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RESEARCH ARTICLE :

Effect of pre-harvest spray of plant growth regulators and nutrients on yield and marketable quality of guava (*Psidium guajava* L.)

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SUMMARY : A field experiment to study the effect of pre-harvest application of plant growth regulators and nutrients namely giberellic acid (30, 60 & 90 ppm), naphthalene acetic acid (30, 60 & 90 ppm), calcium nitrate (1.0, 1.5 & 2.0 %), zinc sulphate (0.3, 0.6 & 0.9 %) and control (Water spray) on yield and marketable quality of guava (Psidium guajava L.) cv. Gwalior-27 was conducted at Fruit Orchard, College of Agriculture, RVSKVV, Gwalior (M.P.) during the year 2015-16 & 2016-17. The experiment was laid out with thirteen treatments replicated three times in a Randomized Block Design. In the present investigation, the application of plant growth regulators, giberellic acid had significantly enhanced the yield parameters viz., maxmum number of fruits/tree was recorded with NAA, (90 ppm), average fruit weight and the maximum yield (kg) per tree was recorded with GA_3 (90 ppm) followed by GA_3 (60 ppm). Nutrients namely; zinc sulphate and calcium nitrate had also significantly enhanced the yield parameters and retained marketable quality during different storage period (0, 3, 6, & 9 days) viz. marketable fruits retained (%), unmarketable fruits (Decay loss) (%) & marketable fruits retained over control (%) in the year of 2015-16, 2016-17 & in pooled..

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KEY WORDS :
Pre-harvest application, Plant growth regulators, Nutrients, Yield, Marketable Quality, Guava

BACKGROUND AND OBJECTIVES

Guava (Psidium guajava L.) the apple of the tropics, is one of the most well-liked fruits grown in tropical, sub-tropical and some parts of arid regions of India, that belongs to the family Myrtaceae. Because of hardy nature of plant it can survive in adverse climate and grows under a varied range of soils mainly from sandy loam to clay loam (Dhaliwal and Singla, 2002). Guava is generally consumed fresh as a dessert fruit, or processed into many products such as puree, juice, concentrate, jam, jelly, nectar or syrup (Jagtiani et al., 1988). There is an increasing demand of fruits for fresh as well as for processing purpose in domestic and international markets. Under ambient conditions fruits become overripe and mealy within a week, whereas, in cold storage guava cv. Allahabad Safeda fruits maintained quality up to 15 days at 8-10 ºC and 85-90% RH (Tandon et al., 1989). Therefore, it needs

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immediate marketing and utilization after harvesting.

During marketing, the guava producers may face manifold problems which have direct bearing upon the prosperity of producers. Chemicals like plant growth regulators (GA_3 and NAA) and nutrients (calcium nitrate and zinc sulphate) have various effects on guava fruit with respect to its growth, yield, and Quality like TSS, total sugar, acidity, ascorbic acid, specific gravity reducing sugar and also on shelf life. Plant growth regulators like auxins and gibberellins are being used for improving the fruit quality, delaying deterioration in storage and increasing the shelf life (Tandon et al. 1989). The application of GA_3 improves the size, shape and weight of the fruits. GA_3 increases fruit set and fruit retention on the tree. By the application of NAA, T.S.S. and Ascorbic- acid content of fruits are increased and acidity is reduced. NAA reduces the number of seed of the fruits. It also induces heavier fruiting and promotes flowering. Calcium has been shown to affect a wide range of physiological processes in plants and fruits (Wvn-Jones and Lunt, 1967) and to inhibit specific aspects of abnormal senescence in numerous fruits. Calcium compounds extend the shelf-life of fruits by maintaining firmness, minimizing rate of respiration, protein breakdown, disintegration of tissues and disease incidence (Bangerth et al., 1972). Zinc is an essential trace element for plants, being involved in many enzymatic reactions and is necessary for their good growth and development. Zinc is also involved in regulating the protein and carbohydrate metabolites (Patel and Tiwari, 2014). Hence, keeping this in view present investigation was conducted to find out the effect of pre-harvest spray of plant growth regulators and nutrients on growth, yield and post harvest behavior of guava fruits.

