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Standardization of GA_3 and biomix concentrations for growth and success of softwood grafts in sapota Cv. Kalipatti under polyhouse conditions

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Abstract
The treatment (T_6) GA_3 125 ppm + Biomix 4% found superior in terms of minimum number of days required for sprouting (13.27 days), highest success percentage (92.83%) at 30 DAG. While the maximum number of leaves (39.20), maximum height of graft (50.13 cm), girth of scion (7.57 mm), girth of rootstock (11.02 mm), sprout length (7.85 cm), maximum number of shoot (5.13), maximum fresh and dry weight of shoot (37.73 g and 33.73 g respectively), maximum fresh and dry weight of leaves (12.93 & 11.40 g respectively) were recorded in same treatment at 150 DAG. Whereas the maximum leaf area (41.77 cm^2) at 150 DAG was recorded in treatment (T_8) GA_3 150 ppm + Biomix 3%.

Keywords: Biomix, GA_3, graft success, Kalipatti, polyhouse, sapota

Introduction
Sapota (*Manilkara achras* Mill.) is an evergreen tree and significant tropical fruit of the family Sapotaceae. In India softwood grafting method is being employed on commercial scale for production of planting material but such grafts becomes successful at early stage of growth and subsequently death rate rises with time and becomes very slow growth is noted in softwood grafting under open condition.

Additionally, it is noted that in softwood grafting, strong sprouting occurs early on, but later, development becomes problematic and the grafts are unable to survive. To overcome this bottleneck in sapota grafting the GA_3 and Biomix applications are necessary. The GA_3 involves in synthesis of amylase and other hydrolytic enzymes during the sprouting process. In order to fix atmospheric nitrogen in the soil and to make available essential nutrients to the grafts by enhancing microbial activities in the soil, biomix is a unique and well-balanced blend of 14 different bio agents. It also solubilizes soil-based minerals, such as iron, magnesium and residual phosphorus, to increase their availability to plants. It promotes sprouting and helps increase the soil's capacity to retain water. The ideal temperature range required for cellular activity and overall growth in sapota graft is typically between 12 °C and 35 °C. Hence, polyhouse condition found better for higher growth of grafts. After critical review it is revealed that there is great scope for the use of GA_3 and Biomix for increasing growth and success of softwood grafts in sapota under polyhouse condition. Therefore, the present investigation was undertaken with an object to assess the effect of GA_3 and biomix on growth and success of softwood grafts in sapota.

Materials and Methods
The present investigation was carried out at Central Nursery, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during the year 2022- 2023. The experiment was laid out in randomized block design with ten treatments replicated thrice. The bud sticks were collected during morning hours and kept in wet gunny bags to conserve moisture. The bud sticks were selected suitable to the thickness of rootstocks. The activated bud sticks with matching slant cuts of 2"2.5" length on either side was placed into the cut to form a wedge. The cut end of the scion is shaped to a wedge of 4-5 cm long by chopping the bark and wood from two opposite sides. The khirni rootstock was collected for sapota grafting and the foliar application of GA_3 and soil drenching of Biomix at three distinct stages *i.e.*, immediately after grafting, 30 DAG and 60 DAG was done. Immediately after grafting capping of grafts was done for next 20 days with plastic bags of having 25 cm length, 7.5 cm breadth and 200 guage thickness and grafts were kept under poly house for assessing growth and success of sapota grafts.

Results and Discussion

The perusal of data presented in Table 1 and 2 regarding growth and success of sapota grafts as influenced by different concentrations of GA_3 and biomix applications recorded significant differences.

