Indian J. Hort. 67(2), June 2010: 177-180

Studies on the effect of plant growth regulators on qualitative characters of sapota cv. Cricket Ball

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ABSTRACT

An experiment was conducted to study the effect of cycocel *i.e.*, 0, 200 and 400 ppm at fruit bud differentiation stage followed by other growth regulators (GA/NAA, GA-50 and NAA-100 ppm) at flowering stage and further GA 50 and NAA 100 ppm were sprayed either at pea stage or lag phase of fruit development. Length, diameter, weight and volume of fruit, pulp thickness, pulp as well as peel weight of fruits were increased considerably with the application of cycocel CCC (400 ppm) followed by CCC (200 ppm) at FBD stage. While, at flowering stage NAA (100 ppm) proved to be the best for all the physical characters of fruit as compared to GA (50 ppm). Similarly, NAA (100 ppm) applied at pea stage also gave better response to the fruit characters than GA (50 ppm) applied at same stage of fruit development. Whereas, a reduction in number of seeds and weight was observed by the application of growth regulators as compared to no application. TSS, sugars and ascorbic acid were enhanced with the treatment of CCC (400 ppm) applied at FBD stage followed by CCC (200 ppm). Whereas, acidity of fruits was found to be decreased by the application of CCC (400 ppm) at FBD over no application (control). At fruit development stage pea stage was more beneficial than lag phase.

Key Words: Fruit quality, plant-growth regulators, sapota.

INTRODUCTION

Sapota or sapodilla (*Achras sapota* L.) popularly known as *chiku* in India is an evergreen fruit tree belonging to the family Sapotaceae and is native of tropical America especially the south Mexico or central America. The fruit is a good source of digestible sugar (12 to 18 per cent) and has appreciable quantities of protein, fat, fibre and minerals like calcium, phosphorus and iron. Cricket Ball is an attractive large-round fruit having crisp or gritty pulp with moderate sweetness and flavour. Growth regulating chemicals govern all stages of crop development from germination to fruit maturity as well as ripening of the fruits. Because of the diverse effect, it is possible to use certain growth regulating chemicals at particular stage of fruit growth and development to have its maximum effect. Different groups of PGRs like auxins, gibberellins and growth retardants at various concentrations have been reported to influence the quality characters of several fruit crops. The fruit quality of October-November flowering (*Hast bahar*), which matures during August-September is somewhat poor as against July-August (*Mrig bahar*) flowering. The crop of July-August flowering matures in April-May, when the price is comparatively remunerative.

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MATERIALS AND METHODS

The present investigation was undertaken during 2002-03 and 2003-04 in the Department of Horticulture, College of Agriculture, IGAU, Raipur. The experiment was carried out with factorial randomized block design considering stages of fruit bud differentiation (FBD), flowering and fruit development (pea stage and lag phase). Three levels of growth retardant *i.e.,* cycocel (0, 200 and 400 ppm) applied at FBD stage, followed by no application of GA/NAA and GA (50 ppm) as well as NAA (100 ppm) at flowering stage were tested for growth and yield of sapota. Furthermore, GA (50 ppm) and NAA (100 ppm) were sprayed either at pea stage or lag phase of fruit development. The observations on qualitative (physical) characters *viz*., length, diameter, weight and volume of fruit, pulp thickness, pulp as well as peel weight of fruits number and weight of seeds were recorded. While the chemical characters in terms of TSS, acidity, ascorbic acid and sugars were recorded and statistically analysed.

RESULTS AND DISCUSSION

A significant increase in fruit length, diameter and weight of sapota fruits were recorded with the increasing concentration of cycocel (200 and 400 ppm) applied at FBD stage. Similar observations on physical characters of fruit has also been reported by Ilango and Vijayalakshmi (7) in tamarind. The increase in physical characters of fruit due to application of CCC could be attributed to increased accumulation of assimilates and further translocation of extra metabolites through better partitioning towards reproductive growth.

However, the fruit length, diameter and weight were considerably increased due to NAA as compared to GA. The increased fruit growth might be due to exogenous application of NAA at flowering that caused cell elongation by enlargement of vacuoles and loosening of cell wall after increasing its plasticity. The results are in close conformity with the findings of Vijayalalitha and Rajasekaran (13) in sapota. Similar observations on fruit weight due to GA were also reported by Rathod and Amin (9).