RESOURCES AND METHODS

The present investigations were conducted at Fruit Orchard, College of Agriculture, RVSKVV, Gwalior (M.P.) during the year 2014-15 and 2015-16. In the present investigation, twelve year old Guava cv. Gwalior-27, uniform in vigour and productivity, were selected as experimental material to find out the response of guava to pre harvest foliar application of growth regulators and nutrients on yield and post harvest quality of guava. Single plant per treatment of guava spaced at 7x7 m was selected. The selected tree were given pre harvest spray with GA_3, NAA, Calcium nitrate and Zinc sulphate of different concentrations. Two sprays were given at 15 days interval before harvesting. Total 13 treatments comprising of different levels of GA_3- 30 ppm, 60 ppm and 90 ppm, NAA- 30 ppm, 60 ppm and 90 ppm, calcium nitrate- 1.0%, 1.5% and 2.0% zinc sulphate 0.3%, 0.6% and 0.9% were formed and repeated three times in RBD. The observational data were statistically analyzed. The chemicals were sprayed as aqueous solution. The first foliar spray of crop regulating chemical was done on 10 November 2015 and second spray was repeated after 15 days of first spray and similarly foliar spray was repeated in the year 2016. The details of the treatments of experiment are given in tables.

OBSERVATIONS AND ANALYSIS

In the present investigation, all the treatments of growth regulators and nutrients had significantly increased the yield attributes (Table 1 & Table 2) of guava and maintained the marketable quality (Table 3, Table 4 & Table 5) of guava fruits as compared to control. The results are described on the pooled bases.

The data pertaining (Table 1 & 2) in the pooled analysis, the data pertaining to various yield attributing parameters of the guava plant viz; number of fruits per plant, average weight per fruit, and yield per plant (kg), and per hectare (q) were significantly increased by the various sprays of plant growth regulators NAA and GA3. All the treatments were superior over control with respect to number of fruit per tree but there was not much difference in number of fruits among the chemical treatments. Highest retention of fruit 246.50 number of fruits was recorded where 90 ppm NAA was sprayed whereas the minimum number of fruits (236.35) was observed under the control and application of NAA had positive effect on fruit weight and yield. The maximum average fruit weight (220.30 g) and yield (53.87 kg per tree) was recorded where the plants were with sprayed of 90 ppm GA3, while the minimum (146.40 g) and (34.62 kg/tree) was recorded under control. The increase in yield under this growth regulators treatment was associated with low percentage of fruit drop, more fruit retention and increased fruit size and weight. This result is in conformity with the earlier report by Shawky et al. (1978) in mango and Shikhamany and Reddy (1989) in grape. NAA maintaining higher level of auxin in the various parts of fruits ought to have helped in increasing optimum fruit growth (Awasthy et al. 1975).

These findings are in agreement with the earlier reporters by the Chaitanya et al. (1997) and Pandey et al. (1988) in guava. The increased in number of fruits per tree and yield was due to increase in auxin concentration. NAA increases sugar metabolism in the cell which might have improved the physical characters of guava fruit and thus increased the yield per tree and per hectare. Heavier fruits under the NAA treatment might be due to retarded abscission of fruits and thereby increased fruit retention. Similar findings were also reported by Gurjar et al. (2015), Kumar and Lal (2014), and Bakshi et al. (2013).

A definite relationship between auxin content of the seeds and the abscission of the fruits during the various stages of development has been established by Luckwill (1948). High amount of gibberellins and auxin appears in the seeds after fruit set coincide with the formation of endosperm may inhibit fruit drop and thereby improve retention of fruits on the tree. The increase in weight of fruit by GA_3 application might be due to significant

Table 1: Effect of pre-harvest spray of plant growth regulators and nutrients on number of fruits and average fruit weight (g) of guava of guava (*Psidium guajava* L.)

