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Effect of Different Growth Promoting Substances on Rejuvenated Sapota Plants

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ABSTRACT: An experiment on "Effect of growth promoting substances on rejuvenated sapota plants" was carried out at Main Garden, University Department of Horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, India during the year 2013-2014. The investigation was done on uniform and rejuvenated 45 year old plants of sapota variety Kalipatti. The experiment was laid out in Randomized Block Design with nine treatment combinations and each treatment was replicated thrice. Plant growth promoting substances like KNO_3 (potassium nitrate) and GA_3 alone or in combination with different concentration was sprayed in 1st week of July, August and September in 2013 during the course of the investigation. Growth observations like leaf area (cm^2), Chlorophyll content (mg/g); Yield and yield contributing characters like number of flowers per shoot, fruit set percentage, Fruit drop %, Days required for flowering to harvesting, Number of fruits per plant, fruit yield, fruit size, fruit volume, fruit weight; Quality parameters like fruit moisture, peel weight, pulp weight, total soluble solids, acidity, total sugar content, seed weight were studied during the research. The treatment T_9 (2% KNO_3 + 50 ppm GA_3) was found superior among all other treatments in terms of the highest number of fruit per plant and fruit yield with earlier flowering along with the various fruit quality parameters such as highest in pulp content, total soluble solids, total sugar content.

Key word: Fruit quality, GA_3, KNO_3, rejuvenation, yield

Introduction

Sapota (*Achras sapota L.*) belongs to family Sapotaceae, is native of Mexico and Central America and now widely cultivated throughout the tropics. The sapota fruits are good source of sugar, which ranges between 12-14%, carbohydrate 21.49 per 100 g, protein 0.79% per 100g, fat 1.1 g/100 g, Calcium 28 mg/100g, Phosphorus 27.0 mg/100g, Iron 2.0 mg/100 g, ascorbic acid 6.0 mg/100 g and moisture 73.7 g/100 g (Sulladmath and Reddy, 1990).

Control of flowering is one of the most important practical aspect of sapota cultivation. Induction of flowering with the use of chemicals is one way of tackling the problem of excessive vegetative growth and erratic flowering habit in sapota. Another major problem confronting, sapota crop is heavy flower and fruit drop (Patil and Narwadkar, 1974; Farooqui and Rao, 1976). Fruit set in sapota ranged between 2 to 22% depending upon the extent of self or cross pollination, seasons and cultivars (Patil and Narwadkar, 1974). In recent years, considerable attention has been given to increase the fruit set and to check fruit drop of many fruit crops with the help of plant growth regulators. Different groups of plant growth gegulators like auxins, gibberellins and ripening hormones at various concentrations have been reported to influence the flowering, fruit set, fruit retention, ripening advancement characters and quality characters of several fruit crops (Chacko *et al*., 1972; Das). Mostly the trees become unfruitful due to their age. Hence the rejuvenation of the old orchards is the need of sapota plant now days. The plant treated with growth promoting substances always gives higher yield and better quality fruit. India's fruit requirement for 2025 is estimated to 120 MT. These productions and productivity targets can be achieved only if modern intensive horticulture is practiced using most recent technologies, including the rejuvenation of orchards along with the use of growth promoting substances. However, very little information is available on the use of various growth promoting substances and ripening hormones on sapota. Keeping this in view the study was undertaken on "Effect of growth promoting substances in rejuvenated sapota orchard" during 2013-14 with the objectives to know the effect of different growth promoting substances on the growth of rejuvenated sapota orchard and to find out suitable growth promoting substances for higher fruit yield and quality of the rejuvenated sapota orchard.

Materials and Methods

The investigation entitled "Effect of growth promoting substances on rejuvenated sapota plants" was carried out at main garden, university department of horticulture and the analytical work was done in the analytical laboratory, university department of horticulture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra, during the year 2013-2014. The investigation was undertaken on uniform and rejuvenated 45 year old plants of sapota variety Kalipatti planted at a spacing of 7.5 m X 7.5 m. An experiment was laid out in randomized block design with nine treatment combinations and replicated thrice. Two plants were taken as one treatment unit. The flowering of July-September season was utilized for the studies. All the plants were nourished uniformly by providing the similar cultural practices such as ploughing, harrowing, fertilization, irrigation and plant protection measures during the entire period of studies. Plant growth promoting substances like KNO_3 and GA_3 alone or in combination in different concentration as T_1- Control (No spray), T_2- 1% KNO_3, T_3- 2% KNO_3, T_4-25 ppm GA_3, T_5- 50 ppm GA_3, T_6- 1% KNO_3 + 25 ppm GA_3, T_7- 1%

Table 1 : Effect of growth promoting substances on leaf and flowering of rejuvenated sapota plant

