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Effect of plant growth regulators and chemicals on seed germination and seedling growth of swollen root (*Decalepis hamiltonii*Wight &Arn.)

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Abstract
A one year research was conducted during 2019-2020 as a part of fulfillment of post graduate degree on "Effect of plant growth regulators and chemicals on seed germination and seedling growth of swollen root (*Decalepis hamiltonii*Wight &Arn.)" at Dr.Y.S.R Horticultural University, Venkataramannagudem, West Godavari District of Andhra Pradesh. Among the treatments studied, pre sowing seed soaking with H_2O_2 @ 0.3% for 8 h recorded maximum values for germination percentage (30.50), survival percentage (99.60), seedling growth parameters *viz.*, fresh weight of seedling (0.661g, 3.35 g), dry weight of seedling (0.181 g, 0.920 g), chlorophyll content (45.99 SPAD, 32.87 SPAD), vigour index I (192.15 cm, 234.85 cm), vigour index II (20.11 g, 102.53 g), root length (6.20 cm, 6.90 cm), fresh weight of root (0.256 g, 2.15 g) and dry weight of root (0.161 g, 0.461 g) at 25 and 50 days after germination respectively. Significantly highest seedling height (7.97 cm, 9.10 cm), number of leaves (7.60, 9.30) and absolute growth rate (0.320 cm,0.360 cm) at 25 and 50 days after germination respectively was recorded with seed soaking in GA_3 @ 1000 ppm for 24 h.

Keywords: *Decalepis*, plant growth regulators, chemicals, seed germination, seedling growth

Introduction
Swollen root (*Decalepis hamiltonii* Wight & Arn.) is a data deficient, endangered medicinal plant of South India belonging to the family Asclepiadaceae. It grows in open rocky slopes and crevices of dry and moist deciduous forests of Karnataka (Hassan, Mysore, Bellary, Tumkur, Kolar), Andhra Pradesh (Kurnool, Chittoor, Nellore, Anantapur, Cuddapah districts) and in Tamil Nadu (Chengalpattu, Coimbatore, Dharampuri, Nilgiri) at an altitude ranging from 300-1200 m. Though relatively widespread, its population is fragmented and gradually declining due to destructive harvesting of the tuberous roots. Swollen root is a perennial, woody climber and reddish brown when young; tend to become purplish when older. It has clusters of numerous, fleshy, cylindrical tuberous roots with a sweet, vanilla-like fragrance. An analogue of vanillin, chemically known as 2-hydroxy-4-methoxy benzaldehyde is the important key metabolite for the characteristic aromatic flavor in its tubers. The roots are pale brown in colour with fleshy outer layer and woody inner core, elongated to grow up to 150 cm in length and 3.5 cm width. Each plant produces 4 to 10 roots of each in 5-10 cm diameter. A 2-3 year old plant produces 15-20 kg of roots and a one year old plant produces 1-2 kg of roots (Vedavathy, 2004) [39]. The tubers of this plant are used for culinary and medicinal purposes (Jacob, 1937). Root extract can be used as food preservative, preparation of neutraceuticals and pharmaceutical products for use in folk medicine and in Ayurvedic preparations. Natural population of swollen root is declining due to over exploitation and habitat destruction. Regeneration of this species is severely affected, since most of the plants are being harvested in a reproductively immature stage. Destructive harvesting of this plant's tubers for small economic gains by tribal communities deliberated it as an endangered plant. Due to its limited natural availability in forest areas and increasing demand for its roots both in the domestic and International markets, its commercial cultivation on a large scale is necessary to sustain its production, meet market demand and overcome the problem of over exploitation.
For commercial cultivation, seed propagation is preferred for which low seed germination is the main hindrance. In nature, seed germination is 18%, out of which seedling establishment is

6% to total seeds sown (Raju and Ramana, 2009) [35]. Natural seed germination is very low because of hard seed coat, short viability and due to self-incompatibility (Chandrasekhara and Ramamurthy, 2013) [2]. Moreover, the cultivation of this crop in the last couple of years by small and marginal farmers in Andhra Pradesh has been significantly increased. At present, the high seed cost (fluctuate between Rs 35,000 to Rs 70,000/kg) and low germination percentage are the main barriers for commercial cultivation of swollen root. In view of the above reasons, the present study was taken up to improve the germination percentage of seeds as well as seedling growth for large scale supply of seedlings to the growers to take up commercial cultivation in marginal and waste lands. Furthermore, the studies on the method of seed propagation are necessary for conservation of genetic diversity existing *in situ* as well as *ex situ*.

Materials and Methods

The experiment was carried out at Dr. Y.S.R Horticultural University, Venkataramannagudem, West Godavari district of Andhra Pradesh during 2019-2020 and laid out in Completely Randomized Design replicated twice comprising of 13 pre-sowing seed treatments *viz.*, T_1 – seeds soaked in water for 24 h, T_2 - GA_3 @ 500 ppm for 24 h, T_3 -GA_3 @ 750 ppm for 24 h, T_4 - GA_3 @ 1000 ppm for 24 h, T_5 - IAA @ 50 ppm for 24 h, T_6 - IAA @ 75 ppm for 24 h, T_7 - IAA @ 100 ppm for 24 h, T_8 - KNO_3 @ 0.3% for 24 h, T_9 - KNO_3 @ 0.5% for 24 h, T_{10} - KNO_3 @ 1% for 24 h, T_{11} - H_2O_2 @ 0.3% for 8 h, T_{12} - H_2O_2 @ 0.4% for 8 h and T_{13} - H_2O_2 @ 0.5% for 8 h.

