield without affecting fruit quality (Gomsataet al., 2024).

Gibberellic acid (GA_3), a key growth-promoting chemical, stimulates cell elongation and division, supporting growth and development of various plants. The application of GA_3 enhances fruit size, shape, and weight, while also improving fruit set and retention in trees. Gibberellins regulate fruit development through different mechanisms at various stages. They are frequently applied to improve fruit quality and to prevent fruit drop. Many factors contribute to the loss of some fruits at different stages of ontogenic development, from fruit set to ripening and final maturity (Suman et al., 2017).

Plant growth processes such as cell elongation, division, vascular tissue differentiation, and root initiation, apical dominance, leaf senescence, and the control of leaf and fruit abscission are all aided by NAA, a synthetic version of auxin. Additionally, it contributes to raising floral sex ratio, minimising fruit drop, and enhancing fruit setting ratios (Mehraj et al., 2015). NAA treatments have been shown to increase fruit production, size, and total yield per tree in loquat, without negatively affecting the fruit's nutritional or organoleptic qualities. In guava, NAA has significantly improved fruit collection, length, diameter, weight, total soluble solids, sugars content, vitamin C levels, and has reduced overall fruit drop. The translocation of metabolites from other sections of the plant towards the developing fruits is known to be enhanced by auxins and GA_3(Mahmood et al., 2016).

Triacontanol, a naturally occurring regulator of plant growth present in epicuticular waxes, is extensively employed to increase crop yields, particularly on millions of hectares in Asia. Studies on various crops have shown that TRIA enhances growth, yield, photosynthesis, protein synthesis, water and nutrient absorption, nitrogen fixation, and enzyme activity, and the levels of soluble proteins, reducing sugars, free amino acids, and components of essential oils (Kumar et al., 2021). It is a natural plant hormone, present in beeswax and plant cuticles, that regulates numerous physiological processes in fruit crops. They consist of enhancing photosynthesis, transpiration, stomatal conductance, growth promotion, and nutrient absorption. TRIA also enhances stress tolerance in crops by modulating the expression of photosynthetic genes, stress-related genes, and antioxidant levels in response to stresses such as acid mists, heavy metals, salt, water, and by regulating the expression of genes linked to photosynthetic processes, stress-related genes, and antioxidant levels in response to various stimuli, including acid mists, heavy metals, salt, water, and temperature, TRIA further improves crops' ability to withstand stress (Pankaj et al., 2022). In Punjab, guava productivity has declined due to factors like poor soil health, pest infestations, and erratic weather conditions. To counter this, farmers have turned to plant growth regulators (PBRs) such as gibberellic acid and NAA, which help enhance flowering, fruit size, and yield. These PBRs have shown promising results, leading to increased guava production and improved fruit quality.

2. MATERIALS AND METHODS

2.1 Study Area and Treatments Detail

The research was conducted at the Agriculture Research Farm, Department of Agriculture at Mata Gujri College in Sri Fatehgarh Sahib, Punjab, India. The farm is located at a latitude of 30°56'11.90°N and a longitude of 76°18'13.18°E, with an average elevation of 279 meters above sea level.There are three different seasons in Sri Fatehgarh Sahib's subtropical climate: winter, summer, and the rainy season and winter season crop is used for further study. Temperatures can drop as low as 4–8°C during the winter (December–January), and they can climb as high as 42–45°C during the summer (May–June). Winter brings sporadic frost and precipitation. Most of the rainy season falls between mid-July and the end of September, when it starts to get less intense. An estimated 67 cm of rain fall on the area each year on average. The study was conducted in a guava orchard with the Allahabad Safeda variety, planted at a spacing of 5x5 meters. The total ten treatments were designated as PBR_1, (NAA 50 ppm), PBR_2 (NAA 75 ppm), PBR_3 (NAA 100 75 ppm), PBR_4 (GA_3 50ppm), PBR_5 (GA_3 100 ppm), PBR_6 (GA_3 150 ppm), PBR_7 (Triacontanol 25 ppm), PBR_8 (Triacontanol 50 ppm), and PBR_9 (Triacontanol 75ppm) and PBR_{10} (Control). The trial was conducted in randomized block design with 3 numbers of replications.