Treatment	Leaf area (cm^2)	Chlorophyll content (mg/g)	Number of flowers per shoot	Fruit set (%)	Days required from flowering to harvesting
T_1	39.60	1.81	27.40	19.45	273.33
T_2	40.87	1.87	29.39	21.92	260.66
T_3	42.11	1.84	31.15	23.13	257.33
T_4	41.43	1.88	32.78	24.19	254.00
T_5	41.07	1.92	32.65	26.11	253.66
T_6	43.26	2.02	32.22	25.74	253.66
T_7	43.17	1.99	33.15	26.52	255.33
T_8	45.16	2.04	33.35	28.17	250.66
T_9	46.12	2.10	34.04	29.14	244.70
'F' test	Sig	Sig	Sig	Sig	Sig
SEm±	0.10	0.016	1.19	0.57	3.52
CD at 5%	0.32	0.050	3.58	1.73	10.61

Table 2 : Effect of growth promoting substances on fruit of rejuvenated sapota plant

Treatment	Fruit drop (%)	Number of fruit/plant	Fruit yield (kg/plant)	Fruit size (cm)		Fruit Vol. (cc)	Fruit weight (g)
				Length	Breadth		
T_1	80.82	1086	98.08	3.35	3.30	66.2	78.17
T_2	79.04	1162.66	104.1	4.16	3.76	68.8	79.02
T_3	78.85	1171	106.17	4.14	3.78	73.5	78.05
T_4	78.48	1171	110.4	4.13	3.81	77	84.85
T_5	76.56	1209	127.27	4.30	3.83	81.4	89.45
T_6	78.26	1203	135.57	4.23	3.86	91.2	100.02
T_7	76.48	1345.99	175.53	4.96	4.12	99.6	113.05
T_8	76.16	1466*	185.2	5.11	4.20	108.6	123.37
T_9	73.86	1469.88	197.53	5.16	4.36	117.2	126.89
'F' test	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SEm±	1.02	12.28	3.15	0.13	0.14	5.27	2.55
CD at 5%	3.08	36.98	9.49	0.40	0.43	15.89	7.69

Table 3 : Effect of growth promoting substances on fruit quality of rejuvenated sapota plant

Treatment	Fruit moisture (%)	Peel weight (g)	Pulp weight (g)	T.S.S (°Brix)	Acidity (%)	Total sugar content (%)	Seed weight
T_1	71.06	12.13	67.66	17.12	0.028	17.20	1.23
T_2	71.79	13.41	72.83	19.00	0.025	17.33	1.25
T_3	70.62	14.45	76.40	19.25	0.025	18.33	1.25
T_4	72.67	14.85	73.30	19.32	0.025	18.70	1.25
T_5	72.06	15.59	76.00	20.25	0.024	18.53	1.33
T_6	71.59	15.50	83.79	20.45	0.025	18.55	1.37
T_7	71.66	16.69	92.45	20.62	0.021	18.70	1.46*
T_8	72.13	16.74	103.56	20.51	0.021	18.85	1.45*
T_9	73.2	18.30	106.56	22.15	0.019	19.01	1.50
'F' test	NS	Sig	Sig	Sig	NS	Sig	Sig
SEm±	0.50	0.63	3.15	0.44	0.002	0.17	0.04
CD at 5%	-	1.85	9.49	1.35	-	0.36	0.12

KNO_3 + 50 ppm GA_3, T_8- 2% KNO_3 + 25 ppm GA_3, T_9- 2% KNO_3 + 50 ppm GA_3 were sprayed in 1st week of July, August and September in 2013 to enhance its effect on plant during the course of investigation. Plants of each treatment selected and marked and kept under observations for recording various observations. The fifteen-labeled shoots of each tree were used for recording the observations on the various parameters such as growth observations like Leaf area (cm^2), Chlorophyll content (mg/g), yield and yield contributing characters like number of flowers per shoot, fruit set percentage, fruit drop percentage, days required from flowering to harvesting, number of fruits per plant, fruit yield (kg/plant), fruit size (Length x Breadth in cm^2), fruit volume (cc), fruit weight (g), quality parameters like fruit moisture (%), peel weight (g), pulp weight (g), total soluble solids (°Brix), acidity (%), total sugar content (%), seed weight (g).