The required concentration of GA_3 solutions (500, 750 and 1000 ppm) were prepared by dissolving (50 mg, 75 mg and 100 mg respectively) ofGA_3 separately in a small quantity of absolute ethyl alcohol solution and the volume was made up to 100 ml by addition of distilled water. Similarly 50, 75 and 100 ppm of IAA solutions were prepared by dissolving 5 mg, 7.5 mg and 10 mg respectively of IAA in small quantity of absolute ethyl alcohol solution and the volume of each was made up to 100 ml by adding distilled water. Potassium nitrate (KNO_3) solutions of 0.3%, 0.5% and 1% concentration were prepared by dissolving 0.3 g, 0.5 g and 1 g ofKNO_3 separately in a small quantity of distilled water and the volume of each was made up to 100 ml with distilled water. Hydrogen peroxide (H_2O_2) solutions of 0.3%, 0.4% and 0.5% were prepared by dissolving 0.3 ml, 0.4 ml and 0.5 ml of Hydrogen peroxide separately in small quantity of distilled water and then the volume was made upto 100 ml with distilled water. In control treatment the seeds were soaked in water for 24 hours at room temperature.

Sound and healthy seeds were selectedand soaked in respective solutions of different concentrations as per the treatments. The treated seeds were sown in protrays which were properly filled with cocopeat and were properly labeled. Five sprouted seeds were randomly selected and tagged in each replication for recording the observations.

Observations pertaining to days taken for germination, germination percentage at 5, 10 and 15th day after sowing, total seed germination percentage and survival percentage at 50 days after sowing were recorded periodically. Seedling growth parameters such as seedling height, number of leaves, absolute growth rate, chlorophyll content, vigour index I, vigour index II, fresh weight of seedling, dry weight of seedling, root length, fresh weight of root, dry weight of root was recorded at 25 and 50 days after germination.

The germination percentage was calculated using the following formula.

$$\text{Germination percentage (\%)} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

The percentage of germination was calculated based on formula

$$\text{Total seed germination percentage (\%)} = \frac{\text{Total number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

The survival percentage was calculated using the formula

$$\text{Survival (\%)} = \frac{\text{Number of seedlings survived}}{\text{Total number of seedlings germinated}} \times 100$$

For recording growth parameters, five seedlings were randomly selected and tagged in each replication. Observations on root and shoot parameters were recorded at 25 and 50 days after germination (DAG) of the seeds. Seedlings were carefully removed from protrays without any damage. Portrays were profusely watered before removal of the seedlings. The seedlings along with a ball of rooting media were placed in water to remove the soil particles and the seedlings were further washed thoroughly with water to clean the roots.

Absolute growth rate (AGR) for plant height was calculated at 25 and 50 DAG using formula suggested by Radford (1967) and expressed in cm per day.

$$\text{AGR for plant height} = \frac{h_2 - h_1}{t_2 - t_1}$$

Where h_1 and h_2 are plant heights at times t_1 and t_2 respectively.

The total number of seedlings present in each replication of a treatment was counted and its average length was measured with the help of a scale at 25 and 50 DAG. The vigour index I was calculated by using the following formula.

Vigour index I (cm) = No. of seedlings x Average length of seedling

The germination counts were recorded and germination was expressed in percentage. The fresh weight of seedling was weighed with the help of an electronic balance at 25 and 50 DAG and the mean fresh weight of the seedling was expressed in g. The vigour index II was calculated by using the following formula.

Vigour index II (g) = Germination percentage x Mean seedling weight

The total chlorophyll content was measured for five randomly selected plants in each treatment at 25 and 50 DAG by using SPAD meter and the average total leaf chlorophyll content was calculated.

Results and Discussion

Data from table 1 and fig 1 revealed that the treatments didn't show any significant variation among days taken for germination. However the number of days taken for germination in all the treatments ranged from 4 to 5 days. Data regarding germination percentage revealed that the maximum germination percentage of 14.85 and 22.10 at 5th and 10th day after seed sowing was recorded with the seeds

soaked in GA_3 @ 500 ppm for 24 h (T_2) followed by seed soaking with KNO_3 @ 0.5% for 24 h (13.90% and 21.50%) at 5th and 10th day after seed sowing respectively. The increased germination percentage in gibberellic acid treated seeds in initial stages might be attributed to the participation of GA_3 in the synthesis of enzymes like alpha-amylase, which converts starch into simple sugars during the process of germination. These sugars provide energy required for various metabolic processes associated with seed germination (Hartmann and Kester, 1979). These results are in conformity with the findings of Kalidas *et al.* (2011) in *Leptadenia reticulata*, Dhoran and Gudhadhe (2012) in *Asparagus sprengeri*, Anandalakshmi and Prakash (2010) in *Decalepis hamiltonii*.