2.2 Fruit Physical and Quality Parameters

2.2.1 Fruit volume, firmness, specific gravity

The fruit volume was measured with the help of water displacement method, and the mean of the observations is calculated and represented in cm^3.A fruit's crispness is its firmness. Pressing it is one of the simplest ways to measure it. Penetrometers and pressure testers are two types of equipment that can be used to measure stiffness. They cause damage because a fruit is pressed or a probe is put inside of it to distort it.Five randomly chosen fruits were weighed and the results were noted. These fruits were put in a glass jar with water, and a measuring cylinder was used to determine how much water needed to be changed. The specific gravity was calculated as per formula given below-

Specific gravity = Total weight of five fruits/ Total volume of water replaced by five fruits

2.2.2 Sugars and ascorbic acid

Fruit juice (10 ml) is taken in a conical flask and 3% HPO_3 solution is added to make final volume of 100 ml. A 10 ml sample of this newly made and filtered stock solution is then taken. Standard dye 2, 6-Dichlorophenol-Indophenol, is used to titrate this solution until it has a pink end point look. Titrated quickly and assessed the titer in an initial manner. The vitamin C content of the sample, calculated by the following formula

Ascorbic acid (mg/100 g) of fruit = (Titre ×Dye factor × volume made up × 100) / Weight of sample

Total sugar content is stated as a percentage based on the weight of fresh fruit (A.O.A.C. 1980).

Total sugar (%) = (Fehling factor × Dilution × Dilution) / (Titre value × Volume of aliquate taken for measurement × Weight or volume of sample taken (g)) × 100

Fehling Factor = 0.052

The results are presented as a percentage based on the weight of fresh fruit as given in (A.O. A.C. 1980).

Reducing sugar (%) = (Fehling factor × Dilution) / (Titre value × Weight or volume of sample taken (g)) × 100

Fehling Factor = 0.052

Non-reducing sugars = (Total sugars - reducing sugars) x 0.95

Total SolubleSolids: Using an Erma-hand refractometer (0-32 °Brix), the total soluble solid of the juice is calculated by placing a few drops of juice on the prism. Prior to usage, the refractometer is calibrated using purified water. Whenever the temperature went over or below 20 ˚C, an adjustment was performed (A.O.A.C. 2002).

Acidity: The percentage of acidity was computed with the use of a particular

Titratable acidity (%) = (Titer value × Normality of NaOH × Volume made up (ml) × Equivalent weight of acid × 100) / (Volume of sample taken for estimation (ml) × Weight or volume of sample taken (g) × 1000)

TSS/a**cid Ratio:** Divide the total soluble solids by the acidity to find the total soluble solids to acid ratio.

2.2.3 Yield attributes

Fruit weight, No. of fruits per tree, fruit yield: To determine weight of the fruit, we weighed the ten selected fruits and calculated the average weight in grams (g). At the time of harvesting, the number of fruits harvested from five randomly chosen plants was recorded. Next, the average quantity of fruits produced by each plant was determined. At each harvest, the entire quantity of fruit produced by each plant is weighed, recorded, and reported as the yield of fruits per plant in grams (g).

2.3 Economic Parameters

The cost of cultivation per hectare is determined by calculating the expenses for inputs, managerial aspects and cultural practices. The net profit per hectare is obtained by deducting these costs from the gross income according to the going market selling rate. The net return is then divided by the cultivation cost to determine the benefit-cost ratio.

2.3.1 Cost of cultivation

Each treatment's cultivation cost was determined using the variables, fixed inputs, and corresponding prices.

2.3.2 Gross income

In a similar manner, the market rate of the produce was used to determine gross income for each treatment.

2.3.3 Net returns

The total cost of cultivation is then subtracted from the gross income for each treatment to determine net returns.