Results and Discussion

The data pertaining to leaf area revealed that leaf area in sapota was significantly influenced by growth promoting substances (Table 1). It was observed that the maximum leaf area in T_9 (2% KNO_3 + 50 ppm GA_3) 46.12 cm^2 which was significantly superior over rest of the treatments followed by treatment T_8 (2% KNO_3 + 25 ppm GA_3) 45.16 cm^2 and T_7 (1% KNO_3 + 50 ppm GA_3) 43.17 cm^2 The minimum leaf area 39.60 cm^2 was recorded in treatment T_1 (control). The application of KNO_3 plays important role in nutrients and sugar translocation in plants and also increases turgor pressure of plant cells. Potassium activates numerous enzyme systems involved in the formation of organic substances and in the buildup of compounds, enlargement and in triggering the young tissues lead to plant meristematic growth. GA_3 had a stimulatory influence on auxin transport rather than auxin synthesis that results in cell elongation and cell enlargement (Sachs *et al.,* 1960). The results of present findings are in conformity with the findings of Agrawal and Dikshit (2008) in sapota and by Zahoor *et al.* (2011) in grape.

It was observed that highest leaf chlorophyll content (2.10 mg/g) was observed in T_9 (2% KNO_3 + 50 ppm GA_3) followed by T_8 (2% KNO_3 + 25 ppm GA_3) (2.04 mg/g), T_6 (1% KNO_3 + 25 ppm GA_3) (2.02 mg/g), T_7 (1% KNO_3 + 50 ppm GA_3) (1.99 mg/g) and the minimum leaf chlorophyll content was recorded in treatment T_1 (control) (1.81 mg/g). The leaf area increases with the use of growth regulating chemicals in different stages of development. GA_3 stimulates downward movement of auxin which in turn promote the transport of assimilates to the apex and ultimately result in the production of new leaves (Luckwill, 1968) and better synthesis of PGR like IAA, GA_3 and cytokines which result in higher chlorophyll content in T_9. The above results are in close agreement with the finding of Agrawal and Dixshit (2008) in sapota.

The number of flowers per shoot (34.04) was found maximum with treatment T_9 (2% KNO_3 + 50 ppm GA_3) which was found at par with T_8 (33.35), T_7 (33.15), T_4 (32.78), T_5 (32.65), T_6 (32.22) and T_3 (31.15), while minimum number of flowers per shoot was recorded with treatment T_1 (27.40) (Table 1). The KNO_3 treated plants demonstrated earlier panicle emergence compared to others and induce early flowering in sapota. The application

of GA_3 was found to be effective to increase flower per shoot. The treatment T_9 (2% KNO_3 + 50 ppm GA_3) in combination probably induces the ethylene biosynthesis which results in earlier flowering. Similar results are also recorded by Nahar *et al*. (2010) in mango; Mosqueda and Avila (1985) in mango and Dalal *et al.* (2005) in mango.

The maximum fruit set percentage (29.14%) was found in treatment T_9 (2% KNO_3 + 50 ppm GA_3) which was at par with T_8 (28.17%) (Table 2). However, minimum fruit set (19.45%) recorded in T_1 (control). The treatment T_9 leads to higher fruit retention that may lead to higher fruit set percentage which might be due to the cumulative effect of KNO_3 and GA_3. Above finding are in similar with the finding of El-Agamy *et al.* (1989) in Guava.

Sapota plant under treatment T_9 (2% KNO_3 + 50 ppm GA_3) recorded minimum fruit drop (73.86%) followed by T_8 (76.16%), T_6 (78.26%) and T_7 (76.48%). However, treatment T_1 (control) recorded maximum fruit drop (80.82%). It is also observed that flowers situated at the base of inflorescence opened and set earlier. Such early set fruits developed rapidly remaining which set relatively late often dropped down (Cheema *et al.,* 1954) and due to balanced supply of photosynthates at various stages of fruit development result minimum fruit drop in T_9. Similar findings were recorded by Panigrahi *et al.* (2011) in sapota.

Minimum days required for flowering to harvesting (244.70 days) were noted in the treatment T_9 (2% KNO_3 + 50 ppm GA_3) which was found statistically at par with T_8 (250.66 days). The maximum days required for flowering to harvesting (273.33 days) were recorded in T_1 (control). The KNO_3 treated plants demonstrated earlier panicle emergence and foliar spraying of KNO_3 advanced the harvesting date; besides that KNO_3 act as a bud dormancy breaking agent and which promotes ethylene biosynthesis probably result into minimum time to reach harvesting stage. Exogenous application of GA_3 also found beneficial in earlier flowering and thus leads to earlier fruiting and reach to the harvesting stage in the minimum number of days. The results are confirmed with the findings of Nahar (2010) in sapota, Sarker (2013) in mango.

The maximum numbers of fruit per plant (1469.88) were harvested in treatment T_9 (2% KNO_3 + 50 ppm GA_3) which was found statistically at par with T_8 (1466) whereas, minimum numbers of fruits per plant (1086) were harvested in treatment T_1 (control). The numbers of fruit yield per tree were increased with increasing concentration of KNO_3 and GA_3, respectively. The yield increases might be due to inhibition of vegetative growth result in better flowering, fruit set and ultimately higher fruit retention as well as translocation of extra metabolites toward the reproductive growth or sink i.e. fruit. Application of GA_3 also contributed higher yield and number of fruits and it might be due facts that GA_3 is responsible for the faster mobilization of stored metabolites or photosynthates from source to sink and it is also due to increasing auxin biosynthesis. Foliar application of KNO_3 produced the highest number of panicles, highest number of fruits and yield in mango (Nahar *et al.*, 2010).