The significantly highest germination percentage of 24.35 at 15th day after seed sowing was recorded with seeds soaked in H_2O_2 @ 0.3% for 8 h (T_{11}) followed by KNO_3 @ 0.5% for 24 h with 23.75%. Similar trend was observed with total seed germination percentage also with H_2O_2 @ 0.3% (30.50%) followed by KNO_3 @ 0.5% with 27.53%. The increase in germination percentage with H_2O_2 treatment might be due to the release of Reactive Oxygen Species (ROS) and activation of existing ROS by H_2O_2 which participate in endosperm weakening during germination through cell wall loosening. Muller *et al.* (2007) showed that H_2O_2 abolishes inhibitory effects of abscisic acid (ABA) on endosperm rupture. Zhang *et al.* (2014) showed that during seed germination, exogenous application of ROS and ROS generation inducers increase the percentage of endosperm cap ruptures. Lariguet *et al.* (2013) [22] suggested that H_2O_2 regulates the expression of the gene encoding enzyme by hydrolyzing the testa and endosperm, which facilitate germination by releasing the embryo from the control of the seed envelope. The lowest germination percentage at all the stages was recorded with seeds soaked in water alone *ie.*, control treatment. The present results are in accordance with the findings of Espin *et al.* (2012) [8] in *Pisum sativum*, Hafez *et al.* (2012) [13] in *Brassica oleracea* var. *capitata* and *Citrulluslanatus* (Thunb), Omokhua *et al.* (2015) [31] in *Maesobotryabarteri*. (Table 1, fig 1 and plate 1)

Data regarding survival percentage from table 1 revealed that significantly highest survival percentage of 99.60 was recorded with seeds soaked in H_2O_2 @ 0.3% for 8 h (T_{11}) followed by KNO_3 @ 0.5% (T_9) with 97.45% whereas the minimum seedlings survival percentage of 74.20% was recorded with seeds soaked in water for 24 h (T_1). The increased survival percentage with H_2O_2 might be attributed to the compensatory elevation of enzymes activity in the seedlings treated with H_2O_2. These enzymes are known to be associated with the antioxidants that contribute to oxidative stress protection providing necessary intracellular oxidant/antioxidant balance in the cell (Lushchak *et al.*, 2005) [25] which helps in plant resistance against pathogens as well as the production of healthy seedlings. These results are in line with the findings of Hafez *et al*. (2012) [13] in *Brassica oleracea* var. *capitata* and *Citrulluslanatus* (Thunb), Omokhua *et al*. (2015) [31] in *Maesobotryabarteri.*

Data depicted in table 2 revealed that seed soaking with GA_3 @ 1000 ppm (T_4) for 24 h recorded the maximum seedling height of 7.97 cm and 9.10 cm at 25 and 50 DAG respectively followed by GA_3 @ 750 ppm (T_3) with 6.72 cm at 25 DAG but was on par at 50 DAG (9.10 cm). Increase in seedling height might be due to the fact that GA_3 attributed to the cell multiplication and cell elongation in the cambium tissues of the internodal region (Dohono and Walker, 1957) [7] and GA_3 activates the metabolic processes or nullifies the effect of growth inhibitors (Singh *et al*., 1989) [38] ultimately increasing seedling height. The observations are in agreement with the findings of Gholap *et al.* (2000) [11] in *Phyllanthus sps.*, Chetouani *et al.* (2017) [3] in *Thymus satureioides L and Lavandula dentate;* Rajasekharan *et al.* (2016) [34] in *Celastruspaniculatus.* Number of leaves per seedling was found to be non significant among the treatments at 25 DAG where as GA_3 @ 1000 ppm (T_4) recorded significantly highest number of leaves (9.3) that was on par with GA_3 @ 750 ppm (T_3)with 9.2 leaves at 50 DAG. The increase in number of leaves with GA_3, treatment might be due to its activity at apical meristem resulting in more synthesis of nucleoprotein responsible for increasing leaf initiation and leaf expansion (Sen and Ghunti, 1976) [37]. A similar effect of GA_3 treatment on the number of leaves was also reported by Gomathinayagam *et al*. (2009) [12] in *Andrographispaniculata*, Waman *et al.* (2018) [40] in *Semecarpuskurzii* and Muruganandam *et al*. (2019) [28] in *Gloriosa superba.*

The data on absolute growth rate (AGR) from table 2 showed significantly maximum AGR of 0.320 cm/day in the seedlings raised from the seeds soaked in GA_3 @ 1000 ppm for 24 h (T_4) at 25 DAG. At 50 DAG, maximum AGR of 0.360 cm/day was observed in the seedlings treated with GA_3 @ 750 ppm (T_3) and GA_3 @ 1000 ppm for 24 h (T_4) followed by GA_3 @ 500 ppm (T_2) with 0.340 cm/day. The enhanced AGR with GA_3 treatment might be attributed to the increased rate of photosynthesis leading to greater accumulation of photosynthates thereby increasing dry matter of plant ultimately causing significant improvement in absolute growth rate (Harsha *et al*, 2012) [14]. The present results are in accordance with the findings of Harsha *et al.* (2012) [14] in *Artocarpusheterophyllus*, Ramteke *et al*. (2016) in *Carica papaya.*

