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Study The Efficacy of Chemicals on The Quality Parameters of Guava (Psidium Guajava)

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ABSTRACT

Plant growth hormones are chemicals that, in small amounts promote growth, development, and differentiation of cells and tissues. It plays a vital role in guava production and helps in the induction of flowering, fruiting buds development, fruit set, fruit thinning, fruit elongation, premature fruit drop prevention, and inhibiting the ripening process. An investigation was conducted to study the efficacy of chemicals on the quality parameters of guava in the Experimental Laboratory, Department of Botany, B. R. A. Bihar University, Muzaffarpur. A total of 6 (six) treatments with four replications and two seasons (rainy and winter) were laid out in a Randomized Block Design.

Keywords: Escherichia coli, Staphylococcus aureus, Bacillus cereus, Penicillium sp

I. INTRODUCTION

The treatments comprised of T_1 – Naphthalene acetic acid (NAA at 100 ppm), T_2 – Naphthalene acetamide (NAD at 40 ppm), T_3 – Naphthalene acetamide (NAD at 60 ppm), T_4 - Urea (2%), T_5 – Urea (5%) and T_6 – Urea (10%) which were applied during the flowering in April 2017. It helped in deblossoming of flowers, increase the yield (20.73kg/plant), juice content (48.45%), TSS (10.73°Brix), reducing sugar (3.74%), non-reducing sugar (3.10%), total sugar (6.82%), sugar acid ratio (45.46), pectin content (3.42%), ascorbic acid (264.18 mg/100 g) and also decrease the titrable acidity (0.15%). NAD @ 60ppm was recorded to be the best treatment to fulfill the quality parameters of guava in the winter season [1-7].

Guava, the "apple of the tropics" is the most important commercial fruit crop grown in the sub-tropical region of the Indian subcontinent. It gives an assured crop with a low cost of production as compared to most other commercial fruit crops. It has gained considerable prominence on account of its high nutritive value, cheap and easy availability at moderate prices. India is the leading producer of guava in the world and the fruit occupies a place of considerable importance in the fruit economy of the country. In the north-eastern region of

India, Bihar claims to be in the position in growing Guava (Anon, 2015) but its productivity is far below the national average due to poor fruit set and high fruit drop (Ojah, 2013).

In Bihar, Guava bears two seasons only i.e. Rainy and winter seasons. The rainy season fruits are insipid, and rough (Ojah, 2013) and are affected by many biotic and abiotic stresses. The quality of the fruits is inferior, less nutritive due to high temperature and humidity, and are also affected by many pests and diseases and infected by fruit flies (Sharma *et al.,* 2016). It has maximum yield but low demand in the market. The winter season fruits are more in demand for more nutritive, superior quality, high sugar content with a good aroma, free from pests and diseases but the yield is low. Thus, the winter season fruits should be preferred more, and is advisable to take one crop in a year. Keeping these facts in view, a systematic study by using plant growth hormones was undertaken to study the efficacy of chemicals on the quality parameters of guava (*Psidium guajava* L) for improving the chemical parameters of the fruit in the winter season during 2021-2023.

II. MATERIALS AND METHODS

The guava orchard with an area of 1728m^2 was well maintained with a spacing of 6m x 6m apart from each plant. A total of six treatments with four replications, two plants in each treatment were laid out in the randomized block design. The treatments with different concentrations of NAA (100 ppm), NAD (40 ppm and 60 ppm), and Urea (2%, 5%, and 10%) were sprayed twice in April 2022. The first spray was in the first week of April at the flowering stage and the second spray was after 10 days of the first spray. The changes in the chemical parameters of the fruit in the winter season rather than the rainy season were determined by different formulas –To find the TSS of the fruit, the fresh fruit was cut into pieces and squeezed out. The juice obtained was determined by Zeiss Hand Refractometer and expressed in percentage [8-15].

$$Titrable\ Acidity = \frac{Titre\ value \times Normality\ of\ alkali \times Volume\ \ made\ up \times Equivalent\ Weight\ of\ citric\ acid}{Wt\ of\ Sample \times Aliquot \times 10}$$

$$Reducing\ sugars\ (\%)\ = \left[\frac{mg\ of\ invert\ sugar \times Dilution\ \times 100}{Titre \times Wt\ of\ sample\ \times 1000}\right]$$

Non-reducing sugars (%) = total sugar (%) - Reducing sugar (%)

Total sugar = % sucrose + % reducing sugar

The ratio of sugar to acid was determined by dividing the percent of total sugar by the percent of total acidity. Pectin content is expressed as a percentage of calcium pectate.

