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Influence of plant growth regulators on growth of kokum seedlings

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Abstract
The experiment was carried out to study the effect of plant growth regulators on growth of kokum seedlings (*Garcinia indica* Choisy) at College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli 415712 during the year 2021-2022. The experiment was laid out in Randomized Block Design with three replications and ten treatments namely T_1 - NAA @ 50 ppm, T_2 - NAA @ 100 ppm, T_3 - NAA @ 150 ppm, T_4 - GA_3 @ 100 ppm, T_5 - GA_3 @ 200 ppm, T_6 - GA_3 @ 300 ppm, T_7 - Triacontanol @ 100 ppm, T_8 - Triacontanol @ 200 ppm, T_9 - Triacontanol @ 300 ppm and T_{10} – Control. Present investigation revealed that the seedling sprayed with GA_3 at 300 ppm were recorded highest seedling height (33.62 cm), number of leaves (11.25), girth at collar region (4.24 mm), leaf area (52.67 cm^2), number of nodes (23.21) and internodal length (3.57 cm). Similarly, accelerated rate of growth within 180 days was also observed in the treatment with GA_3 at 300 ppm recording the absolute growth rate (0.162 cm/day) and relative growth rate (0.00520 cm/cm/day).

Keywords: Kokum, plant growth regulators, seedlings, growth parameters

Introduction
Kokum (*Garcinia indica* Choisy) is an ancient fruit and one of the important indigenous tree spice crops originated and grown in Western Ghats of India (Subhas Chandran, 2005) [9]. The tree is mostly found in Konkan region, which includes the districts of Ratnagiri and Sindhudurg in Maharashtra, Goa, Uttara Kannada, Udupi, and Dakshin Kannada Districts of Karnataka and Kasaragod area of Kerala. In Ayurvedic medicine kokum was traditionally used to treat sores, dermatitis, ear infection and to facilitate digestion. Kokum and its derivatives have drawn the attention of several pharmaceutical industries. India is now the sole nation benefiting from the monopoly in kokum production in the world. There is great scope for cultivation of kokum in the konkan region, since the soil and climatic condition are ideal for its growth; however, its cultivation has not extended because of its dioecious nature. The sex of plant is recognized only after completion of juvenile period; fifty per cent plants being male are unproductive. One of the main issues with raising seedlings and producing planting material for elite kokum is low seed viability, along with poor seed germination and slow seedling growth. Seed availability is also limited for one to two months. As a result, the seeds available during that season must be used to raise rootstock. The most important factor in achieving a higher rate of grafting success is healthy rootstock growth. Chemicals such as GA3 and NAA spray received a lot of attention from nurserymen and growers because they help seedlings grow faster (Rajamanickam *et al.*, 2002) [8]. It is necessary to shorten this period by use of different plant growth regulators or by modifying management practices. Hence, it is essential to standardize proper concentration of plant growth regulators to improve growth of kokum seedling at nursery stage. Therefore, the information on effect of plant growth regulators on growth was lacking in Konkan region of Maharashtra. Hence present investigation was undertaken with to study the effect of plant growth regulators on growth of kokum seedling.

Material and Methods
The experiment was conducted at the Nursery No. 4, at College of Horticulture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli 415 712 during the year 2021-22. The fresh seed material collected during the fruiting season was used for the experiment. These fresh seeds were used for sowing after soaking in water for 24 hours. The seeds were first sown in protray filled with sterilized coco peat mixed with well decomposed fine compost. The protray having standard size of 104 cavities each of 35 cc were used to raise the seedling.

After sowing, the trays were kept under polyhouse conditions and light watering was given regularly to keep media moist. Germination was observed 30 days after sowing. One-month seedlings in the protray were used for transplanting in poly bag of size 6" X 8" having soil and FYM media. The growth regulators were sprayed at 4 leaf stage *i.e.*, one month after transplanting and subsequently three more sprays were given at 30-day intervals. The experiment was laid out in Randomized Block Design with three replications and ten treatments namely T_1 - NAA @ 50 ppm, T_2 - NAA @ 100 ppm, T_3 - NAA @ 150 ppm, T_4 - GA_3 @ 100 ppm, T_5 - GA_3 @ 200 ppm, T_6 - GA_3 @ 300 ppm, T_7 - Triacontanol @ 100 ppm, T_8 - Triacontanol @ 200 ppm, T_9 - Triacontanol @ 300 ppm and T_{10} - Control. A group of 50 seedlings was formed a unit and data collected from the ten labelled seedlings in each treatment were averaged. The observations on seedling height (cm), number of leaves, girth at collar region (mm), number of nodes, leaf area (cm^2), internodal length (cm), Absolute growth rate and relative growth rate were recorded. The data generated from the studies were subjected to analysis by using standard method suggested by Panse and Sukhatme (1985) [6].

