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The effect of plant growth regulators and urea on physico-chemical parameters of custard apple (*Annona squamosa* L.) cv. Sindhan

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Abstract

The experiment was conducted to maximize of yield with good quality of fruits in custard apple at Horticulture Instructional farm, Department of Horticulture, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Dist. Banaskantha, Gujarat during the year 2005 and 2006. The experiment involved fourteen treatments comprising of three levels each of NAA and GA_3 (50 ppm, 100 ppm and 150 ppm) and their combinations with 2 % Urea, 2 % Urea alone and Control. Seventeen year old custard apple plants of uniform growth and size were selected. Plants were planted at distance of 6 m x 6 m. The experiment was laid out in Randomized Block Design (RBD) with three replications. The combined effect of GA_3 ppm + Urea 2 % recorded significantly maximum fruit volume (208.33 ml), pulp weight (122.03 g), pulp : peel ratio (1.78), total soluble solids (27.67 %), reducing sugars (18.93 %), non-reducing sugars (3.91 %) and total sugars (22.87 %) while significantly minimum number of seeds per fruit (29.21), peel weight (69.07g) and titrable acidity (0.081 %) as compared to control and all other treatments. The combined effect of GA_3 ppm + Urea 2 % proved to the best treatment for the improvement of fruit quality of custard apple.

Introduction

Custard apple is mostly subtropical fruit preferring warm climate with moderate winter and humidity for higher production. The tree remains dormant during cold season for a short period, yet frost and prolonged cool weather adversely affect its growth. It can also tolerate adverse weather conditions, such as extreme temperature, high and low humidity, heavy and scantly rainfall and desiccating winds. Custard apple is delicious fruit. The fruits composed of pulp, peel and seed on varying proportions. The black seeds are surrounded by white, creamy or custard like pulp that is very sweet and pleasantly flavoured. Custard apple is used as table fruit, the pulp can be used in Juice, Ice-cream, confectionary, beverages and certain milk products. The seeds are abortifacient and roots are drastic purgative. The seeds contain about 30 per cent oil which can used in soap and paint industry. It contains alcohol ancorin, which possess insecticidal properties. Due to presence of annonaine the leaves, stem and other parts of the plants are bitter. One hundred gram edible pulp composition of custard apple fruit contains 75.97 g Moisture, 1.89 g Protein, 0.57 g Fat, 20.82 g Carbohydrate, 17.0 g Calcium, 22.0 g Magnesium, 54.0 g Phosphorus, 142.0 g Potassium, 2.0 g Sodium, 0.30 g Iron, 35.90 g Ascorbic acid, 0.10 g Thiamine, 0.06 g Riboflavin and 0.89 g Niacin.

Auxin promotes apical dominance and thus suppresses development of lateral buds into branches. It also inhibits abscission of leaves and fruits. It means leaves and fruits must continuously produce auxins to prevent formation of the abscission zone which cuts off their nutrient and water supply. Naphthalene Acetic Acid (NAA) prevent formation of abscission layer panicle. Gibberellic acid promote fruit growth and development and induce parthenocarpy in pome fruits and help in enlargement of seedless grape berries. The plant growth regulators like GA_3 and NAA are used because they reduce flower drop. Gibberellic acid is present in seed so, seeds produce antidrop hormone i.e. Gibberellin. Naphthalene Acetic Acid (NAA) and Gibberellic acid (GA_3) increase fruit weight, size and number of fruits because they increase the rate of cell elongation, cell division and more inter cellular space. Nitrogen in plants performs several functions like growth, formation of flowers, fruits and fruit production. Therefore, foliar application of nitrogenous fertilizers is bound to affect the growth and production in custard apple. Urea provides sufficient nutrition at time of enzymatic activity.