To find out the fruit juice, the fruit was cut into pieces at over ripe stage and squeezed and the juice was expressed in percent.

$$Ascorbic\ acid\ (\frac{mg}{100gm}) = \frac{Titre\ value \times Dye\ factor \times Volume\ \ made\ up}{Aliquot\ of\ extract\ ta\ \ ken\ for\ estimation \times \frac{Weight}{Volume}of\ sample\ taken\ for\ estimation}$$

III. STATISTICAL ANALYSIS

Significance and non-significance of variance due to the different concentrations of NAA, NAD, and Urea were determined by calculating the respective 'F' values (Panse and Sukhatma, 1985). Critical difference (CD) at a 5 % probability level was calculated only when the 'F' value was significant [16].

IV. RESULTS AND DISCUSSION

4.1 Titrable acidity

Table 1 shows a significant difference in titrable acidity due to various treatments. T_4 (2% Urea) recorded the highest titrable acidity of 0.36% and 0.25% followed by 0.33% and 0.24% under T_6 (10% Urea) during both the rainy and the winter seasons. Similarly, the lowest titrable acidity of 0.26% and 0.15% was recorded under treatment T_3 (60 ppm NAD) during both the rainy and the winter seasons respectively. The interaction effect of seasons and treatments was found to be non-significant [17].

The reason for the reduction in acidity with the application of NAD @60ppm might be due to the rapid utilization of organic acid as the respiratory substrate in the respiration process at maturity. It might also be due to the early ripening of fruits where acid might have been used during respiration or firstly converted into sugars. Similar results were obtained by Rajput *et al.,* (1977), Singh *et al.,* (1992), and Dubey *et al.,* (2002).

4.2 Total Soluble Solid (TSS)

T_3 (60 ppm NAD) recorded the highest TSS of 9.13°Brix during the rainy season followed by 8.30°Brix in T_2 (40 ppm NAD) whereas in the winter, the highest TSS (10.73°Brix) was recorded under T_3 (60 ppm NAD) followed by 10.46°Brix in T_1 (100 ppm NAA). The interaction effect of seasons and treatments was found to be significant. The highest TSS of 9.93°Brix was recorded in T_3 (60 ppm NAD) followed by 9.14°Brix under T_2 (40 ppm NAD). However, the treatments T_2 (40 ppm NAD) and T_5 (5% Urea) were statistically *at par* (Table 2).

According to Boora *et al.,* (2016), total soluble solids are the index of sweetness of the fruit. The appreciable improvement in total soluble solids (TSS), due to the application of growth substances might be due to the quick metabolic transformation of starch into sugars and rapid mobilization of photosynthetic metabolites and minerals from other parts of the plant to the developing fruits (Maji *et al.,* 2015).

4.3 Reducing sugar and non-reducing sugar

The data presented in Table 3 revealed that in both the rainy and the winter seasons the highest reducing sugar content of 2.94% and 3.74% was recorded in T_3 (60 ppm NAD) followed by 2.92% and 3.68% in T_1 (100 ppm NAA) [18-20].

The interaction effect of treatments and the seasons was found to be significant. The highest reducing sugar content was recorded in T_3 (60 ppm NAD) at 3.33% followed by 3.30% in T_1 (100 ppm NAA). However, the three treatments T_1 (100 ppm NAA), T_2 (40 ppm NAD), and T_3 (60 ppm NAD) were found to be non-significant.

The non-reducing sugar content of fruit was significantly influenced by various treatments which were shown in Table 4.4. The highest non-reducing sugar content of 2.48% and 3.10% was recorded in T_3 (60 ppm NAD) followed by 2.24% and 3.08% in T_1 (100 ppm NAA) and 2.24% in T_5 (5% Urea).