Data pertaining to total chlorophyll content from table 2 and fig 2 revealed that pre sowing seed treatment with H_2O_2 @ 0.3% for 8 h (T_{11}) recorded significantly highest chlorophyll content of 45.99 SPAD and 32.87 SPAD at 25 DAG and 50 DAG respectively followed by KNO3 @ 0.5% for 24 h (T_9) with 43.75 SPAD and 30.65 SPAD at 25 DAG and 50 DAG respectively. H_2O_2 treated plants exhibited increase in total chlorophyll content which may be the indication of H_2O_2 effect on the net photosynthetic rate and the related attributes in plants (Fariduddin *et al.*, 2014, Khan *et al.*, 2015, Hasan *et al.*, 2016) [9, 20, 16]. Exogenous application of H_2O_2 in creased photosynthetic rate and dry matter content of the leavesin wax apple under field conditions (Khandaker *et al.*, 2018) [21]. The H_2O_2 treatments significantly increased the photochemical efficiency of PS II and initial Rubisco activity (Jiang *et al.*, 2012) [18] which indirectly increases the chlorophyll content. The total chlorophyll content of the seedlings at 25 DAG was more when compared to the seedlings at 50 DAG which might be because of the reduced availability of light in the hardening chamber due to excessive growth of the seedlings resulting in shade effect on the older leaves coupled with depletion of food material availability to the seedlings grown in the protrays filled with cocopeat from which nutrients were continuously taken up by the growing seedlings in nursery stage. The results are in conformity with Hafez *et al.* (2012) [13] in *Citrulluslanatus* (Thunb), Othman *et al.* (2015) [32] in *Ficusdeltoidea* var. *trengganuensis*, Khandaker *et al.* (2018) [21] in *Syzygiumsamarangense*, Jamaludin *et al*. (2020) [17] in *Ficus deltoidea.*

Data pertaining to vigour index I from table 2 and fig 2 revealed that significantly maximum vigour index I (192.15 and 234.85 cm) was recorded in the seedlings raised from the seeds soaked in H_2O_2 @ 0.3% for 8 h (T_{11}) at 25 DAG and 50

DAG respectively followed by KNO_3 @ 0.5% for 24 h (T_9) with 177.50 cm and 213.63 cm at 25 DAG and 50 DAG respectively. Increased vigour index I with H_2O_2 pre treatment might be attributed to its participation as a chemical messenger that acts in different manners to stimulate germination and growth in seedlings. The oxidation of germination inhibitors present in pericarp by H_2O_2 might also promote seedling height (Ogawa and Iwabuchi, 2001) [30]. These results are in harmony with the findings of Omukhua *et al.* (2015) in *Maesobotryabarteri* and Nandi *et al*. (2016) [29] in *Capsicum frutescens*.

From the data on vigour index II in table 3 and fig 2 it is evident that, significantly the highest vigour index II values of 20.11 g and 95.60 g was recorded in the seedlings raised from the seeds soaked in H_2O_2 @ 0.3% for 8 h (T_{11}) at 25 DAG and 50 DAG respectively followed by KNO_3 @ 0.5% for 24 h (T_9) with 17.50 g and 84.32 g at 25 DAG and 50 DAG respectively. The increase in vigour index II with H_2O_2 might be due to increase in fresh weight of seedlings which could be attributed to increase in oxygen and water uptake (Ching 1959). H_2O_2 induces the proteins related to plant growth, cellular signaling and cell cycle control as well as with a substantial decrease in the levels of ABA and zeatin-riboside hormones (Espin *et al.*, 2012) [8].

The seedling fresh weight and dry weight was found to be significantly different among the treatments (Table 3). Maximum seedling fresh weight of 0.661 g and 3.35 g at 25 DAG and 50 DAG respectively was recorded with H_2O_2 @ 0.3% for 8 h (T_{11}) followed by KNO_3 @ 0.5% for 24 h (T_9) with 0.636 g and 3.07 g at 25 DAG and 50 DAG respectively. These results are in conformity with Espin *et al.* (2012) [8] in *Pisum sativum*, Hafez *et al.* (2012) [13] in *Brassica oleracea* var. *capitata* and *Citrulluslanatus* (Thunb). Similar trend was recorded for seedling dry weight with 0.181 g and 0.920 g at 25 DAG and 50 DAG respectively followed by KNO_3 @ 0.5% for 24 h (T_9) with 0.171 g and 0.820 g at 25 DAG and 50 DAG respectively. These results are in agreement with the findings of Omokhua *et al*. (2015) [31] in *Maesobotryabarteri* and Migahid *et al*. (2019) in *Silybum marianum.* The increase in seedling fresh weight with H_2O_2 treatment might be due to the induction of oxidative stress which accelerates root growth resulting in a higher fresh weight finally resulting in higher dry weight of seedling as reported by (Hafez *et al.*, 2012) [13].

Data on root parameters depicted in table 3 and fig 3 indicated that significantly highest values for root length, root fresh and dry weights was recorded with H_2O_2 @ 0.3% for 8 h (T_{11}) at 25 DAG (6.20 cm, 0.256 g and 0.161 g respectively) and 50 DAG (6.90 cm, 2.150 g and 0.461 g respectively) followed by KNO_3 @ 0.5% for 24 h (T_9) at 25 DAG (5.45 cm, 0.241 g and 0.160 g respectively) and root fresh and dry weight only at 50 DAG with 2.070 g and 0.440 g respectively. In terms of root length at 50 DAG, the second highest root length of 6.00 cm was recorded with H_2O_2 @ 0.5% for 8 h (T_{13}). Seedlings in T_9 treatment produced short and thicker roots compared to seedlings in T_{13} treatment having long and thin roots resulting in higher root fresh and dry weights as evident from plate 2.