Treatments	Number of fruit per tree			Average fruit weight per tree (g)		
	Year (2015-16)	Year (2016-17)	Pooled data	Year (2015-16)	Year (2016-17)	Pooled data
T_1 Control	235.67	241.23	238.45	146.96	150.51	148.73
T_2 GA_3- 30 PPM	244.00	249.77	246.88	158.81	162.63	160.72
T_3 GA_3- 60 PPM	260.67	266.83	263.75	173.39	177.55	175.47
T_4 GA_3- 90 PPM	263.67	269.92	266.79	184.53	188.93	186.73
T_5 NAA-30 PPM	241.33	247.06	244.20	157.21	160.97	159.09
T_6 NAA-60 PPM	252.67	258.65	255.66	172.22	176.37	174.30
T_7 NAA-90 PPM	246.00	251.84	248.92	167.00	170.99	168.99
T_8 CN- 1.0 %	264.00	270.27	267.13	185.95	190.42	188.18
T_9 CN- 1.5 %	276.00	282.52	279.26	191.23	195.83	193.53
T_{10} CN- 2.0 %	287.33	294.20	290.77	200.45	205.28	202.87
T_{11} ZN- 0.3 %	295.00	301.97	298.49	203.52	208.42	205.97
T_{12} ZN- 0.6%	305.00	312.24	308.62	218.90	224.18	221.54
T_{13} ZN- 0.9 %	302.00	309.16	305.58	207.54	212.54	210.04
S.E. ±	2.20	2.29	1.42	1.37	1.46	0.90
C.D. (P=0.05)	6.41	6.68	4.03	3.99	4.27	2.55

Table 2 : Effect of pre-harvest spray of plant growth regulators and nutrients on yield of guava of guava (*Psidium guajava* L.)

Treatments	Fruit yield (kg) per tree			Fruit yield (q) per hectare		
	Year (2015-16)	Year (2016-17)	Pooled data	Year (2015-16)	Year (2016-17)	Pooled data
T_1 Control	34.63	36.31	35.47	95.92	100.56	98.24
T_2 GA_3- 30 PPM	38.75	40.62	39.69	107.34	112.52	109.93
T_3 GA_3- 60 PPM	45.19	47.38	46.29	125.19	131.23	128.21
T_4 GA_3- 90 PPM	48.65	50.99	49.82	134.76	141.25	138.00
T_5 NAA-30 PPM	37.94	39.77	38.85	105.09	110.17	107.63
T_6 NAA-60 PPM	43.52	45.63	44.57	120.54	126.39	123.46
T_7 NAA-90 PPM	41.08	43.06	42.07	113.78	119.28	116.53
T_8 CN- 1.0 %	49.09	51.48	50.28	135.98	142.59	139.29
T_9 CN- 1.5 %	52.78	55.33	54.06	146.21	153.27	149.74
T_{10} CN- 2.0 %	57.61	60.44	59.03	159.59	167.42	163.51
T_{11} ZN- 0.3 %	60.04	64.45	62.24	166.31	174.36	170.33
T_{12} ZN- 0.6%	66.77	67.70	67.24	184.95	193.95	189.45
T_{13} ZN- 0.9 %	62.68	66.38	64.53	173.62	182.05	177.84
S.E. ±	0.59	0.67	0.45	1.63	1.93	1.17
C.D. (P=0.05)	1.72	1.96	1.26	4.76	5.62	3.31

increase in fruit width and length. This action of GA_3 might have raised auxin level leading to diminished drop rate and attributed to its reduction in fruit drop which prevents the formation of abscission layer as reported by Addicot (1970) in apple. Lal and Das (2017) and Lal et al. (2013) reported that foliar spray of gibberellins increased fruit set, reduced pre- harvest abscission and increased yield. The similar results were also reported by Manivannan et al. (2015) and Pandey et al. (1988) in guava.