The data pertaining to days required for sprouting reveals that treatment (T_6) GA_3 125 ppm + Biomix 4% recorded minimum days for sprouting (13.27) while (T_{10}) control took maximum days (24.46) this might be due to GA_3 as it is involved in cell elongation and proliferation. The results are in accordance with the findings of Pawar *et al*. (2018) [5] and Ramteke *et al*. (2015) [6]. The maximum success percentage (92.87%) was also recorded in treatment (T_6) GA_3 125 ppm + Biomix 4%, while minimum (55.33%) was found in (T_{10}) control. The highest success rate may be attributed to the application of GA_3, which stimulates bridging of the callus during the union of the grafts process. Also GA_3 involved in alpha amylase activity, which catalyses the conversion of starch into simple carbohydrates. This activity releases chemical energy, which is utilised to activate sprouts in grafts and it is caused by favourable internal and external conditions under polyhouse, Pawar *et al*. (2018) [5] also reported similar results in his findings. Significant outcomes may also be attributable to the biomix consortium, which carried out biological nitrogen fixation, solubilized insoluble phosphates and mobilised additional plant nutrients for plant uptake by the root-associated organisms. The maximum graft height at 150 DAG (50.13 cm) was found in treatment (T_6) GA_3 125 ppm + Biomix 4%, while minimum (41.47 cm) was recorded in treatment (T_{10}) control. The application of GA_3 resulted in an increase in graft height because it enhanced osmotic uptake of nutrients, which in turn caused cell multiplication and cell elongation in the internodal region's cambium tissue. Gibberellins commonly raise the content of auxins and transfer them to the location of action. Similar outcomes were reported by Kawthalkar and Kunte (1974) [3], Hore and Sen (1985) [2]. The maximum girth of scion at 150 DAG (7.57 mm) was found in treatment (T_6) GA_3 125 ppm + Biomix 4%, while minimum (4.80 mm) noted in treatment (T_{10}) control. The increased girth may have been caused by enhanced photosynthetic activity, faster translocation and more effective use of photosynthetic products, which led to rapid cell division and elongation in the growing section of the plant (Sargent 1965) [8]. The maximum girth of rootstock at 150 DAG (11.02 mm) was found in treatment (T_6) GA_3 125 ppm + Biomix 4%, while minimum (8.14 mm) was found in treatment (T_{10}) control. This could be due to GA_3 treatment, which increases somatic nutrition intake, promoting cell elongation and a rise in rootstock girth (Feucht and Watson, 1958) [1]. The use of Biomix, a combination of different bio agents helps for increasing microbial activities in the soil resulting into the availability of essential nutrients to the plants and hence the application of biomix might promotes shoot growth in the grafts (Sinish *et al*. 2005) [9]. The maximum sprout length at 150 DAG (7.85) was found in treatment (T_6) GA_3 125 ppm + Biomix 4%, while minimum (3.91) found in treatment (T_{10}) control. This may be due to gibberellic acid's ability to improve nutrient osmotic absorption, which in turn causes cell elongation and multiplication. This longer intermodal length eventually leads to an increase in sprout length. According to Sachs *et al*. (1960) [7], the application of GA_3 caused each individual cell to elongate, which in turn led to the production of a large number of cells and the rapid growth of sprouts. The maximum number of shoots at 150 DAG (5.13) was found in treatment (T_6) GA_3 125 ppm + Biomix 4%, while minimum (2.80) observed in treatment (T_{10}) control. It might be due to GA_3 treatment resulted in an increase in the number of shoots per graft. GA_3 activates cell elongation and division. The presence of microorganism inoculants in the Biomix may have contributed significantly to the observed results. However, the perusal of literature available fails to throw light on these findings. The maximum fresh and dry weight of shoot (37.73 g and 33.73g respectively) was found in (T_6) GA_3 125 ppm + Biomix 4% while the minimum fresh and dry weight of shoot (23.20 g and 18.33 g respectively) was recorded in treatment (T_{10}) control at 150 DAG. This may also be attributed to the role played by GA_3, which raises the fresh and dry weight of shoots by accelerating the movement of water and nutrients during the period of cell elongation. This may have encouraged the production of more photosynthetic products, which in turn may have been translocated to different parts of the plant and produced better fresh and dry weight of shoots, Pawar *et al*. (2018) [5]. The maximum number of leaves at 150 DAG (39.20) was observed in treatment (T_6) GA_3 125 ppm + Biomix 4%, while minimum (18.46) observed in treatment (T_{10}) control. The positive effects of Biomix, which boost N uptake with increased nitrate reductase activity in the plant, may be the cause of the increased leaf count. These are in accordance with the findings of Wani (1990) [10]. The maximum fresh and dry weight of leaves (12.93g and 11.40 g, respectively) was found in (T_6) GA_3 125 ppm + Biomix 4% while minimum fresh and dry weight of leaves (8.66 g and 7.33 g respectively) was recorded in treatment (T_{10}) control at 150 DAG. The application of GA_3 and Biomix may have contributed to the rise in fresh and dry leaf weight which promotes leaf growth and ultimately increased leaf biomass. However, the perusal of literature available fails to throw light on these findings. The maximum leaf area (41.77 cm^2) was found in treatment (T_8) GA_3 150 ppm + Biomix 3%, while minimum (18.53 cm^2) found in treatment (T_{10}) control. The application of GA_3 and Biomix might have contributed to the increased leaf area (Mandal *et al.* 2021) [4].