At flowering stage, spraying of NAA and GA also increased the volume of fruit than control. The results are in conformity with the findings of Babu and Lavania (2) in lemon. Similarly, NAA applied at pea stage of fruit development gave better response to fruit volume as compared to GA. Moreover, NAA and GA applied at pea stage also enhanced the volume of fruit as compared to aplication at lag phase. The exogenous application of NAA at pea stage might be responsible for increase in volume of fruits. The maximum pulp and peel weight was recorded with the higher concentration of cycocel (400 ppm) as compared with no application at FBD stage. It might be due to higher accumulation and translocation of extra metabolites from other parts of the plant towards developing fruits. Similar result was obtained by Singh and Dhillon (11) in mango. The increase in pulp and peel weight could be attributed to increased size and weight of fruits. Moreover, probably there was a greater diversion of photosynthates to sink (fruit) which ultimately added to the pulp and peel weight. The results are in conformity with the findings of Abou-Rawash *et al.* (1). However, application of NAA at pea stage had more pulp and peel weight as compared to GA. The increased pulp weight by the spray of NAA and GA was probably due to increased cell size and intercellular spaces coupled with accumulation of water, sugars and other soluble solids in greater amount as a result of translocation of metabolites towards the fruits. The present findings are in agreement with the report of Ganvit (5) in sapota.

The pulp thickness of fruits was found to be increased with an increase in cycocel concentration (200 and 400 ppm) applied at FBD stage. This might be due to retarded vegetative growth especially shoot length and ultimately accumulation and translocation of metabolites towards sink (fruit), which resulted in thicker pulp.

Besides, NAA and GA applied at pea stage of fruit development increased the pulp thickness of fruits as compared to NAA and GA applied at lag phase. However, NAA applied at pea stage gave better response to increase in pulp thickness than GA application at pea stage of fruit development. The improvement in pulp thickness by the spray of NAA and GA appears to be due to increase in cell size and intercellular spaces coupled with accumulation of water, sugars and other soluble solids in greater amount. The present finding also corroborated with earlier reports made by Brahmachari and Rani (3).

Table 1. Effect of plant growth regulators (ppm) at different stages on physical parameters of sapota cv. Cricket Ball.

Treatment (ppm)	Length (cm)	Diameter (cm)	Weight (g)	Volume (cc)	Pulp wt. (g)	Peel wt. (g)	Pulp thickness (cm)	No. of seeds/fruit	Seed wt./ fruit (g)
FBD									
CCC - 0	14.96	77.11	5.74	70.10	65.20	7.49	2.65	5.07	4.43
CCC - 200	15.49	84.13	6.09	79.37	68.51	11.38	2.82	4.91	4.24
CCC - 400	15.60	85.85	6.16	81.76	69.40	13.18	2.86	4.27	3.28
CD at 5%	0.047	0.434	0.007	0.326	0.502	0.240	0.004	0.072	0.040
Flowering									
GA/NAA - 0	14.96	76.35	5.71	69.73	64.62	7.27	2.63	4.98	4.47
GA - 50	15.50	84.54	6.10	79.39	69.23	11.49	2.83	4.61	4.33
NAA - 100	15.60	86.21	6.18	81.23	69.75	13.31	2.87	4.16	3.16
CD at 5%	0.047	0.434	0.007	0.326	0.502	0.240	0.004	0.072	0.040
Fruit development									
GA - 50 (P)	15.50	84.34	6.09	79.20	68.64	12.00	2.82	4.56	3.71
GA - 50 (L)	15.17	79.82	5.88	73.91	66.66	8.82	2.71	4.99	4.35
NAA - 100 (P)	15.52	84.89	6.11	80.09	68.93	12.36	2.83	4.53	3.61
NAA - 100 (L)	15.22	80.42	5.91	74.82	66.55	9.59	2.74	4.94	4.28
CD at 5%	0.055	0.501	0.00	0.438	0.580	0.27	0.005	0.084	0.047

The application of CCC at FBD stage exhibited significantly less number and weight of seeds as compared with no application of CCC. Similarly, NAA (100 ppm) and GA (50 ppm) applied at flowering stage also reduced number of seed and weight as compared to no application of NAA or GA. The reduction in number of seeds and weight may probably be due to the parthenocarpic fruit development stimulated by these hormonal sprays. Similar finding was reported by Babu and Lavania (2) in lemon, where they observed a negative correlation between the number of seeds and fruit size. The response of NAA was better in reducing the number and weight of seeds as compared to GA applied at pea stage of fruit development. Similar findings were also reported by Hartmann and Anvari (6) in plum.

The application of higher concentration of cycocel (400 ppm) resulted more TSS in the fruits as compared to lower concentration of CCC (200 ppm) and its no application (control) at FBD stage. The increase in TSS in response to CCC may be due to increased accumulation of carbohydrates resulted by the reduction in shoot growth and ultimately enhanced conversion of starch and pectin into soluble sugars. Similarly, Thonte (12) reported higher TSS in the fruits of fig treated by CCC at 500 ppm. The increase in TSS may be the result of more accumulation of metabolites and quick conversion of starch into soluble sugars during the fruit development in response to growth regulators (NAA and GA). In conformity of this, similar observations were reported by Rathod and Amin (9) and Ray *et al.* (10) in sapota.