Increased root length with H_2O_2pre treatment might be due to the induced activity of peroxidase enzyme in roots by H_2O_2. The peroxidase enzyme mediates the formation of cell walls (Liszkay *et al.*, 2003) [23] and contributes to cell expansion. Hydrogen peroxide pre treated seeds resulted in a maximum fresh weight of root which might be due to increased activity ofNADPH oxidases present in the cell which control development through ROS, that regulate plant cell expansion through the activation of Ca^{2+} channels; then activates MAPK cascades as calcium and MAPKs regulate the activity of other signaling proteins to induce the adventitious root formation as well as root elongation (Foreman *et al.*, 2003, Liu *et al.*, 2009 and Zhang *et al.*, 2009) [10, 24, 42]. The maximum dry weight of roots with H_2O_2 pre soakingwas attributed to the production of roots with maximum fresh weight. Similar results in terms of root length, root fresh and dry weights were earlier reported by Deng *et al.* (2012) [5] in *Ipomoea batatas.*

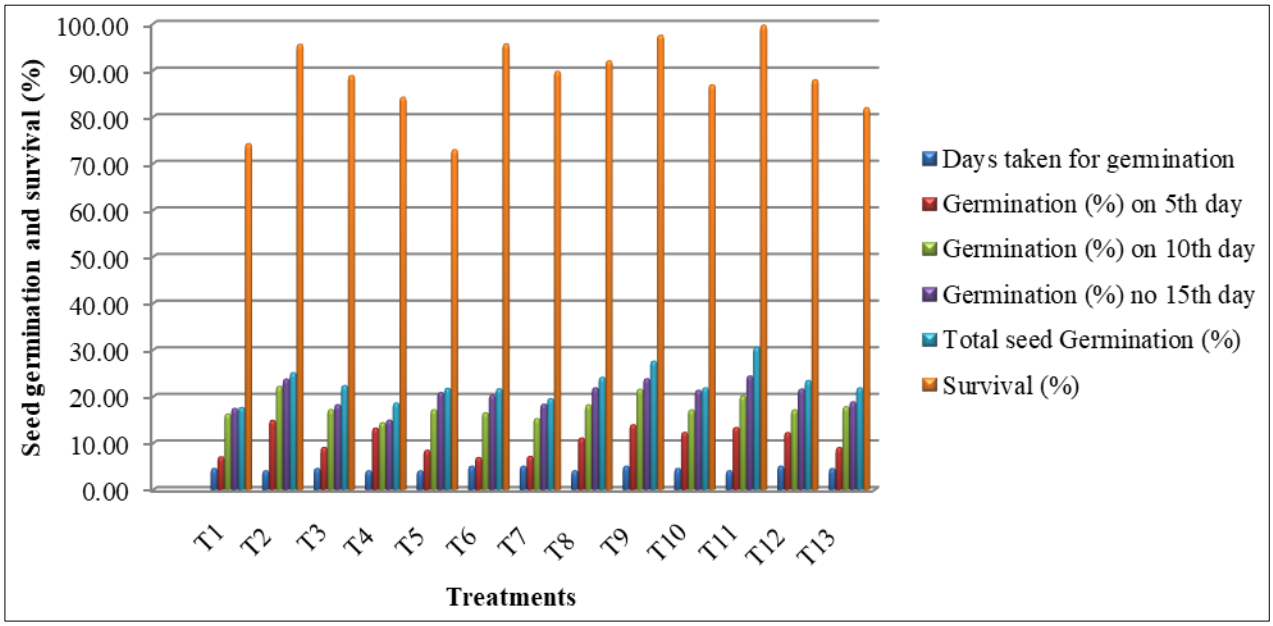

Fig 1: Effect of pre sowing seed treatments on seed germination and survival percentage in swollen root