The ripening of guava fruits (Table 3, 4 & 5) was delayed under 0.6 % zinc sulphate by retention of (92.22, 79.25 & 53.12 %) marketable fruits after 3, 6 & 9 days of storage, respectively, in the first year (2015-16), (94.05, 80.81 & 53.68 %), in the second year (2016-17) and in the pooled data of both year (93.14, 80.03 & 54.14 %),

Table 3: Effect of pre-harvest spray of plant growth regulators and nutrients on marketable fruits retained (%) of guava of guava (*Psidium guajava* L.)

Treatments	Marketable fruits retained (%) during different storage period								
	Year (2015-16)			Year (2016-17)			Pooled data		
	3 Days	6 Days	9 Days	3 Days	6 Days	9 Days	3 Days	6 Days	9 Days
T_1 Control	89.33	59.56	19.38	91.13	60.75	19.78	90.23	60.16	19.58
T_2 GA_3- 30 PPM	90.67	71.12	25.15	92.49	72.56	25.67	91.58	71.84	25.41
T_3 GA_3- 60 PPM	90.74	72.25	30.45	92.56	73.69	31.09	91.65	72.97	30.77
T_4 GA_3- 90 PPM	90.85	72.28	45.65	92.67	73.72	46.58	91.76	73.00	46.12
T_5 NAA-30 PPM	90.33	69.45	22.25	92.15	70.86	22.71	91.24	70.15	22.48
T_6 NAA-60 PPM	90.73	72.16	27.75	92.57	73.61	28.32	91.65	72.88	28.04
T_7 NAA-90 PPM	90.75	72.26	30.55	92.57	73.72	31.17	91.66	72.99	30.86
T_8 CN- 1.0 %	90.99	72.48	46.85	92.82	73.98	47.78	91.90	73.23	47.31
T_9 CN- 1.5 %	91.11	72.65	47.89	92.92	74.12	48.86	92.01	73.38	48.37
T_{10} CN- 2.0 %	91.46	73.86	49.42	93.29	75.35	50.38	92.38	74.60	49.90
T_{11} ZN- 0.3 %	91.45	74.74	50.02	93.29	76.27	51.00	92.37	75.51	50.51
T_{12} ZN- 0.6%	92.22	79.25	53.12	94.05	80.81	53.68	93.14	80.03	53.63
T_{13} ZN- 0.9 %	91.75	77.15	52.62	93.60	78.69	54.14	92.67	77.92	53.15
S.E. ±	0.33	0.72	0.57	0.33	0.73	0.51	0.21	0.46	0.35
C.D. (P=0.05)	0.96	2.10	1.67	0.97	2.12	1.48	0.59	1.29	0.98

Table 4 : Effect of pre-harvest spray of plant growth regulators and nutrients on unmarketable fruits (Decay loss) (%) of guava of guava (*Psidium guajava* L.)

Treatments	Unmarketable fruits (Decay loss) (%) during different storage period								
	Year (2015-16)			Year (2016-17)			Pooled data		
	3 Days	6 Days	9 Days	3 Days	6 Days	9 Days	3 Days	6 Days	9 Days
T_1 Control	10.67	40.44	80.62	8.87	39.25	80.22	9.77	39.84	80.42
T_2 GA_3- 30 PPM	9.33	28.88	74.85	7.51	27.54	74.33	8.42	28.21	74.59
T_3 GA_3- 60 PPM	9.26	27.75	69.55	7.44	25.84	68.91	8.35	26.80	69.23
T_4 GA_3- 90 PPM	9.15	27.72	54.35	7.33	26.85	53.42	8.24	27.28	53.88
T_5 NAA-30 PPM	9.67	30.55	77.75	7.85	29.77	77.29	8.76	30.16	77.52
T_6 NAA-60 PPM	9.27	27.84	72.25	7.43	27.77	71.68	8.35	27.81	71.96
T_7 NAA-90 PPM	9.25	27.74	69.45	7.43	26.40	68.83	8.34	27.07	69.14
T_8 CN- 1.0 %	9.01	27.52	53.15	7.18	29.17	52.22	8.10	28.35	52.69
T_9 CN- 1.5 %	8.89	27.35	52.11	7.08	27.50	51.14	7.99	27.43	51.63
T_{10} CN- 2.0 %	8.54	26.14	50.58	6.71	26.65	49.62	7.62	26.40	50.10
T_{11} ZN- 0.3 %	8.55	25.26	49.98	6.71	26.11	49.00	7.63	25.68	49.49
T_{12} ZN- 0.6%	7.78	20.75	46.88	5.95	20.93	45.86	6.86	20.84	46.37
T_{13} ZN- 0.9 %	8.25	22.85	47.38	6.40	24.20	46.32	7.33	23.53	46.85
S.E. ±	0.33	0.72	0.57	0.33	1.16	0.51	0.21	0.66	0.35
C.D. (P=0.05)	0.96	2.10	1.67	0.97	3.38	1.48	0.59	1.86	0.98