The acidity of fruits was significantly reduced by the spray of CCC (200 and 400 ppm), while its level was found to be increased in the fruits with no application of CCC at FBD stage. The reduction in acidity under the influence of growth retardant might be due to the metabolic changes with fast conversion of organic acids into sugars and their derivatives by the reactions involving reversal of glycolytic pathway or be used in respiration or both. In conformity of present findings, Khan *et al.* (8) in litchi and Daulta *et al.* (4) in mango also noted similar response by spraying of cycocel.

The decrease in acidity due to application of growth regulators may be attributed to early maturity and rapid utilization of organic acids during respiration after harvesting, as sapota is a climacteric fruit. The findings are in agreement with the results obtained by number of investigators on sapota (Ganvit, 5; Ray *et al*., 10).

The maximum ascorbic acid was observed in the fruits under the treament of cycocel at 400 ppm as compared to no application of CCC at FBD stage. The perceptive increase in ascorbic acid content might be due to catalytic influence of growth regulators on its bio-synthesis from its precursor glucose-6-phosphate or inhibition of its conversion to dehydro ascorbic acid by enzyme ascorbic acid oxidase or both. The observation is in close agreement with the reports of Khan *et al.* (8), and Brahmachari and Rani (3) in litchi.

Table 2. Effect of plant growth regulators at different growth stages on chemical constituents/ quality characters in fruits of sapota cv. Cricket Ball.

Treatment (ppm)	TSS (%)	Acidity (%)	Ascorbic acid (mg/100g of pulp)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugars (%)
FBD						
CCC - 0	18.25	0.15	10.80	8.36	5.91	14.28
CCC - 200	19.36	0.11	11.63	8.83	6.46	15.30
CCC - 400	19.61	0.10	11.80	9.08	6.58	15.67
CD at 5%	0.042	0.002	0.102	0.016	0.013	0.022
Flowering						
GA/NAA - 0	18.20	0.15	10.78	8.36	5.86	14.22
GA - 50	19.37	0.11	11.66	8.88	6.49	15.38
NAA - 100	19.63	0.10	11.80	9.03	6.60	15.63
CD at 5%	0.042	0.002	0.102	0.016	0.013	0.022
Fruit development						
GA - 50 (P)	19.34	0.11	11.62	8.93	6.47	15.40
GA - 50 (L)	18.69	0.13	11.20	8.53	6.11	14.64
NAA - 100 (P)	19.47	0.11	11.61	9.01	6.52	15.53
NAA - 100 (L)	18.79	0.13	11.22	8.57	6.17	14.45
CD at 5%	0.048	NS	0.119	0.019	0.016	0.026

At flowering stage, application of NAA produced more ascorbic acid in fruits than GA. While, no application of growth regulators recorded minimum ascorbic acid in the fruits. Similar findings were also reported by Ray *et al.* (10) in sapota. The increase in ascorbic acid content of fruit by growth regulators may be due to perpetual synthesis of glucose-6-phosphate throughout the growth and development of fruit which is thought to be precursor of vitamin 'C'. A similar finding was also reported by Ray *et al*. (10) in sapota.

In contrast to acidity, sugar formation was significantly enhanced by CCC (200 and 400 ppm) applied at FBD stage as compared to control. The increased level of sugar was possibly due to ripening of fruits which is associated with high metabolic changes in the fruits leading to conversion of complex polysaccharides into simple sugars. It seems possible that cycocel hastened ripening of fruits and accelerated the activities of hydrolytic enzymes resulting into higher sugar content. Similar results have been reported in fig (Thonte, 2) and litchi (Brahmachari and Rani, 3) in response to cycocel.

The application of NAA (100 ppm) and GA (50 ppm) applied at flowering stage induced maximum reducing and total sugars percent of fruits. At fruit development, treatment of NAA (100 ppm) recorded more reducing and total sugars than GA applied at pea stage. Further, the application of NAA and GA at pea stage had more sugar content in the fruits as compared to those applied at lag phase of fruit development. It was also observed that there was a rapid increase in total sugars (starch), a simultaneous decrease in non-reducing sugar (sucrose) and a progressive rise in the content of reducing sugars. In conformity of this, similar observations were also reported by Rathod and Amin (9), Ganvit (5), and Ray *et al.* (10) in sapota.

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Received: September, 2006; Revised: December, 2009; Accepted : January, 2010