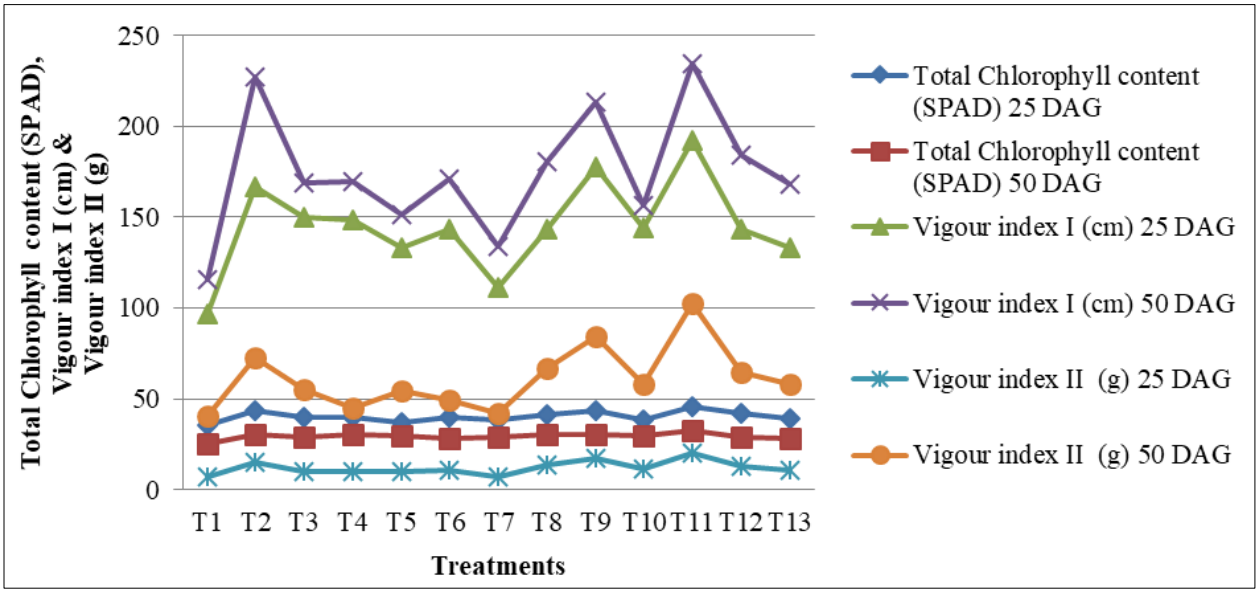

Fig 2: Effect of pre sowing seed treatments on total chlorophyll content, vigour index I and vigour index II in swollen root seedlings

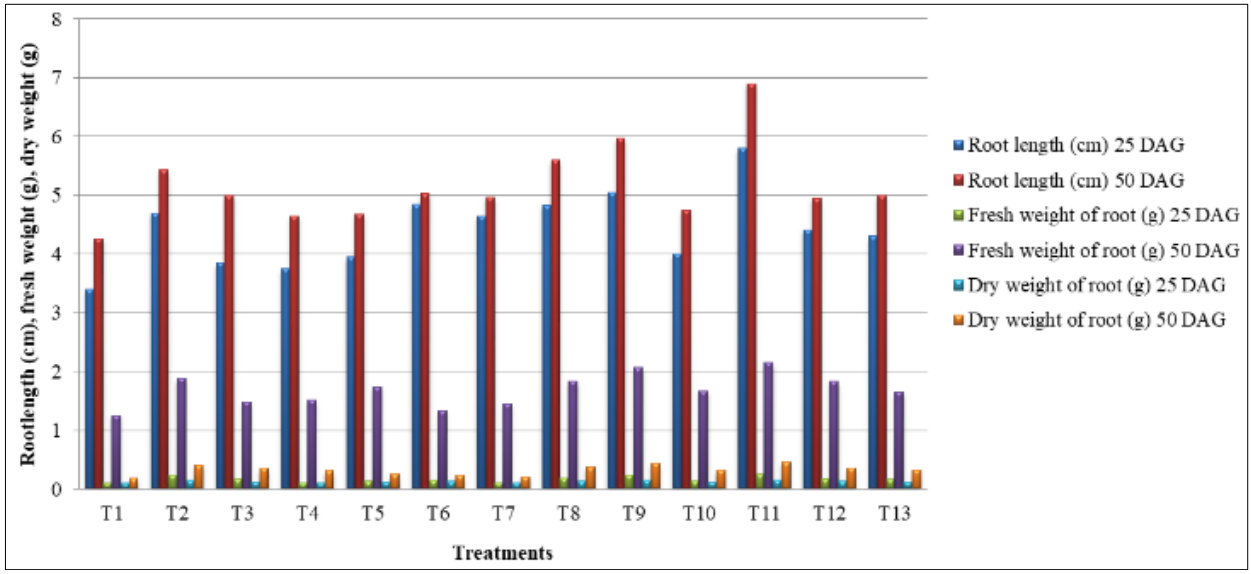

Fig 3: Effect of pre sowing seed treatments on root length, fresh weight and dry weight of root in swollen root seedlings

Table 1: Effect of pre sowing seed treatments on seed germination and survival percentage in swollen root *(Decalepis hamiltonii)*

Treatments	Days taken for germination	Germination (%)			Total seed germination (%)	Survival (%)
		5th day	10th day	15th day		
T_1: Water soaking	4.50 (2.34)	7.00 (2.82)	16.20 (4.15)	17.40 (4.29)	17.60 (4.31)	72.90 (8.60)
T_2: GA_3 500 ppm	4.00 (2.24)	14.85 (3.98)	22.10 (4.81)	23.70 (4.97)	25.05 (5.10)	95.50 (9.82)
T_3: GA_3 750 ppm	4.50 (2.34)	9.03 (3.17)	17.15 (4.26)	18.20 (4.38)	22.30 (4.83)	88.80 (9.48)
T_4: GA_3 1000 ppm	4.00 (2.24)	13.18 (3.77)	14.33 (3.91)	14.88 (3.98)	18.55 (4.42)	84.15 (9.23)
T_5: IAA 50 ppm	4.00 (2.24)	8.43 (3.07)	17.10 (4.25)	20.80 (4.67)	21.70 (4.76)	74.20 (8.67)
T_6: IAA 75 ppm	5.00 (2.45)	6.85 (2.80)	16.45 (4.18)	20.20 (4.60)	21.60 (4.75)	95.60 (9.83)
T_7: IAA 100 ppm	5.00 (2.45)	7.10 (2.85)	15.20 (4.03)	18.30 (4.39)	19.50 (4.53)	89.70 (9.52)
T_8: KNO_3 0.3%	4.00(2.24)	11.05 (3.47)	18.15 (4.38)	21.80 (4.78)	24.06 (5.01)	91.95 (9.64)
T_9: KNO_3 0.5%	5.00 (2.45)	13.90 (3.86)	21.50 (4.74)	23.75 (4.98)	27.53 (5.34)	97.45 (9.92)
T_{10}: KNO_3 1%	4.50 (2.34)	12.25 (3.64)	17.08 (4.25)	21.26 (4.72)	21.80 (4.78)	86.80 (9.37)
T_{11}: $H_2O_2$0.3%	4.00 (2.24)	13.30 (3.78)	20.08 (4.59	24.35 (5.04)	30.50 (5.61)	99.60 (10.03)
T_{12}: $H_2O_2$0.4%	5.00 (2.45)	12.20 (3.63)	17.08 (4.33)	21.55 (4.75)	23.37 (4.94)	87.90 (9.43)
T_{13}: $H_2O_2$0.5%	4.50 (2.34)	9.00 (3.16)	17.73 (4.34)	18.80 (4.45)	21.80 (4.78)	81.90 (9.11)
Mean	4.46 (2.33)	10.63 (3.38)	17.76 (4.32)	20.38 (4.61)	22.72 (4.86)	88.19 (9.43)
SE(m)	0.059	0.094	0.063	0.046	0.068	0.067
C.D	NS	0.289	0.196	0.141	0.209	0.206