The interaction effect of treatments and seasons was found to be significant. The highest non-reducing sugar content was recorded in T_3 (60 ppm NAD) as 2.79% followed by 2.66% in T_1 (100 ppm NAA). However, the treatments T_1 (100 ppm NAA) and T_5 (5% Urea) were statistically *at par* with T_2 (40 ppm NAD). The reason for the increase in the content of reduced sugar and non-reducing sugar in winter might be due to a delay in the ripening of fruits, hence providing a long period of fruits to remain on the tree during which they accumulate more carbohydrates within them (Singh, 1986). Similar results were obtained by Kumar and Hoda (1977) and Mitra *et al.,* (1982) when they treated the guava plant with the treatment NAD at 50 ppm or 30 ppm.

4.4 Total sugar

The data presented in Table 5 revealed that in both the rainy and the winter seasons the highest total sugar content of 5.42% and 6.82% was recorded in T_3 (60 ppm NAD) followed by 5.16 % and 6.78% in T_1 (100 ppm NAA) and the lowest of 4.62% and 6.03% wasin T_4 (2% Urea).

The interaction effect of treatments and the seasons was found to be significant. The highest total sugar content of 6.12% was recorded in T_3 (60 ppm NAD) followed by 5.98% in T_1 (100 ppm NAA). However, non-significant differences were observed in the treatments T_1 (100 ppm NAA), T_2 (40 ppm NAD), and T_5 (5% Urea) respectively.

During the rainy season, guava fruits are not so sweet to taste as compared to the winter fruits as they contain more water and are insipid in taste due to greater utilization of sugars (Ojah, 2013). This increase in the content of total sugars in winter season fruits was due to the degradation of polysaccharides into simple sugars by metabolic activities, conversion of organic acids into sugars, and loss of moisture (Kumar, 2012). A similar finding was observed by Shanker (2003) in guava.

4.3.5 Sugar: acid ratio

In Table 6, T_3 (60 ppm NAD) recorded the highest sugar-acid ratio of 20.84 followed by 18.42 in T_1 (100 ppm NAA) during the rainyand the winter season.

The interaction effect of seasons and treatments was found to be significant in Table 6. The highest sugar-acid ratio of 33.15 was recorded in T_3 (60 ppm NAD) followed by 30.33 under T_1 (100 ppm NAA). The lowest sugar-acid ratio of 18.47 was recorded in T_4 (2% Urea).

The increase in sugar acid ratio with auxins application might be attributed to increased sugar content and reduced levels of titrable acidity. The increase in TSS, sugar content, and decrease in acidity with the application of bioregulators results in the maximum sugar: acid ratio when treated with 60 ppm NAD in the guava plant (Maji *et al.,* 2015). A similar improvement in fruit quality in guava through deblossoming with NAD, NAA, and Urea has also been reported by Dubey *et al.,* (2002), Sanjay and Kumar (2004), Dutta and Banik (2006), Tiwari and Lal (2007), and Singh (2008).

4.6 Pectin content

In both the rainy and winter seasons T_3 (60 ppm NAD) recorded the highest pectin content of 2.83% and 3.42% followed by 2.61% and 3.36% in T_1 (100 ppm NAA). Similarly, the lowest pectin content of 1.72% and 3.11% was recorded under treatment T_4 (2% Urea). The interaction effect of seasons and treatments was found to be significant in Table 7. The highest pectin content of 3.14% was recorded in T_3 (60 ppm NAD) followed by 2.98% under T_1 (100 ppm NAA). The auxin might increase the synthesis of pectic acid or it might lead to enhanced methylation of soluble pectin due to which there might be an increase in the highest pectin content in the winter season.

Table-1: Titrable acidity (%)

Treatment	Rainy Season	Winter Season	Pooled

T_1 (100 ppm NAA)	0.28	0.16	0.22
T_2 (40 ppm NAD)	0.29	0.17	0.23
T_3 (60 ppm NAD)	0.26	0.15	0.20
T_4 (2% Urea)	0.36	0.25	0.30
T_5 (5% Urea)	0.32	0.23	0.27
T_6 (10% Urea)	0.33	0.24	0.28
Mean	0.31	0.20	0.25
S.Ed	0.014	0.014	
CD – 5%	0.030	0.030	
	S.Ed	**CD– 5%**	
Treatment	0.016	0.033	
Season	0.005	0.012	
Season X treatment		NS	