Net return = Gross income – Total cost of cultivation

2.3.4 Benefit: cost ratio

Net returns are divided by total cost of production to get the benefit-cost ratio.

Benefit: cost ratio= Net return / Total cost of production

2.4 Statistically Analysis

The statistical analysis conducted in R (R Studio version 2022.07.1) involved performing a one-way analysis of variance (ANOVA) at a 5% significance level, using the "stats" package. Additionally, a Duncan Multiple Range Test

(DMRT) was applied as a post-hoc analysis to compare the means of various treatment combinations, utilizing the "agricolae" package.

3. RESULTS AND DISCUSSION

3.1 Fruit Physical Parameters (Fruit Volume, Firmness and Specific Gravity)

The result showed in Table 1 demonstrated the significant effects of GA_3, Tricontonal, and NAA on the volume of guava fruits. The results demonstrated that PBR_3 NAA (100ppm) had the largest fruit volume (85.72 cm^3), which was statistically equivalent to PBR_2 (NAA 75ppm) at 83.12 cm^3 and PBR_4 GA_3 50ppm (82.73 cm^3) whereas in control, the lowest fruit volume (57.36 cm^3) was noted.

The data presented in Table 1. It showed the impact of NAA, GA_3, and Tricontonal on guava fruits volume. The results showed that minimum firmness (8.05 Kg/cm^2) was found in PBR_3 NAA (100ppm) while the maximum firmness (8.73 Kg/cm^2) was recorded in control PBR_3 NAA (100ppm) which was statistically followed by PBR_7 (Tricontonal 25ppm) i.e., 8.63 Kg/cm^2.

The data regarding the effect of NAA, GA_3, and Tricontonal on the specific gravity of guava is presented in Table 1. The maximum specific gravity (1.02 %) was recorded in PBR_3 (NAA 100ppm), which was statistically equivalent with PBR_2 NAA 75ppm (0.99 %) and PBR_4 GA_3 50ppm (0.96 %) while in control, the lowest specific gravity (0.83 %) was noted. Awasthi and Lal (2009) suggested that an increase in fruit size (length and breadth) could result from a balanced supply of nutrients and growth regulators to the plant throughout the entire crop growth period, which would drive the plant's vigorous vegetative development and ultimately increase the amount of photosynthates produced.

3.2 Fruit Quality Parameters

Ascorbic acid: In Table 2, data on the presence of ascorbic acid is presented. The result indicated that PBR_3(NAA 100ppm) had the highest ascorbic acid content (252.85 mg/100g), followed by PBR_2 NAA 75ppm (248.14 mg/100g), and control had the lowest ascorbic acid content (205.14 mg/100g).

Total Sugar: The total sugar content data has been shown in Table 2 Maximum total sugar content (10.73%) was recorded in PBR_3 (NAA 100ppm), which was statistically equivalent with PBR_2 NAA 75ppm (10.68%) and minimum total sugar (7.84%) was observed in control.

Reducing Sugar: The data analysis showed that the response of NAA, GA_3, and Tricontonal was significant. The results indicated that PBR_3 (NAA 100ppm) had the highest reducing sugar content (5.17%), which was statistically comparable to PBR_2 NAA 75ppm (5.16%) and PBR_4 (GA_3 50ppm), or 5.14%. In control, the lowest reducing sugar content (3.86%) was recorded.

Non-reducing Sugar: Table 2 displays the non-reducing sugar content data. The maximum non-reducingsugar content (5.57%) was found in PBR_3 (NAA 100ppm), which was statistically comparable with PBR_2 (5.55%) and minimum non-reducing sugar (3.98%) was observed in control.