Table 1: Effect of GA_3 and Biomix on days required for sprouting, success percentage, height of grafts, girth of scion, girth of rootstock, sprout length and number of shoots at 150 DAG.

Treat No.	Treatments	Days required for sprouting	Success (%)	Graft height (cm) at 150 DAG	Girth of scion (mm) at 150 DAG	Girth of rootstock (mm) at 150 DAG	Sprout length (cm) at 150 DAG	Number of shoots at 150 DAG
T_1	GA_3 100 ppm + Biomix 2%	14.07	70.00	45.20	6.82	9.07	5.41	3.26
T_2	GA_3 100 ppm + Biomix 3%	15.53	62.00	47.07	6.55	8.83	5.77	3.60
T_3	GA_3 100 ppm + Biomix 4%	14.13	72.67	47.80	6.46	9.33	5.69	3.07
T_4	GA_3 125 ppm + Biomix 2%	21.00	60.00	48.73	6.16	9.07	6.87	3.13
T_5	GA_3 125 ppm + Biomix 3%	15.13	76.67	47.13	6.13	8.89	6.17	3.20
T_6	GA_3 125 ppm + Biomix 4%	13.27	92.83	50.13	7.57	11.02	7.85	5.13
T_7	GA_3 150 ppm + Biomix 2%	14.67	64.67	45.40	6.84	9.71	6.34	3.20
T_8	GA_3 150 ppm + Biomix 3%	15.33	63.33	48.60	6.34	8.90	6.47	3.27
T_9	GA_3 150 ppm + Biomix 4%	14.00	82.67	48.27	6.53	10.36	6.82	4.43
T_{10}	Control	24.46	55.33	41.47	4.80	8.14	3.91	2.80
SE (m) ±		0.77	3.45	1.67	0.42	0.54	0.33	0.28
CD @ 5%		2.29	10.27	4.98	1.27	1.62	0.99	0.85

Table 2: Effect of GA_3 and Biomix on fresh and dry weight of shoot, number of leaves, fresh and dry weight of leaves, leaf area at 150 DAG.

Treat No.	Treatments	Fresh weight of shoot (g) per graft at 150 DAG	Dry weight of shoot (g) per graft at 150 DAG	Number of leaves per graft at 150 DAG	Fresh weight of leaves (g) per graft at 150 DAG	Dry weight of leaves (g) per graft at 150 DAG	Leaf area (cm^2) at 150 DAG
T_1	GA_3 100 ppm + Biomix 2%	28.73	23.73	23.20	10.33	8.80	31.03
T_2	GA_3 100 ppm + Biomix 3%	29.80	25.47	26.93	11.47	9.73	29.62
T_3	GA_3 100 ppm + Biomix 4%	24.46	20.86	27.67	10.87	9.33	34.67
T_4	GA_3 125 ppm + Biomix 2%	27.93	24.33	27.47	10.46	9.13	31.40
T_5	GA_3 125 ppm + Biomix 3%	28.60	23.53	30.73	11.60	9.80	34.27
T_6	GA_3 125 ppm + Biomix 4%	37.73	33.73	39.20	12.93	11.40	26.90
T_7	GA_3 150 ppm + Biomix 2%	28.53	23.33	30.87	11.67	10.27	27.67
T_8	GA_3 150 ppm + Biomix 3%	29.73	24.67	34.07	11.80	10.33	41.77
T_9	GA_3 150 ppm + Biomix 4%	35.56	29.78	36.23	12.47	10.93	36.63
T_{10}	Control	23.20	18.33	18.46	8.66	7.33	18.53
	SE (m) ±	1.62	1.80	1.43	0.69	0.61	2.96
	CD @ 5%	4.83	5.40	4.26	2.05	1.82	8.80

Conclusion

It can be concluded that the foliar application of GA_3 125 ppm and soil drenching of Biomix 4% at three distinct stages i.e. immediately after grafting, 30 DAG and 60 DAG was found significantly superior over rest of the treatments, under poly house condition with the capping of polythene bags for twenty days of grafting to get better growth and success of softwood grafts in Sapota Cv. Kalipatti.

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