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# Effect of Plant Growth Regulators in Return and Profitability of Cultivation of Guava (*Psidium guajava* L.) in Prayagraj, Uttar Pradesh: (An Economic Analysis)

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**ABSTRACT: The current study was undertaken to determine the most cost-effective treatment that will provide the greatest return for the smallest outlay in the treatment of plant growth regulators during 2021-22 at Central Research Farm, Department of Horticulture, Sam Higginbottom Institute of Agriculture & Sciences, Prayagraj (U.P.). The experiment consist of ten treatments (one control, three Gibberellic acid ($GA_3$) @75ppm, @100ppm and @125ppm, three levels of Naphthalene acetic acid (NAA) @200ppm, @250ppm and @300ppm and three levels of 2 Chloroethyl tri-methylammonium Chloride, Chlormequat (CCC) @400ppm, @500ppm and @600ppm). It was found that the cost of cultivation of guava varied from ₹ 229850 $ha^{-1}$ to ₹ 226100 $ha^{-1}$. The productivity level was found to be highest from the concentration of NAA @ 250 ppm i.e. 730.4 q $ha^{-1}$. It is abundantly obvious that NAA's (naphthalene acetic acid) effectiveness as a plant growth regulator was shown to be more effective and profitable due to increases in productivity, profitability, and economic efficiency. The treatment ($T_4$) of NAA @ 200 ppm gave the highest (1:5.8) benefit-cost ratio followed by NAA @ 250 ($T_5$) and NAA @ 300 ($T_6$). It means the guava growers are getting the highest return i.e. ₹ 5.8 from guava production over expenditure of ₹1.00.**

**Keywords:** Guava, $GA_3$, NAA, CCC, Cost of Cultivation, yield, Economics.

## INTRODUCTION

Guava is one of India's most widely grown and significant fruit crops (Mitra *et al*., 2008). It is ranked fourth in terms of area and production importance. It can be grown in a variety of climatic and soil environments. The total area of guava in the country was 304 thousand hectares with a production of 4.92 mm tons (2022). The production of the crop had increased from the previous year (Published by Statista Research Department, 2022). Among all the states of the country; Uttar Pradesh, Bihar, Madhya Pradesh, and Maharashtra are the major guava-growing states of the country. Uttar Pradesh being the highest guava-producing state covers around 16.49 per cent of area and 21.78 percent of the production of guava in the country (National Horticulture Board, 2022 and APEDA, Agri exchange, 2022). The guava fruit of Uttar Pradesh of Allahabad city has the reputation of growing the best guava in the country as well as in the world. Fresh guavas are rich in vitamins A, B, C and D. It is a climacteric fruit and highly perishable in nature.

In the country's tropical and subtropical regions, guavas are a significant fruit crop. Due to the extensive tree canopy, the traditional style of farming frequently presented difficulties in achieving the required levels of productivity. As a result, it became necessary to enhance the current production system in addition to raising its productivity. There is a current trend for fruit trees to be planted more densely or in the meadow, orchards to manage tree size, preserve the ideal design, and make operations like pruning, pest control, and harvesting easier. High density orcharding in meadows helps to improve fruit yield and quality. Therefore, keeping in view the importance of the wheat crop, the present study was undertaken with the following specific objective.

To determine the most cost-effective treatment that will provide farmers with the greatest return for the smallest outlay in the treatment of plant growth regulators.

## MATERIAL AND METHODS

The present study was carried out at the Horticulture Research Farm, Sam Higginbottom Institute of Agriculture & Technology Sciences, Prayagraj during the year 2021-22. Eight years old 30 guava trees with uniform vigor and size with 2 × 1 m plant spacing were selected for investigation. The whole tree was used as the single experimental unit. Suitable tools i.e. simple randomized block design and B:C ratio were applied to

determine the effectiveness of the plant growth hormones in the cultivation of the Guava fruit crop in the study area. The details of methods of analysis using the following statistical and econometrical models are presented as under.

**Experimental Details.** This experiment was laid out in a simple randomized block design (RBD) with three replications. The treatment consists of three different plant growth regulators namely $GA_3$ (Gibberellic acid), NAA (Naphthalene acetic acid), CCC (2 Chloroethyl tri-methylammonium Chloride, Chlormequat) with three concentrations of each PGR. This plain distilled water was sprayed on the plants as a control. In this way total ten treatments were used in this experiment.