Table 1. Effect of foliar application of plant bioregulators on fruit volume, firmness and specific gravity on guava cv. Allahabad Safeda

Treatments	Fruit volume (cm^3)	Firmness (Kg/cm^2)	Specific gravity (%)
Treatments	71.39e	8.20^{de}	0.93^{cd}
PBR_1 (50 ppm NAA)	83.12bc	8.07^{fg}	0.99^{ab}
PBR_2 (75 ppm NAA)	85.72b	8.05^{g}	1.02^{a}
PBR_3 (100 ppm NAA)	82.73bc	8.13^{efg}	0.96^{abc}
PBR_4 (GA_3 50 ppm)	76.21d	8.14^{ef}	0.95^{bc}
PBR_5 (GA_3 100ppm)	65.34f	8.24^{d}	0.92^{cd}
PBR_6 (GA_3 150ppm)	60.09g	8.63^{b}	0.85^{ef}
PBR_7 (Tricontonal 25 ppm)	81.58c	8.27^{d}	0.89^{de}
PBR_8 (Tricontonal 50 ppm)	93.47a	8.36^{c}	0.94^{bcd}
PBR_9 (Tricontonal 75 ppm)	57.36g	8.73^{a}	0.83^{f}
C (Control)	1.09	0.02	0.01
SE(m)±	3.28	0.06	0.04

Table 2. Effect of foliar application of plant bioregulatots on ascorbic acid, total sugar, reducing sugar, and non-reducing sugar on guava cv. Allahabad Safeda

Treatments	Ascorbic acid (mg/100 g)	Total sugar (%)	Reducing sugar (%)	Non reducing sugar (%)
PBR_1 (50 ppm NAA)	232.33^e	8.84^f	4.35^{bc}	4.49^d
PBR_2 (75 ppm NAA)	248.14^b	10.68^a	5.16^a	5.55^a
PBR_3 (100 ppm NAA)	252.85^a	10.73^a	5.17^a	5.57^a
PBR_4 (GA_3 50 ppm)	247.95^b	10.41^b	5.14^a	5.26^b
PBR_5 (GA_3 100ppm)	242.75^c	9.55^d	4.54^b	4.94^c
PBR_6 (GA_3 150ppm)	224.04^f	8.64^g	4.55^{bc}	4.45^d
PBR_7 (Tricontonal 25 ppm)	209.52^h	7.96^h	3.56^e	4.02^e
PBR_8 (Tricontonal 50 ppm)	212.77^g	9.36^e	4.21^c	4.05^e
PBR_9 (Tricontonal 75 ppm)	240.78^d	9.93^c	4.40^{bc}	4.51^d
C (Control)	205.14^i	7.84^i	3.86^d	3.98^e
SE(m)±	0.62	0.02	0.07	0.02
CD $_{(0.05)}$	1.86	0.08	0.23	0.08

The combined action of plant regulators may result in a higher sugar concentration. The larger amount of growth may be the cause of the increase in total sugars. In addition, because these regulators aid in photosynthesis, there is an increased build-up of polysaccharides and oligosaccharides. Along with this, they also control the activity of the enzymes, which rapidly converted starch into soluble sugars and accelerated ripening in response to building blocks (Kaur and Kaur, 2017).

TSS and Acidity: Table 3 presents the examination data for total soluble solids. The data showed that the maximum TSS resulted in PBR_3 NAA 100ppm (10.86 ^{0}Brix) and statistically followed by PBR_2 (NAA 75ppm) i.e., 10.36 ^{0}Brix whereas the minimum (8.34 ^{0}Brix) was observed with the control. The Table 4. showed the data for titratable acidity and data revealed that minimum titratable acidity was recorded in PBR_3 NAA (100ppm) (0.24%). Whereas the maximum was (0.43%) observed and statistically followed by PBR_7 Tricontanol (25ppm) having value (0.41%).

TSS: Acid Ratio: Table 3 presents the results of the TSS: Acid ratio analysis. The results demonstrated that maximum TSS: Acid ratio (37.24%) was recorded in PBR_3 NAA 100ppm and statistically followed by PBR_2 NAA 75ppm i.e., 35.38%, whereas in control the minimum TSS: Acid ratio was (18.82%) observed.