Materials and methods

The experiment was laid out in Randomized Block Design (RBD) with three replication and two plants in each replication. The experiment was conducted to maximize of yield with good quality of fruits in Custard apple at Horticulture Instructional farm, Department of Horticulture, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar, Dist. Banaskantha, Gujarat during the year 2005 and 2006. Sindhan variety of custard apple was taken under investigation as this variety is promising one and most of cultivators of North Gujarat regions are growing extensively. The experimental field was loamy sand in texture and good drainage property. Seventeen year old custard apple orchard uniform in growth and size which were planted at the distance of 6 x 6 meters. All the plants were subjected to uniform application of cultural practices like irrigation, weeding and fertilizer etc. Farm Yard Manure was applied at the rate of 50 Kg to each plants uniformly, while chemical fertilizers were applied at the rate of 250 g : 125 g : 125 g NPK/plant/year. Three irrigation were given during experimentation.

The experiment comprising of three levels each of NAA and GA_3 (50 ppm, 100 ppm and 150 ppm) alone and their combinations with 2 % Urea, 2 % Urea alone and Control thus fourteen number of treatment combinations were T_1 – NAA 50 ppm, T_2 – NAA 100 ppm, T_3 – NAA 150 ppm, T_4 – GA_3 50 ppm, T_5 – GA_3 100 ppm, T_6 – GA_3 150 ppm, T_7 – Urea 2 %, T_8 – NAA 50 ppm + Urea 2 %, T_9 – NAA 100 ppm + Urea 2 %, T_{10} – NAA 150 ppm + Urea 2 %, T_{11} – GA_3 50 ppm + Urea 2 %, T_{12} – GA_3 100 ppm + Urea 2 %, T_{13} – GA_3 150 ppm + Urea 2 %, T_{14} – Control.

Result and discussion

Effect of GA_3 and GA_3 with Urea

It was observed that all the treatments of GA_3 with 2 % Urea as well as GA_3 alone significantly increased the fruit volume of custard apple fruit cv. Sindhan. Gibberellins are phytohormones known to contribute to growth by both ways, namely cell division and cell expansion. After anthesis, it is the cell expansion and cell density which contribute the most for fruit growth. The probable reason behind the increase in fruit weight and volume might be the rapid cell division and cell enlargement and accumulation of more sugar and water under the influence of exogenous application of growth promoting substances. Specific gravity of fruits was not influenced significantly by the sprays of different chemicals. The findings are supported with the results Brahmachari *et al.* (1995) in Guava and Rani and Brahmachari (2004) in Mango.

The maximum pulp weight and pulp : peel ratio was recorded under the treatment GA_3 50 ppm + Urea 2 % and minimum pulp weight under the control during the individual years and pooled year also. It might be due to enhanced uptake of water and accumulation of sugar and other food reserves in greater amount as well as increased volume of intercellular spaces in the pulp of fruit. These results are in accordance with the findings of Chaudhari *et al.* (1992) and Rani and Brahmachari (2004) in Ber.

The lower concentration of treatments was found beneficial for reduction in peel weight. The lowest peel weight was recorded under the treatment GA_3 50 ppm + Urea 2 % and highest under the control treatment. The findings are in conformity with those of Pradhan *et al.* (1988) in Banana and Kaur *et al.* (2000) in Kinnow mandarin.

The foliar application of GA_3 and GA_3 + urea treatment was found to be effective for reduction in number of seeds per fruit. GA_3 50 ppm + 2 % urea treatment recorded significant recorded significantly minimum number of seeds per fruit as compared to control and other treatments. This could be attributed to an exogenous supply of gibberellins. The results are supported by Verma and Verke (1973) in Grape and Kumar *et al.* (1975) in Lime.

Amongst different concentrations, GA_3 50 ppm with 2 % urea and GA_3 50 ppm alone significantly increased Total Soluble Solid (T. S. S.) during the experimental years. The concentration of GA_3 significantly reduced the acidity of fruit as compared to controls during individual and pooled years. It might be attributed to the early degradation of acid had occurred. It also appears that acid might have either been fastly converted into sugars and their derivatives are utilized in respiration or both. The findings are in accordance with the results of Singh et al. (1995) in Mango and Ahmad and Zargar (2005) in Grape.