Date of treatments applications: (3 Spray)

(i) 1st Spray-: 17 September 2021

(ii) 2nd Spray-: 2 October 2021

(iii) 3rd Spray-: 17 October 2021

**Table 1: Plant Growth Regulators along with concentration.**

| Sr. No. | Treatment number with notations | Plant Growth Regulators | Concentration |
|---|---|---|---|
| 1. | $T_0$ | CONTROL | Water spray |
| 2. | $T_1$ | $GA_3$ | 75 ppm |
| 3. | $T_2$ | $GA_3$ | 100 ppm |
| 4. | $T_3$ | $GA_3$ | 125 ppm |
| 5. | $T_4$ | NAA | 200 ppm |
| 6. | $T_5$ | NAA | 250 ppm |
| 7. | $T_6$ | NAA | 300 ppm |
| 8. | $T_7$ | CCC | 400 ppm |
| 9. | $T_8$ | CCC | 500 ppm |
| 10. | $T_9$ | CCC | 600 ppm |

Thus, the selected trees were sprayed 3 times with the treatments of different concentrations of $GA_3$, NAA and CCC during September and October 2021. A very small quantity of teepol was mixed in each spray solution of treatments as a surfactant. Spraying was done by knapsack sprayer @ 25 liter plant.

**Return and Profitability.** Different economic tool were applied to analyse the economic efficiency and profitability of guava crop. The similar methodology used by Rai and Tripathi (2019).

Net Income (Rs/ha) = Gross Income - Total Cost

$$B:C\ Ratio = \frac{\text{Gross income (Rs/ha)}}{\text{Total cost (Rs/ha)}}$$

**Table 2. Analysis of variance (ANOVA).**

| Source of Variance | d.f. | S.S. | M.S.S. | F(cal)-subscript | F(tab)-subscript At 5% | Result |
|---|---|---|---|---|---|---|
| Replications | (r-1) | SSR | SSR / d.f. | MSSR/MESS | - | S/NS |
| Treatments | (t-1) | SSTr | SSTr / d.f. | MSSTr/ MESS | - | S/NS |
| Error | (r-1)(t-1) | SSE | SSS / d.f. | - | - | - |
| Total | (rt-1) | TSS | - | - | - | - |

**Source-** Author's calculation based upon data

**[Note-:** D.F. = Degree of freedom, R = Replication, S.S. = Sum of squares, T= Treatment, M.S.S. = Mean sum of squares R.S.S. = Replication sum of squares, T.S.S. = Total sum of squares, E.S.S. = Error sum of squares, S.S.R. = Sum of squares due to replications, S.S.I. = Sum of squares due to interaction, S.S.F. = Sum of squares due to organic manure, E.M.S.S. = Error mean sum of squares, M.M.S.I. = Mean sum of squares due to organic fertilizer, M.R.S.S. = Mean replication sum of squares, M.T.S.S. = Mean treatment sum of squares, M.E.S.S. = S.E. (d) x 't' error df. at 5 % level of significance, $F_{(Cal)}$ = Calculated value of 'F', $F_{(tab)}$ = Tabulated Value of 'F' ]

$$C.D = S.E. \times t\ (error)\ df@5\%$$

$$\text{Where, } S.E.(d) = \sqrt{\frac{2 \times M.E.S.S.}{r}}$$

The significance and non-significance of the treatment effect was judged with the help of F test known as the variance ratio test. The Calculated 'F' value was compared with the table value of 'F' at 5% level of significance. If the calculated value exceeds the table value, the effect was considered to be significant. The significant differences between the means were tested against the critical differences at 5% level of significance. ANOVA (Table 2) was used for testing the hypothesis.

## RESULT AND DISCUSSION

The effect of different PGR's on the cost, return, and profitability of guava crop was examined and the data on the same are presented in the Table 3. The economics of treatments is an important goal in determining the best treatments that will improve the income and return structure of the farming community. The information on the dynamics of cost and profitability of guava production will be helpful to policymakers for deciding over on the price, bonus and other related issues of the guava producers.

**Cost of cultivation of guava per the different concentrations of PGR.** Per hectare costs of cultivation of guava for different concentrations of different PGRs are worked out and data on the same are presented in Table 3. The cost of cultivation of guava was varied from ₹229850ha$^{-1}$ to ₹ 226100 ha$^{-1}$. It is depicted from the data that the cost of cultivation of guava was highest for $T_3$ i.e. $GA_3$ @ 100 ppm (₹229850ha$^{-1}$) and it was lowest for $T_0$ i.e. control (water spray) (₹226100ha$^{-1}$). It was observed that the overall cost of cultivation of guava was highest for all the concentrations of Gibberellic acid rather than the control, NAA and CCC. It can be also concluded that guava cultivation through control treatment followed by different concentrations of NAA are more cost-effective than the other treatments of guava.