TSS may have increased because auxin synthesised more metabolites, which were then rapidly translocated from other areas of the plant to growing fruits (Garasiya, 2013). As a result, fruits treated with NAA served as a powerful sink for metabolites extracted from the leaves. According to Rajput et al. (2016), fruits' higher metabolic activity was caused by the TSS's ability to transform complicated chemicals into simpler ones. Auxin-mediated mobilisation of carbohydrates from the sink source (fruits) may be the cause of the rise. This could be explained by the possibility that NAA boosted amylase activity, resulting in a rapid metabolic conversion of starch to soluble sugars and a rise in TSS from early ripening in response to growth chemicals. Agnihotri et al. (2013) gave similar findings in his research on guava. The results of Dubey et al. (2002) are likewise consistent with the current findings.

3.3 Yield Parameters (Weight, Number of Fruits, Yield/Tree)

Table 4 displays the fruit weight data where the effect of different treatments was found significant. PBR_3 (NAA 100ppm) had the largest fruit weight (182.6 g), statistically followed by PBR_2 (175.86 g), and C (control) had the lowest fruit weight (132.16 g). Table 4 data demonstrates that plants treated with 100 ppm of NAA produced the greatest number of fruits per tree (167.86), statistically followed by PBR_2 (141.06), while control showed the lowest number of fruits per tree (102.33). An examination data for fruit yield per plant data under different treatment was found significant shown in Table 4. The data indicates that 100ppm NAA resulted in the maximum fruit yield per plant (30.65 kg/tree) and followed by treatment PBR_2 (24.80 Kg/tree) while in control the minimum fruit yield per plant (13.52 Kg/tree) was observed.

The weight gain of the fruit may have contributed to the increase in yield, and this weight gain may have strengthened the cell walls and middle lamella. This improvement probably allowed more solutes to freely flow to the fruits, increasing their length, diameter, and ultimately weight. The application of NAA (naphthaleneacetic acid) may contribute to this by promoting higher metabolite flow from the leaves to the fruits, resulting in heavier fruits. Furthermore, the intermediate lamella and cell walls may have been reinforced by the exogenous NAA supply, which would have made it easier for nutrients and minerals to be transferred from other plant sections to the growing fruits, which are extremely active metabolic sinks.The weight of the fruit may have increased as a result. Therefore, the increased weight and volume of the fruits account for the increase in yield per plant (Katiyar et al., 2008).

3.4 Economic Parameters

Table 5 presents the average statistics for the cost of cultivation, gross income, and net return (Rs/ha) under the different treatments. The cost at which guava fruit was sold was set at Rs. 40 per kilogram.

Cost of cultivation: The cost of cultivation per hectare for different doses of plant growth regulators was calculated to be the lowest (Rs 1,30,790) with the control, and the highest (Rs 2,10,790) in PBR_3 NAA 100 ppm.

Gross income: An examination of data from different treatments of plant growth regulators revealed that the highest gross income (Rs 586074.9) was calculated in PBR_3 (NAA 100 ppm), whereas the lowest gross income (Rs 258599.1) was calculated in C control.

Net returns: The net income data showed that the cost of cultivation per hectare was lowest (Rs 127809.1) in the control, while it was highest (Rs 454237.9) in PBR_3 (NAA 100 ppm).

Table 3. Effect of foliar application of plant bioregulators on total soluble solid, acidity, and TSS: Acidity ratio on guava cv. Allahabad Safeda

Treatments	TSS (^{0}Brix)	Acidity (%)	TSS: acidity ratio
PBR_1 (50 ppm NAA)	9.06^{f}	0.30^{de}	26.94e
PBR_2 (75 ppm NAA)	10.36^{b}	0.34^{bcd}	35.38b
PBR_3 (100 ppm NAA)	10.86^{a}	0.24^{e}	37.24a
PBR_4 (GA_3 50 ppm)	10.24^{c}	0.32^{cde}	32.05c
PBR_5 (GA_3 100ppm)	9.84^{d}	0.03^{de}	32.07c
PBR_6 (GA_3 150ppm)	8.93^{g}	0.35^{bcd}	24.85f
PBR_7 (Tricontonal 25 ppm)	8.44^{i}	0.41^{ab}	20.46h
PBR_8 (Tricontonal 50 ppm)	8.06^{h}	0.34^{bcd}	23.88g
PBR_9 (Tricontonal 75 ppm)	9.77^{e}	0.39^{abc}	28.32d
C (Control)	8.34^{j}	0.43^{a}	18.82i
SE(m)±	0.02	0.02	0.30
CD $_{(0.05)}$	0.06	0.07	0.90