Table-2: TSS (0 Brix)

Treatment	**Rainy Season**	**Winter Season**	**Pooled**
T_1 (100 ppm NAA)	6.77	10.46	8.62
T_2 (40 ppm NAD)	8.30	9.98	9.14
T_3 (60 ppm NAD)	9.13	10.73	9.93
T_4 (2% Urea)	7.98	8.48	8.23
T_5 (5% Urea)	7.93	9.72	8.83
T_6 (10% Urea)	8.03	8.95	8.49
Mean	8.023	9.72	8.87
S.Ed	0.609	0.433	
sssCD – 5%	1.298	0.923	
	S.Ed	**CD– 5%**	
Treatment	0.371	0.755	
Season	0.214	0.435	
Season x Treatment	0.523	1.064	

Table-3: Reducing sugar (%)

Treatment	Rainy Season	Winter Season	Pooled
T_1 (100 ppm NAA)	2.92	3.68	3.30
T_2 (40 ppm NAD)	2.89	3.60	3.24
T_3 (60 ppm NAD)	2.94	3.72	3.33
T_4 (2% Urea)	2.54	3.25	2.89
T_5 (5% Urea)	2.64	3.48	3.06
T_6 (10% Urea)	2.63	3.31	2.97
Mean	2.76	3.51	3.13
S.Ed	0.137	0.141	
CD – 5%	0.293	0.302	
	S.Ed	**CD– 5%**	
Treatment	0.105	0.214	
Season	0.061	0.125	
Season x Treatment	0.148	0.301	

Table-4: Non-Reducing Sugar (%)

Treatment	Rainy Season	Winter Season	Pooled
T_1 (100 ppm NAA)	2.24	3.08	2.66
T_2 (40 ppm NAD)	2.14	3.07	2.61
T_3 (60 ppm NAD)	2.48	3.10	2.79
T_4 (2% Urea)	2.08	2.78	2.43
T_5 (5% Urea)	2.24	2.94	2.59
T_6 (10% Urea)	2.13	2.86	2.49
Mean	2.22	2.97	2.59
S.Ed	0.028	0.021	
CD – 5%	0.058	0.038	
	S.Ed	**CD– 5%**	
Treatment	0.026	0.054	
Season	0.010	0.020	
Season x Treatment	0.038	0.077	

Table-5: Total Sugar Content (%)

Treatment	Rainy Season	Winter Season	Pooled
T_1 (100 ppm NAA)	5.16	6.78	5.96
T_2 (40 ppm NAD)	5.03	6.67	5.85
T_3 (60 ppm NAD)	5.42	6.82	6.12
T_4 (2% Urea)	4.62	6.03	5.32
T_5 (5% Urea)	4.88	6.42	5.65
T_6 (10% Urea)	4.76	6.17	5.46
Mean	4.98	6.48	5.73
S.Ed	0.103	0.171	
CD – 5%	0.219	0.364	
	S.Ed	**CD– 5%**	
Treatment	0.183	0.373	
Season	0.068	0.138	
Season x Treatment	0.163	0.332	

Table-6: Sugar acid ratio (%)

Treatment	Rainy Season	Winter Season	Pooled
T_1 (100 ppm NAA)	18.42	42.25	30.33
T_2 (40 ppm NAD)	17.34	39.23	28.28
T_3 (60 ppm NAD)	20.84	45.46	33.15
T_4 (2% Urea)	12.83	24.12	18.47
T_5 (5% Urea)	15.25	27.91	21.58
T_6 (10% Urea)	14.24	25.71	19.97
Mean	16.48	34.11	25.29
S.Ed	0.020	0.071	
CD – 5%	0.045	0.152	
	S.Ed	**CD– 5%**	
Treatment	0.033	0.067	
Season	0.012	0.025	
Season x Treatment	0.193	0.095	

Table-7: Pectin (%)

Treatment	Rainy Season	Winter Season	Pooled
T_1 (100 ppm NAA)	2.61	3.36	2.98
T_2 (40 ppm NAD)	2.43	3.29	2.86
T_3 (60 ppm NAD)	2.86	3.42	3.14
T_4 (2% Urea)	1.72	3.11	2.41
T_5 (5% Urea)	2.32	3.21	2.76
T_6 (10% Urea)	2.10	3.17	2.63
Mean	2.34	3.26	2.79
S.Ed	0.029	0.026	
CD – 5%	0.062	0.056	
	S.Ed	**CD– 5%**	
Treatment	0.012	0.024	
Season	0.031	0.064	
Season x Treatment	0.044	0.090	