The application of GA_3 50 ppm + 2 % urea followed by GA_3 50 ppm significantly increased total sugar as well as reducing and Non reducing sugar in custard apple cv. Singhan. The increase in total soluble solids and sugar percentage is a result of more accumulation of metabolites during the fruit development and that gibberellins are known for their capacity to quick metabolism of starch and pectin into soluble compounds and enhanced conversion of organic acids into sugar. Increase in endogenous gibberellins and auxin levels may have promoted hydrolysis/ conversion of starch into sugar and thus resulted in higher sugar content in treated fruits. The findings are in agreement with the results of Singh *et al.* (1995) in Mango and Ahmad and Zargar (2005) in Grape.

Effect of NAA and NAA with Urea

The application of NAA with 2 % urea and NAA alone did not significantly enhance the fruit volume. It might be due to the activity of cell enlargement and division. The results are in agreement with those of Bhaghel *et al.* (1987) in Mango and Rema and Sharma (1991) in Phalsa.

It was observed that all the treatments of NAA with urea as well as NAA alone improved the pulp weight but failed to reach the level of significance. It might be due to the greater diversion of photosynthates from source to fruit. These results are in conformity with Bhaghel *et al.*

Tablel. Effect of plat growth regulators and urea on fruit volume (ml), pulp weight (g) and peel weight (g) and of custard apple cv. Sindhan

Treatment	Fruit volume (ml)			Pulp weight (g)			Peel weight (g)		
	Year 2005	Year 2006	Pooled	Year 2005	Year 2006	Pooled	Year 2005	Year 2006	Pooled
T_1	173.18	170.26	171.72	82.14	77.11	79.62	92.78	90.75	91.77
T_2	174.39	171.42	172.91	87.94	82.51	85.23	89.68	88.39	89.04
T_3	176.26	175.13	175.70	89.83	85.46	87.65	87.05	85.87	86.46
T_4	206.44	203.31	204.88	118.77	117.05	117.91	70.77	69.34	70.06
T_5	200.38	194.42	197.40	114.70	113.62	114.16	75.23	73.11	74.17
T_6	187.92	184.31	186.11	100.12	96.97	98.54	78.24	76.52	77.38
T_7	168.28	165.86	167.07	74.13	71.21	72.67	96.61	95.07	95.84
T_8	170.02	168.61	169.32	78.18	74.07	76.13	94.73	92.84	93.78
T_9	182.41	178.07	180.24	92.55	87.72	90.13	84.78	82.81	83.80
T_{10}	184.54	181.07	182.81	96.89	91.41	94.15	82.48	79.26	80.87
T_{11}	209.77	206.89	208.33	123.23	120.83	122.03	69.89	68.24	69.07
T_{12}	198.39	191.59	194.99	112.45	110.42	111.44	73.22	71.22	72.22
T_{13}	192.61	187.91	190.26	105.27	101.52	103.40	74.26	72.25	73.25
T_{14}	167.08	163.44	165.26	71.17	69.15	70.16	99.56	97.89	98.73
S. Em +	7.67	7.79	4.90	5.98	6.18	3.86	4.56	5.00	3.03
C.D. at 5%	22.31	22.64	13.91	17.38	17.96	10.95	13.25	14.54	8.59
Y x T Interaction									
S. Em. +	-	-	7.73	-	-	6.08	-	-	4.79
C.D. at 5%	-	-	NS	-	-	NS	-	-	NS
C. V. %	7.18	7.43	7.30	10.76	11.53	11.14	9.45	10.61	10.03

Table 2. Effect of plat growth regulators and urea on pulp : peel ratio and number of seeds per fruit of custard apple cv. Sindhan