followed by 0.9% zinc sulphate (91.75, 77.15 & 52.62 %) in the first year (2015-16), (93.60, 78.69 & 54.14 %), in the second year (2016-17) and in the pooled of both year (92.67, 77.92 & 53.68 %), while the minimum (89.33, 59.56 & 19.38) in the first year (2015-16), (91.13, 60.75 & 19.78) in the second year (2016-17) and in the pooled data of both year (90.23, 60.16 & 19.58 %) marketable fruits were retained under the control after 3, 6 & 9 days of storage, respectively. The maximum retention of marketable fruits under the zinc sulphate might be due to slow degradation of chlorophyll and decreased enzymatic activities, which are responsible for delay in ripening (Patel & Tiwari 2014). Delay in ripening of guava by such chemicals was also reported by Rajput et al. (2008).

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Table 5: Effect of pre-harvest spray of plant growth regulators and nutrients on marketable fruits retained over control (%) of guava of guava (*Psidium guajava* L.)

Treatments	Marketable fruits retained over control (%)								
	Year (2015-16)			Year (2016-17)			Pooled data		
	3 Days	6 Days	9 Days	3 Days	6 Days	9 Days	3 Days	6 Days	9 Days
T_1 Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
T_2 GA_3- 30 PPM	1.34	11.57	5.77	1.37	11.80	5.89	1.36	11.69	5.83
T_3 GA_3- 60 PPM	1.41	12.69	11.07	1.43	12.94	11.31	1.42	12.81	11.19
T_4 GA_3- 90 PPM	1.52	12.73	26.27	1.55	12.97	26.80	1.53	12.85	26.54
T_5 NAA-30 PPM	1.00	9.90	2.87	1.02	10.10	2.93	1.01	10.00	2.90
T_6 NAA-60 PPM	1.40	12.60	8.37	1.45	12.86	8.54	1.42	12.73	8.46
T_7 NAA-90 PPM	1.42	12.70	11.17	1.45	12.96	11.40	1.43	12.83	11.28
T_8 CN- 1.0 %	1.66	12.92	27.47	1.69	13.23	28.00	1.67	13.08	27.74
T_9 CN- 1.5 %	1.78	13.09	28.51	1.79	13.36	29.08	1.79	13.23	28.79
T_{10} CN- 2.0 %	2.13	14.30	30.04	2.17	14.59	30.61	2.15	14.45	30.32
T_{11} ZN- 0.3 %	2.12	15.19	30.64	2.16	15.52	31.22	2.14	15.35	30.93
T_{12} ZN- 0.6%	2.89	19.70	33.74	2.93	20.06	34.37	2.91	19.88	34.05
T_{13} ZN- 0.9 %	2.42	17.59	33.24	2.47	17.93	33.91	2.45	17.76	33.57
S.E. ±	0.33	0.64	0.57	0.33	0.66	0.51	0.21	0.41	0.35
C.D. (P=0.05)	0.96	1.87	1.67	0.97	1.92	1.48	0.59	1.16	0.98

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