Table-8: Ascorbic acid (mg/100g)

Treatment	Rainy Season	Winter Season	Pooled
T_1 (100 ppm NAA)	135.69	254.90	195.30
T_2 (40 ppm NAD)	126.51	232.73	179.62
T_3 (60 ppm NAD)	142.20	264.18	203.19
T_4 (2% Urea)	92.11	128.42	110.26
T_5 (5% Urea)	104.19	154.17	129.18
T_6 (10% Urea)	101.50	132.26	116.88
Mean	117.04	194.45	155.74
S.Ed	1.009	1.675	
CD – 5%	2.150	3.568	
	S.Ed	**CD– 5%**	
Treatment	0.835	1.700	
Season	0.309	0.628	
Season x Treatment	1.182	2.404	

Table-9: Juice Content (%)

Treatment	Rainy Season	Winter Season	Pooled
T_1 (100 ppm NAA)	45.64	46.87	46.25
T_2 (40 ppm NAD)	43.16	42.23	42.69
T_3 (60 ppm NAD)	46.28	48.45	47.37
T_4 (2% Urea)	34.76	36.56	35.66
T_5 (5% Urea)	42.62	41.25	41.93
T_6 (10% Urea)	38.22	40.12	39.17
Mean	41.78	42.58	42.18
S.Ed	0.860	0.570	
CD – 5%	1.832	1.214	
	S.Ed	**CD– 5%**	
Treatment	0.487	0.990	
Season	0.249	0.506	
Season x Treatment	0.785	1.597	

4.7 Ascorbic acid

The data presented in Table 8 revealed that the significant differences in the ascorbic acid content of fruits were due to various treatments. The highest ascorbic acid content of 142.20 mg/100 g and 264.18 mg/100 g was recorded in T_3 (60 ppm NAD) followed by 135.69 mg/100 g and 254.90 mg/100 g in T_1 (100 ppm NAA) during the rainy and the winter season respectively. The interaction effect of treatments and seasons was found to be significant. The highest ascorbic acid content of 203.19 mg/100 g was recorded in T_3 (60 ppm NAD) followed by 195.30 mg/100 g in T_1 (100 ppm NAA). The lowest ascorbic acid content (110.26 mg/100 g) was recorded under T_4 (2% Urea). The highest ascorbic acid content in winter season guava fruits than in those harvested from spring flushed crops might be ascribed to the effect of low temperature. The low temperature governs the enzymatic system involved in biogenesis and catabolism of ascorbic acid. The increase in ascorbic acid also might be due to the catalytic activity of plant bioregulators on its biosynthesis from its precursor glucose-6-phosphate or inhibition of its conversion into dehydroascorbic acid by enzyme ascorbic acid oxidase or both [21-25].

4.8 Juice content

The data shown in Table 9 revealed that T_3 (60 ppm NAD) recorded the highest juice content of 46.28% and 48.45% followed by 45.64% and 46.87% in T_1 (100 ppm NAA) during both the rainy and the winter seasons. The interaction effect of seasons and treatments was found to be significant. The highest juice content of 46.25 % was recorded under T_1 (100 ppm NAA) followed by 45.86% under T_3 (60 ppm NAD). However, treatment T_1 (100 ppm NAA) was statistically *at par* with T_3 (60 ppm NAD) and treatment T_2 (40 ppm NAD) was statistically *at par* with T_5 (5% Urea). The increase in juice content in the winter season might be due to an increase in pulp content, TSS content, less amount of seeds, an increase in ascorbic acid, decrease in titrable acidity.

It has been found from the present experiment that, 60 ppm NAD treatment significantly helped in the deblossoming of flowers in the rainy season and increased the yield along with TSS content, reducing sugar, non-reducing sugar, total sugar, ascorbic acid, and decrease intitrable acidity in the winter season.

From the results, it can be concluded that 60 ppm NAD proved to be the best chemical treatment for enhancing the quality and production of highly remunerative crops.

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