**Table 3: Cost and return from the cultivation of Guava.**

| Sr. No. | Treatment with concentration | Treatment notation | Cost of cultivation (Rs/ha) | Total Yield(q/ha) | Price per quintal (Rs/q) | Gross return (Rs/ha) | Net Return (Rs/ha) | B:C Ratio |
|---|---|---|---|---|---|---|---|---|
| 1. | Control (water spray) | $T_0$ | 226100 | 348.5 | 1800 | 627300 | 401200 | 2.8 |
| 2. | GA3 (75ppm) | $T_1$ | 228350 | 387.6 | 1800 | 697680 | 469330 | 3.1 |
| 3. | GA3 (100ppm) | $T_2$ | 229100 | 425.7 | 1800 | 766260 | 537160 | 3.3 |
| 4. | GA3 (125ppm) | $T_3$ | 229850 | 467.5 | 1800 | 841500 | 611650 | 3.7 |
| 5. | NAA (200ppm) | $T_4$ | 226460 | 734 | 1800 | 1321200 | 1094740 | 5.8 |
| 6. | NAA (250ppm) | $T_5$ | 226550 | 701.9 | 1800 | 1263420 | 1036870 | 5.6 |
| 7. | NAA (300ppm) | $T_6$ | 226640 | 682.4 | 1800 | 1228320 | 1001680 | 5.4 |
| 8. | CCC (400ppm) | $T_7$ | 226772 | 602.3 | 1800 | 1084140 | 857368 | 4.8 |
| 9. | CCC (500ppm) | $T_8$ | 226940 | 556.4 | 1800 | 1001520 | 774580 | 4.4 |
| 10. | CCC (600ppm) | $T_9$ | 227108 | 511.1 | 1800 | 919980 | 692872 | 4.1 |

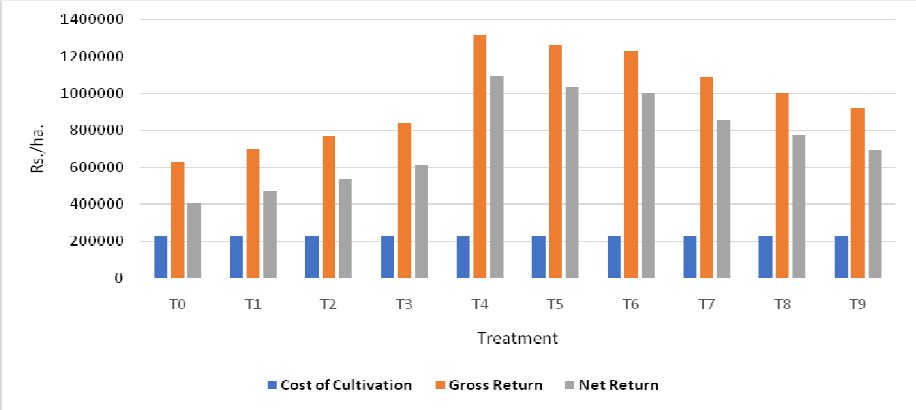


**Fig. 1.** Effect of different PGR's on Cost of cultivation, Gross and Net return of Guava cultivation.

**Return & Profitability from guava cultivation.** The ultimate aim of the farmer is to maximize profit from an agri-enterprise. The increase in profit can be achieved either through reduction in cost or enhancement of the productivity or both of them. The data on profitability from guava cultivation are presented in Table 3. The data shows that the highest gross income was observed from $T_4$ i.e. NAA @ 200 ppm (₹1321200 $ha^{-1}$) followed by NAA @ 250 ppm (₹1263420 $ha^{-1}$), NAA @ 300 ppm (₹1228320 $ha^{-1}$) and it was least from $T_0$ i.e. Control (water spray) (₹627300 $ha^{-1}$). The similar result was observed in case of net return. The highest net income was received from $T_4$ i.e. NAA @ 200 ppm (₹1094740 $ha^{-1}$) followed by other concentrations of NAA i.e. 250 and 300 ppm. According to Rajput *et al.* (1977); Singh *et al.* (2017); Prajapati and Singh (2018); Singh (2019) different concentrations of NAA markedly improved the quality due to increased sweetness of fruit pulp resulted enhance the price of the fruit. Drastic change was observed in the productivity level of guava. Which are ranges from 340- 730 q $ha^{-1}$. The productivity level was found to be highest from the concentration of NAA @ 250 ppm i.e. 730.4 q $ha^{-1}$. It is clearly indicated that among all the plant growth regulators performance of NAA (Naphthalene acetic acid) was found to be more effective and become more profitable on account of increase in productivity, profitability and enhancing economic efficiency. Similarly among all the concentration of all the PGR's and control; the effect of NAA @ 250 ppm showed best result in case of enhancement of yield and profitability from guava cultivation in the Prayagraj (U.P.). Similar result reported by Chaudhary *et al.* (1990); Katiyar *et al.* (2008); Kassem *et al.* (2010); Garasiya *et al.* (2013); Gurjar *et al.* (2018); Kapadnis and Singh (2022).