Results and Discussion

Seedling height (cm)

Data pertaining to plant height as affected by plant growth regulators recorded at different growth stages (Table 1). The maximum plant height was recorded in treatment GA_3 @ 300 ppm concentration (33.62 cm) which was significantly superior over the other treatments. The minimum plant height was found in Control (17.12 cm) which was at par with NAA @ 150 ppm (17.66 cm) and NAA @ 50 ppm (18.53 cm). According to Muralidhara *et al.* (2014) [5] significant increase in the plant height with GA_3, may be due to the action of gibberellins that promotes vegetative growth by way of cell division and cell elongation and this, may have resulted in the increase of plant height in the present study. Similar results were observed by Jadhav (1999) [2] in Kokum seedlings.

Girth at collar region (mm)

Girth at collar region is an important factor for giving the support to seedling at initial stage, which is a vital character in health of the seedling. The data presented in Table 1 showed that the maximum girth at collar region was recorded in GA_3 @ 300 ppm (4.24 mm) which was at par with GA_3 @ 200 ppm (4.04 mm). The minimum girth at collar region was recorded under Control (2.96 mm) which was at par with NAA @ 150 ppm (3.07 mm). The study revealed that the stem girth significantly increased due to different concentrations of plant growth regulators. It might be due to the greater cell division and elongation at the stem portion. The increased in stem girth by application of GA_3 was also reported by earlier workers Patil *et al.* (2017) [7] in jamun and Chavan (2014) [1] in kokum seedling.

Number of leaves

The leaves are the prime important functional units for photosynthesis, which influence the growth and development of crop. The increased in concentration of GA_3 and Triacontanol increases the number of leaves at all stages of crop growth. The maximum number of leaves was recorded with GA_3 @ 300 ppm (23.21). The minimum number of leaves was found in Control (16.17) which was at par with NAA @ 50 ppm (16.76). The increase in the number of leaves with GA_3 treatment may be due to promotion of physiological processes and stimulatory action of GA_3 to form new leaves at faster rate and promotion of linear growth and accelerated translocation of food material in the tissue which create an ideal condition to development of new leaves (Malshe *et al.*, 2016) [3]. The present findings are in line with the findings of Chavan (2014) [1] and Jadhav (1999) [2] in kokum.

Number of nodes

The maximum number of nodes was recorded with GA_3 @ 300 ppm (11.25) which was at par with GA_3 @ 200 ppm (10.97), GA_3 @ 100 ppm (10.86). The minimum number of nodes was recorded under Control (7.21). The increase in concentration of GA_3 and Triacontanol increases the number of nodes at all stages of growth. This is may be due to positive effect of plant growth regulators on number of nodes of kokum seedling.

Internodal length (cm)

The data revealed that the spraying of plant growth regulators influenced internodal length of kokum seedling and increase in concentration of GA_3 increases internodal length. The treatment GA_3 @ 300 ppm recorded highest internodal length (3.57 cm) which was significantly superior over the rest of treatments. Whereas, the lowest internodal length was observed in Control (2.67 cm) which was at par with NAA @ 150 ppm (2.73 cm) and NAA @ 50 ppm (2.80 cm). The regulation of growth by gibberellins relates extensively to its stem elongation properties (Muralidhara *et al.*, 2014) [5]. Gibberellins have direct effect on stem elongation by inducing cell wall loosening by increasing cell wall extensively, stimulating the wall synthesis, reducing the rigidity of cell wall and increasing cell division leading to more growth.

Leaf area (cm^2)

Leaf area is an important determinant of light interception and consequently of transpiration, photosynthesis and plant productivity. The data revealed that the highest leaf area was observed in GA_3 @ 300 ppm (52.67 cm^2) which was found at par with T_9 - Triacontanol @ 300 ppm (50.79 cm^2 and T_5 - GA_3 @ 200 ppm (48.57 cm^2). However, the lowest leaf area was recorded under T_{10} - Control (36.19 cm^2) which was at par with T_1 - NAA @ 50 ppm (36.49 cm^2), T_3 - NAA @ 150 ppm (36.78 cm^2) and T_2 - NAA @ 100 ppm (37.46 cm^2). The significant increase in the leaf area with GA_3, might be due to activity of GA_3 at the apical meristem resulting in more synthesis of nucleoprotein responsible for increasing leaf area. Similar results were reported by earlier workers Chavan (2014) [1] in kokum, Muralidhara *et al.* (2014) [5] in mango and Meshram *et al.* (2015) [4] in acid lime.

Absolute Growth Rate (cm/day)

The absolute growth rate in terms of height (cm) per day per plant as influenced periodically by different growth regulator treatments are presented in Table - 3. The highest absolute growth rate was recorded in GA_3 @ 300 ppm (0.162 cm/day) at 150-180 DAP. While, the minimum absolute growth rate was found in control (0.065 cm/day). It was might be due to positive effect of growth regulators towards cell division, cell elongation, maturity of cells as well as uptake of nutrients and thus resulted into better vigour of kokum seedlings over control. Absolute growth rate was the highest in all treated seedlings over control. Thus, among the all the growth

regulators at different concentration under study, GA_3 at 300 ppm concentration noticed better effect on promoting vigour of kokum seedlings up to 180 days after spraying. The results were confirmative with Chavan (2014) [1] who reported the highest absolute growth rate when kokum seedlings were treated with GA_3 at 200 ppm concentration.