Table 4. Effect of foliar application of plant bioregulators on fruit weight, no. of fruits and fruit yield on guava cv. Allahabad Safeda

Treatments	Fruit weight (g)	No. of fruits per tree	Fruit yield(kg/tree)
PBR_1 (50 ppm NAA)	167.66^{d}	119.03^{f}	38.25^{f}
PBR_2 (75 ppm NAA)	175.86^{b}	141.06^{b}	46.11^{d}
PBR_3 (100 ppm NAA)	182.6^{a}	167.86^{a}	48.34^{c}
PBR_4 (GA_3 50 ppm)	172.36^{c}	131.93^{c}	46.45^{d}
PBR_5 (GA_3 100ppm)	170.93^{c}	125.66^{d}	43.47^{e}
PBR_6 (GA_3 150ppm)	163.05^{e}	115.76^{g}	38.30^{f}
PBR_7 (Tricontonal 25 ppm)	143.06^{g}	109.43^{i}	37.82^{f}
PBR_8 (Tricontonal 50 ppm)	154.56^{f}	110.53^{h}	64.26^{b}
PBR_9 (Tricontonal 75 ppm)	169.76^{cd}	120.07^{e}	79.75^{a}
C (Control)	132.16^{h}	102.33^{j}	33.86^{g}
SE(m)±	0.89	0.32	0.54
CD $_{(0.05)}$	2.67	0.96	1.64

Table 5. Effect of foliar application of plant bioregulators on total cost, Gross income, Net returns, Benefit: cost ratio of guava cv. Allahabad Safeda

Treatments	Total cost	Gross income	Net returns	Benefit: cost ratio
PBR_1(50 ppm NAA)	131313.0	381595.5	250282.5	1.91
PBR_2(75 ppm NAA)	131575.0	474346.6	342771.6	2.61
PBR_3(100 ppm NAA)	131837.0	586074.9	454237.9	3.45
PBR_4(GA_3 50 ppm)	133085.0	434806.2	301721.2	2.27
PBR_5(GA_3 100ppm)	135340.0	410709.5	275369.5	2.03
PBR_6(GA_3 150ppm)	137635.0	361900.5	224265.5	1.63
PBR_7(Tricontonal 25 ppm)	132515.0	300463.7	167948.7	1.27
PBR_8(Tricontonal 50 ppm)	134240.0	326660.8	192420.8	1.43
PBR_9(Tricontonal 75 ppm)	135990.0	391784.8	255794.8	1.88
C(Control)	130790.0	258599.1	127809.1	0.98

Benefit: cost ratio: Data regarding the B: C ratio revealed that the cost of cultivation per hectare among different treatments of plant growth regulators was calculated to be lowest (0.98) with the control, while it was highest B: C ratio (3.45) in PBR_3 (NAA 100 ppm).

4. CONCLUSION

The study highlights the significant role of plant growth regulators in enhancing guava yield, quality, and economic returns. Among the various treatments tested, NAA 100 ppm (PBR_3) delivered the best performance in terms of growth, fruit yield, and quality, resulting in the highest net return of Rs. 454,237 and the most favorable benefit-cost (B:C) ratio. GA_3 75 ppm (PBR_4) also showed promising results but was outperformed by NAA 100 ppm. Therefore, the use of NAA 100 ppm is strongly recommended for guava cultivation to improve both production efficiency and profitability for farmers in India.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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