Treatment	Pulp : peel ratio			Number of seeds per fruit		
	Year 2005	Year 2006	Pooled	Year 2005	Year 2006	Pooled
T_1	0.89	0.85	0.87	51.24	49.00	50.12
T_2	0.99	0.94	0.97	48.64	47.92	48.28
T_3	1.04	1.02	1.03	48.34	46.48	47.41
T_4	1.69	1.70	1.70	31.80	30.73	31.27
T_5	1.54	1.58	1.56	36.13	35.17	35.65
T_6	1.28	1.29	1.29	43.30	42.26	42.78
T_7	0.77	0.75	0.76	54.64	53.96	54.30
T_8	0.84	0.80	0.82	53.56	52.18	52.87
T_9	1.09	1.09	1.09	46.38	45.70	46.04
T_{10}	1.19	1.15	1.17	45.26	44.32	44.79
T_{11}	1.78	1.78	1.78	29.80	28.62	29.21
T_{12}	1.54	1.55	1.55	38.86	37.57	38.21
T_{13}	1.44	1.42	1.43	41.67	40.45	41.06
T_{14}	0.72	0.71	0.71	57.20	54.31	55.76
S. Em +	0.11	0.12	0.07	3.52	3.67	2.28
C.D. at 5%	0.32	0.34	0.20	10.22	10.66	6.46
Y x T Interaction						
S. Em. ±	-	-	0.11	-	-	3.59
C.D. at 5%	-	-	NS	-	-	NS
C. V. %	15.73	17.12	16.43	13.60	14.60	14.10

Table 3. Effect of plat growth regulators and urea on total soluble solids (%) and titrable acidity (%) of custard apple cv. Sindhan

Treatment	Total Soluble Solids (%)			Titrable acidity (%)		
	Year 2005	Year 2006	Pooled	Year 2005	Year 2006	Pooled
T_1	22.67	22.33	22.50	0.134	0.136	0.135
T_2	23.00	22.67	22.83	0.131	0.131	0.131
T_3	23.67	23.33	23.50	0.129	0.131	0.130
T_4	27.67	26.67	27.17	0.084	0.087	0.086
T_5	27.00	26.00	26.50	0.092	0.095	0.093
T_6	25.67	25.00	25.33	0.105	0.108	0.107
T_7	21.67	21.00	21.33	0.139	0.142	0.140
T_8	22.00	21.33	21.67	0.136	0.139	0.138
T_9	24.33	24.00	24.17	0.118	0.121	0.120
T_{10}	25.00	24.33	24.67	0.113	0.116	0.115
T_{11}	28.00	27.33	27.67	0.079	0.082	0.081
T_{12}	26.33	25.67	26.00	0.097	0.100	0.099
T_{13}	26.00	25.33	25.67	0.100	0.105	0.103
T_{14}	21.33	20.67	21.00	0.147	0.152	0.150
S. Em +	1.04	0.99	0.64	0.005	0.005	0.003
C.D. at 5%	3.02	2.88	1.82	0.014	0.013	0.008
Y x T Interaction						
S. Em. ±	-	-	1.01	-	-	0.004
C.D. at 5%	-	-	NS	-	-	NS
C. V. %	7.31	7.15	7.23	7.047	6.682	6.864

Table 4. Effect of plat growth regulators and urea on reducing sugar (%), non-reducing sugar (%) and total sugar (%) of custard apple cv. Sindhan

Treatment	Reducing sugar (%)			Non-reducing sugar (%)			Total sugar (%)		
	Year 2005	Year 2006	Pooled	Year 2005	Year 2006	Pooled	Year 2005	Year 2006	Pooled
T_1	17.56	17.56	17.56	3.15	3.18	3.16	20.71	20.74	20.72
T_2	17.87	17.91	17.89	3.19	3.21	3.20	21.06	21.12	21.09
T_3	18.06	18.09	18.08	3.25	3.24	3.25	21.31	21.34	21.32
T_4	18.82	18.91	18.87	3.87	3.72	3.79	22.69	22.63	22.66
T_5	18.73	18.79	18.76	3.80	3.68	3.74	22.53	22.47	22.50
T_6	18.40	18.37	18.39	3.48	3.47	3.47	21.88	21.84	21.86
T_7	16.83	16.89	16.86	3.11	3.11	3.11	19.93	20.00	19.97
T_8	17.20	17.32	17.26	3.13	3.15	3.14	20.32	20.47	20.40
T_9	18.21	18.25	18.2	3.31	3.30	3.31	21.52	21.55	21.54
T_{10}	18.36	18.32	18.34	3.41	3.43	3.42	21.77	21.74	21.75
T_{11}	18.98	18.94	18.96	3.99	3.83	3.91	22.97	22.77	22.87
T_{12}	18.70	18.64	18.67	3.54	3.57	3.55	22.24	22.21	22.22
T_{13}	18.48	18.40	18.44	3.53	3.54	3.54	22.01	21.95	21.98
T_{14}	16.34	16.44	16.39	3.10	3.09	3.09	19.44	19.53	19.49
S. Em +	0.48	0.47	0.30	0.15	0.17	0.10	0.48	0.84	0.30
C.D. at 5%	1.40	1.37	0.86	0.44	0.49	0.29	1.38	1.39	0.86
Y x T Interaction									
S. Em. +	-	-	0.48	-	-	0.16	-	-	0.48
C.D. at 5%	-	-	NS	-	-	NS	-	-	NS
C. V. %	4.63	4.53	4.58	7.71	8.53	8.13	3.84	3.87	3.86