* Figures in parenthesis are square root transformed values

Table 2: Effect of pre sowing seed treatments on seedling height, number of leaves, absolute growth rate, total chlorophyll content, and vigour index I in swollen root *(Decalepis hamiltonii)*

Treatments	Seedling height (cm)		No. of leaves		Absolute growth rate (cm/day)		Total Chlorophyll content (SPAD)		Vigour index I (cm)	
	25 DAG	50 DAG	25 DAG	50 DAG	25 DAG	50 DAG	25 DAG	50 DAG	25 DAG	50 DAG
T_1: Water soaking	5.50	6.55	6.10 (2.67)	7.00 (2.83)	0.220	0.260	35.50	25.00	96.40	115.43
T_2: GA_3 500 ppm	6.67	8.50	6.90 (2.81)	7.80 (2.97)	0.270	0.340	43.45	30.45	166.81	227.18
T_3: GA_3 750 ppm	6.72	9.00	7.20 (2.86)	9.20 (3.19)	0.270	0.360	39.70	28.70	149.78	169.00
T_4: GA_3 1000 ppm	7.97	9.10	7.60(2.93)	9.30 (3.21)	0.320	0.360	39.45	30.10	148.15	169.78
T_5: IAA 50 ppm	6.14	6.95	6.80 (2.79)	7.90 (2.98)	0.250	0.280	37.00	29.40	133.27	151.19
T_6: IAA 75 ppm	6.65	7.95	7.00 (2.82)	7.30 (2.88)	0.270	0.320	40.00	28.15	143.35	171.09
T_7: IAA 100 ppm	5.71	7.05	6.40 (2.72)	7.60 (2.93)	0.230	0.280	38.55	29.20	111.28	133.65
T_8: KNO_3 0.3%	5.97	7.50	6.50 (2.74)	7.80 (2.97)	0.240	0.300	41.05	30.40	143.60	180.34
T_9: KNO_3 0.5%	6.45	7.95	6.60 (2.76)	7.50 (2.92)	0.260	0.320	43.75	30.65	177.50	213.63
T_{10}: KNO_3 1%	6.60	7.15	7.20 (2.86)	7.40 (2.89)	0.260	0.290	38.60	29.70	144.06	156.64
T_{11}: $H_2O_2$0.3%	6.31	7.70	7.00 (2.83)	7.50 (2.92)	0.250	0.310	45.99	32.87	192.15	234.85
T_{12}: $H_2O_2$0.4%	6.15	7.90	6.60 (2.76)	7.80 (2.97)	0.250	0.320	41.70	29.15	143.64	184.22
T_{13}: $H_2O_2$0.5%	6.10	7.65	7.20 (2.86)	8.30 (3.05)	0.240	0.310	38.75	28.05	133.16	167.92
Mean	6.38	7.77	6.85 (2.80)	7.88 (2.98)	0.256	0.311	40.27	29.37	144.86	174.99
SE (m)±	0.31	0.10	0.06	0.05	0.010	0.004	0.70	0.65	1.04	1.64
CD at 5%	0.96	0.29	NS	0.16	0.040	0.010	2.15	2.00	3.24	5.10

* Figures in parenthesis are square root transformed values

Table 3: Effect of pre sowing seed treatments on and vigour index II, fresh weight and dry weight of seedlings, root length, fresh and dry weight of roots in swollen root *(Decalepis hamiltonii)* seedlings