Relative Growth Rate (cm/cm/day)

The data regarding the mean relative growth rate of kokum seedling as periodically influenced by different growth regulators treatments are presented in Table - 3. The data at 150-180 DAP showed the highest relative growth rate was recorded with T_6 – GA_3 @ 300 ppm (0.00520 cm/cm/day). While, the minimum absolute growth rate was recorded in T_5 – GA_3 @ 200 ppm (0.00324 cm/cm/day). Among the all the growth regulators at different concentration under study GA_3 at 300 ppm concentration noticed better and effect on promoting vigour of kokum seedlings. The results were in line with the results reported by Chavan (2014) [1] in kokum seedlings.

Table 1: Effect of plant growth regulators on plant height, number of leaves and leaf area of kokum seedling

Treatment	Plant height (cm)	No. of leaves	Leaf area (cm^2)
	180 Days after transplanting		
T_1 (NAA @ 50 ppm)	18.53	16.76	36.49
T_2 (NAA @ 100 ppm)	20.11	17.13	37.46
T_3 (NAA @ 150 ppm)	17.66	17.09	36.78
T_4 (GA_3 @ 100 ppm)	25.14	20.12	45.64
T_5 (GA_3 @ 200 ppm)	28.90	21.58	48.57
T_6 (GA_3 @ 300 ppm)	33.62	23.21	52.67
T_7 (Triacontanol @ 100 ppm)	22.89	18.64	45.86
T_8 (Triacontanol @ 200 ppm)	25.15	19.13	47.60
T_9 (Triacontanol @ 300 ppm)	27.89	21.52	50.79
T_{10} (Control)	17.12	16.17	36.19
Mean	23.70	19.07	43.80
F Test	SIG	SIG	SIG
S.Em (±)	0.922	0.230	1.636
C.D @ 5%	2.740	0.685	4.862

Table 2: Effect of plant growth regulators on girth at collar region, number of nodes and intermodal length of kokum seedling

Treatment	Girth at collar region (mm)	No. of nodes	Intermodal length (cm)
	180 Days after transplanting		
T_1 (NAA @ 50 ppm)	3.16	8.09	2.80
T_2 (NAA @ 100 ppm)	3.27	8.38	2.87
T_3 (NAA @ 150 ppm)	3.07	7.84	2.73
T_4 (GA_3 @ 100 ppm)	3.81	10.86	3.13
T_5 (GA_3 @ 200 ppm)	4.04	10.97	3.27
T_6 (GA_3 @ 300 ppm)	4.24	11.25	3.57
T_7 (Triacontanol @ 100 ppm)	3.60	9.57	3.13
T_8 (Triacontanol @ 200 ppm)	3.81	9.66	3.23
T_9 (Triacontanol @ 300 ppm)	3.53	10.05	3.30
T_{10} (Control)	2.96	7.21	2.67
Mean	3.55	9.39	3.07
F Test	SIG	SIG	SIG
S.Em (±)	0.067	0.189	0.059
C.D @ 5%	0.198	0.560	0.175

Table 3: Effect of plant growth regulators on absolute and relative growth rate of kokum seedling

Treatment	Absolute growth rate (cm/day)	Relative growth rate (cm/cm/day)
	150-180 days after transplanting	
T_1 (NAA @ 50 ppm)	0.068	0.00485
T_2 (NAA @ 100 ppm)	0.084	0.00467
T_3 (NAA @ 150 ppm)	0.088	0.00390
T_4 (GA_3 @ 100 ppm)	0.099	0.00421
T_5 (GA_3 @ 200 ppm)	0.089	0.00324
T_6 (GA_3 @ 300 ppm)	0.162	0.00520
T_7 (Triacontanol @ 100 ppm)	0.100	0.00470
T_8 (Triacontanol @ 200 ppm)	0.102	0.00434
T_9 (Triacontanol @ 300 ppm)	0.101	0.00383
T_{10} (Control)	0.065	0.00423
Mean	0.095	0.00431

Conclusion

The foliar application of GA_3 at 300 ppm was found to be the best for maximizing the seedling height (33.62 cm), number of leaves (11.25), girth (4.24 mm), leaf area (52.67 cm^2), number of nodes (23.21), internodal length (3.57 cm), absolute growth rate (0.162 cm/day) and relative growth rate (0.00520 cm/cm/day) within 180 days after transplanting. The present investigation concluded with the use of four sprays of GA_3 at 300 ppm concentration at 30 days interval from the date of transplanting for enhancing growth of kokum seedling.

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