(1987) in Mango and Singh *et al.* (2001) in Ber.

It was also found that the fruit peel weight decreased significantly under treatment NAA 150 ppm + Urea 2 % but remained non-significant during both the years and in pooled of two years. The results are in agreement with Singh *et al.* (2001) in Ber.

The higher pulp : peel ratio was observed under NAA 150 ppm + Urea 2 % treatment. It might be due to the increase in pulp weight under NAA treatments. This suggests that probably these was a greater diversion of photosynthates to fruit which ultimately added to the pulp weight. The result are accordance with Bhati and Yadav (2004) in Ber.

The number of seeds per fruit were significantly influenced by NAA with and without 2 % urea during both the years of experimentation. The superior results were obtained under NAA 150 ppm + 2 % urea treatment as compared to control. These results are in agreement with the findings of Bhaghel *et al.* (1987) in Mango and Rema and Sharma (1991) in Phalsa.

The quality of custard apple fruit was improved with varying concentration of NAA. Among different concentration, NAA 150 ppm + Urea 2 % significantly increased Total Soluble Solids percentage during both the years. It might be due to the auxin synthesis which increased the metabolites available for total soluble solids formation. The results are in accordance with those of Yadav *et al.* (2001) in Guava and Singh *et al.* (2002).

The higher concentration of NAA recorded reduction in acidity of fruit as compared to controls. It might be due to increased sweetness of the fruit pulp. The present findings are in conformity with those reported by Singh *et al.* (2002) and Bhati and Yadav (2003) in Ber.

The sugar content increases in the developing fruits probably due to increase in endogenous auxin levels which might have promoted hydrolysis conversion of starch into sugar and thus resulted in higher sugar content in the treated fruits. The results are in conformity with those of Yadav *et al.* (2001) in Guava, Singh *et al.* (2002) and Bhati and Yadav (2004) in Ber.

Effect of urea

The application of 2 % urea increased fruit volume, Pulp weight, peel weight, Pulp : peel ratio but failed to reach the level of significance. It might be due to the accumulation of food materials which leads to better development of fruits. The findings are supported by the results of Baghel *et al.* (1987) in Mango.

The effect of urea on number of seed was non-significant during both the years and in pooled of two year data. It might be due to the reason that urea is a nitrogenous fertilizer and is known for its growth promoting activity in plant tissues.

The treatment of urea improved the fruit quality of custard apple in terms of total soluble solids, titrable acidity (%), reducing sugar, Non reducing sugar and total sugar percentage but did not reach to the level of significance. The increased total soluble solids due to foliar applications of 2 % urea might be due to the result of more nitrogen availability to the fruit trees. Nitrogen is the constituent of various energy sources like amino acids and amino sugars which increased total soluble solids content in fruits. The findings are in agreement with results of Singh and Ahlawat (1995) in Ber and Malik *et al.* (2000) in Kinnow. The acidity content of fruits decreased with urea treatment which might be due to increased total soluble solids. The findings are accordance with result of Singh *et al.* (1991) in Guava and Malik *et al.* (2000) in Kinnow.

The foliar application of 2 % urea increased sugar content due to increase in rate of photosynthesis as a result of which fruit accumulated more sugars. The similar results are reported by Singh *et al.* (1994) in Mango, Singh and Ahlawat (1995) in Ber and Malik *et al.* (2000) in Kinnow.

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