**Benefit cost ratio.** Benefit cost ratio give rough estimates about the rate of return from the investment. The benefit cost put ratio reflects the criteria for the economic viability of the crop based on return per rupee invested. The data on benefit cost ratios in the cultivation of guava at total cost for the study area are given in Table 3. The data indicated that the foliar spray of NAA, increased benefit cost ratio in guava. The treatment ($T_4$) of NAA @ 200 ppm gave highest (1:5.8) benefit cost ratio followed by NAA @ 250 ($T_5$) and NAA @ 300 ($T_6$). Similar findings were reported by Yadav *et al.* (2001); Dubey *et al.* (2002); Agnihotri *et al.*(2013); Gurjar *et al.* (2018). It means the guava growers are getting highest return i.e. ₹ 5.8 from guava production over an expenditure of ₹1.00. Therefore, it can be concluded that the efficiency of resource use; variable as well as fixed resources, in guava production enhanced at a faster rate by using NAA as compared to control and treatments of different concentration of $GA_3$ and CCC. Thus it is an indicator of higher economic efficiency in guava cultivation. Similar findings were reported by Dhariwal *et al.* (2002); Mohammed *et al.* (2006); Shukla *et al.* (2008); Hiremath *et al.* (2017); Meena *et al.* (2017), with similar treatment application.

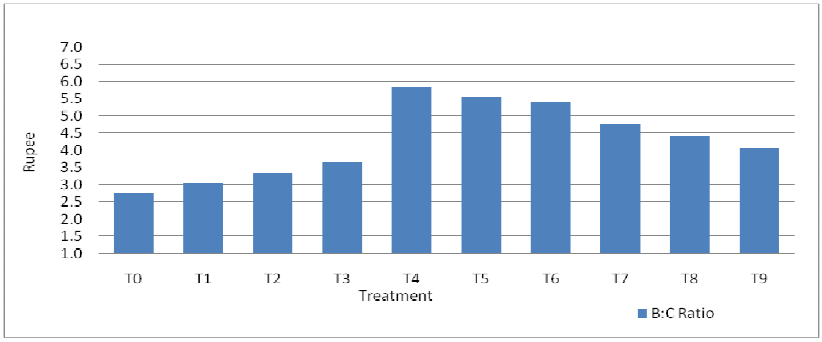


**Fig. 2.** Effect of different PGR's on B:C ratio of Guava cultivation.

## CONCLUSIONS

Guava is one of India's most widely grown and significant fruit crops. It is ranked fourth in terms of area and production. Among all the states of the country; Uttar Pradesh, Bihar, Madhya Pradesh, Maharashtra are the major guava-growing states of the country. Uttar Pradesh being the highest guava-producing state covers around 16.49 percent of the area and 21.78 percent of the production of guava in the country (National Horticulture Board, 2022 and APEDA, Agri exchange, 2022). It is concluded that the overall cost of cultivation of guava was highest for all the concentrations of Gibberellic acid rather than the control and other concentrations of NAA and CCC. It was also found that guava cultivation through control treatment followed by different concentrations of NAA are more cost-effective than the other treatments of guava. The data shows that the highest gross income was observed from $T_4$ i.e. NAA @ 200 ppm followed by NAA @ 250 ppm NAA @ 300 ppm and it was the least from $T_0$ i.e. Control (water spray) (₹627300 $ha^{-1}$). A similar result was observed in the case of net return. Drastic change was observed in the productivity level of guava. It was highest from the concentration of NAA @ 250 ppm i.e. 730.4 q $ha^{-1}$. The foliar spray of NAA, increased the cost ratio in guava. Therefore, it can be concluded that the efficiency of resource use; variable as well as fixed resources, in guava production enhanced at a faster rate by using NAA as compared to control and treatments of different concentration of $GA_3$ and CCC. It is indicated that among all the plant growth regulators performance of NAA (Naphthalene acetic acid) was found to be more effective and become more profitable on account of increase in productivity, profitability and enhanced economic efficiency.

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