Treatments	Vigour index II(g)		Fresh weight of seedling (g)		Dry weight ofseedling (g)		Root length (cm)		Fresh weight of root (g)		Dry weight of root (g)	
	25 DAG	50 DAG	25 DAG	50 DAG	25 DAG	50 DAG	25 DAG	50 DAG	25 DAG	50 DAG	25 DAG	50 DAG
T_1: Water soaking	7.11	40.49	0.376	2.17	0.111	0.500	3.40	4.26	0.096	1.250	0.100	0.180
T_2: GA_3 500 ppm	15.15	72.29	0.606	2.89	0.169	0.780	5.00	5.11	0.236	1.880	0.152	0.410
T_3: GA_3 750 ppm	9.92	55.40	0.446	2.49	0.146	0.590	3.45	5.05	0.173	1.480	0.122	0.355
T_4: GA_3 1000 ppm	9.99	44.61	0.540	2.40	0.143	0.500	3.55	5.05	0.108	1.510	0.105	0.315
T_5: IAA 50 ppm	10.19	54.14	0.470	2.50	0.131	0.720	3.75	4.58	0.135	1.730	0.114	0.250
T_6: IAA 75 ppm	10.70	49.53	0.405	2.30	0.148	0.660	4.85	5.03	0.146	1.330	0.130	0.230
T_7: IAA 100 ppm	7.30	42.10	0.495	2.30	0.140	0.570	3.75	4.97	0.110	1.450	0.111	0.205
T_8: KNO_3 0.3%	13.35	66.53	0.555	2.77	0.159	0.750	4.83	5.78	0.191	1.830	0.144	0.380
T_9: KNO_3 0.5%	17.50	84.32	0.636	3.07	0.171	0.820	5.45	5.60	0.241	2.070	0.160	0.440
T_{10}: KNO_3 1%	11.19	58.12	0.516	2.67	0.128	0.495	4.00	4.75	0.144	1.670	0.116	0.315
T_{11}: $H_2O_2$0.3%	20.11	102.53	0.661	3.35	0.181	0.920	6.20	6.90	0.256	2.150	0.161	0.461
T_{12}: $H_2O_2$0.4%	12.73	64.24	0.545	2.75	0.152	0.715	4.41	4.65	0.178	1.830	0.143	0.355
T_{13}: $H_2O_2$0.5%	10.99	58.05	0.506	2.66	0.137	0.700	3.50	6.00	0.162	1.650	0.117	0.325
Mean	12.02	60.95	0.520	2.64	0.147	0.671	4.32	5.21	0.167	1.680	0.129	0.325
SE (m)±	0.56	1.49	0.005	0.07	0.003	0.011	0.08	0.11	0.005	0.020	0.002	0.005
CD at 5%	1.73	4.60	0.016	0.22	0.009	0.035	0.26	0.35	0.015	0.060	0.006	0.016

Plate 1: General view of germinated seedlings in nursery

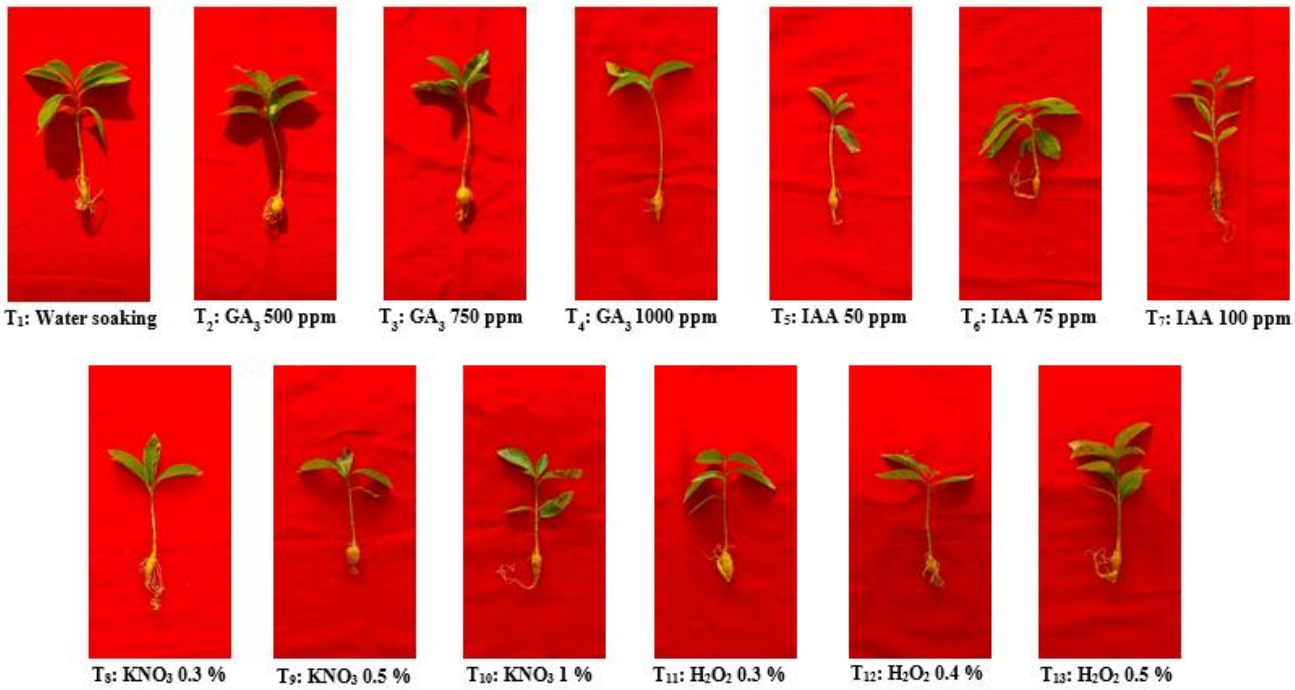

Plate 2: Seedling growth after 50 days after germination

Conclusion

The present investigation on the effect of plant growth regulators and chemicals on seed germination and seedling growth of swollen root (*Decalepis hamiltonii*Wight &Arn.)revealed that seed soaking with H_2O_2 @ 0.3% for 8 h showed the superior performance in terms ofgermination and growth parameters especially root growth in nursery.

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