Maximum fruit yield (197.53 kg/plant) was recorded in treatment T_9 (2% KNO_3 + 50 ppm GA_3) followed by T_8 (185.20 kg/plant), T_7 (175.53 kg/plant), T_6 (135.57 kg/plant) and T_5 (127.27 kg/plant) whereas, minimum number of fruit per plant (98.08 kg/plant) was recorded in treatment T_1 (control).

The fruit size (length and breadth in cm) in treatment T_9 (2% KNO_3 + 50 ppm GA_3) recorded maximum fruit length (5.16 cm) and fruit breadth (4.36 cm) which was at par with T_8 (fruit length 5.11 cm and fruit breadth 4.20 cm) and T_7 (fruit length 4.96 cm and fruit breadth 4.20 cm) while minimum fruit length (3.35 cm) and fruit breadth (3.30 cm) was recorded with treatment T_1 (control). The increase in fruit size might be due to exogenous application of GA_3 which caused cell elongation of vacuoles in losing of cell wall after increasing plasticity. This result is closely in agreement with Patil *et al.* (2011) in sapota.

Highest fruit volume (117.2 cc) was found under treatment T_9 (2% KNO_3 + 50 ppm GA_3) which was at par with T_8 (108.6 cc) while minimum fruit volume (66.2 cc) recorded with treatment T_1 (control). The increase in fruit volume might be due to accumulation of more food material in the trees and lead to an efficient utilization of the same for the development of fruit. These findings are in line with the findings of Ray *et al.* (1992) in sapota, Benjawan *et al.* (2006) in mango and Hegazi *et al.* (2011) in olive.

It was observed that maximum fruit weight (126.89 g) was observed in T_9 (2% KNO_3 + 50 ppm GA_3) which was statistically at par with T_8 (123.37 g), while minimum fruit weight (78.17 g) was recorded in treatment T_1 (control).

Fruit moisture influenced by growth promoting substances, but there was no significant difference was found among the various treatments.

It was observed that maximum pulp weight (106.56 g) was observed in T_9 (2% KNO_3 + 50 ppm GA_3) which was statistically at par with T_8 (103.56 g), while minimum pulp weight (67.66 g) was recorded in treatment T_1 (control) (Table 3). The increase in pulp weight is due application of GA_3 which stimulated the functioning of a number of enzymes in the physiological process which probably caused an increase in pulp percentage. The results are in conformity with the results of earlier workers Hegazi *et al.* (2011) in olive, Benjawan *et al.* (2006)

Maximum peel weight (18.30 g) was recorded in T_9 (2% KNO_3 + 50 ppm GA_3) and followed by T_8 (16.74 g) and T_7 (16.69 g), while minimum peel weight (12.13 g) was recorded in treatment T_1 (control). The results are in accordance with Sarker *et al.* (2013) in mango.

The highest total soluble solids (22.15^0 Brix) was found with treatment T_9 (2% KNO_3 + 50 ppm GA_3), while lowest total soluble solids (17.12^0 Brix) was recorded with treatment T_1 (control). The results are in accordance with Sundararajan *et al.* (1969) in guava, Kumar *et al.* (1975) in sweet lime, Dhawan *et al.* (1981) in grapes.

There was no significant difference was found amongst various treatments of growth promoting substances in respect to acidity.

Maximum (19.01%) total sugar content was found under treatment T_9 (2% KNO_3 + 50 ppm GA_3) which was at par with T_8 (18.85%), T_7 (18.70%) and T_4 (18.70%) while minimum total sugar content (17.20%) recorded with treatment T_1 (control). These findings are in line with the findings of Syamal and

Chhonkar (1984) in aonla; Bondopadhyay *et al.* (1998) in sapota.

It was observed that maximum seed weight (1.50 g) in T_9 (2% KNO_3 + 50 ppm GA_3) which was statistically at par with T_8 (1.45 g) and T_7 (1.46 g), while minimum seed weight (1.23 g) was recorded in treatment T_1 (control). These findings are in line with the findings of Patil (2010) in sapota.

Conclusion

Maximum number of fruit per plant and fruit yield with earlier flowering was obtained from treatment T_9 (2% KNO_3 + 50 ppm GA_3). The various quality parameters of fruit were also recorded in the same treatment. Hence, it is concluded that application of 2% KNO_3 + 50 ppm GA_3 is beneficial for higher yield with earlier flowering and quality of fruit.

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