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RESEARCH PAPER

Effect of growth regulators and chemicals on germination and seedling growth of Rangpur lime under laboratory conditions

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Abstract : The seeds of Rangpur lime were treated with different concentrations of GA_3 (50, 100 and 150 ppm), NAA (50, 100 and 150 ppm), Potassium nitrate (1.0, 1.5 and 2.0 %), thiourea (1.0, 1.5 and 2.0 %) and control (water soaked). The seeds were soaked for 24 hours in 100 ml of solutions of different concentrations. The experiment was carried out adopting Complete Randomized Design with thirteen treatment replicated thrice. The treated seeds of Rangpur lime were placed on rolled towel paper and the paper was rolled and made sufficient wet. The rolled papers with seeds were kept in growth chamber, at 30 $\pm$ 2 ^{o} C temperature. Light was provided for 8 hours a day by using 2 numbers of long fluorescent tube lights. Treatment $GA_3$150 ppm recorded higher germination (98.66 %) at the end of third week, ERI (67.711) and BRI (0.619), more shoot length (4.37cm) and root (2.82 cm) length, more fresh (96.25 g) and dry (14.68 g) weight of Rangpur lime seedlings, maximum SVI (705.19) and least days (3.34 days) took for germination under laboratory conditions. In general pre-soaking treatment to the seeds with different growth regulator and chemical solutions were found to be beneficial to improve the germination percentage compared to control under laboratory conditions.

Key Words : Rangpur lime, Growth regulators, Lab conditions, Germination, Seedling growth

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INTRODUCTION

Citrus fruits have a prominent place among popular and extensively grown tropical and sub-tropical fruits. India is sixth largest producer of citrus in the world contributing 4.8 per cent share in production. The research findings in Maharashtra in respect of mandarin and sweet orange have indicated that Rangpur lime rootstock is reasonably satisfactory both in regard to yield and quality. It is healthy, semi-vigorous, productive, tolerance to salt, ESP in soil, greening disease and resistant to Tristeza virus. (Bennet and Costa, 1949 and Chaudhari *et al*., 1974) and fairly resistant to *Phytophthora* fungus (Moreira, 1964). The experimental evidences under Citrus Fruit Research Scheme, Nagpur (1944-48) indicates that the rate and extent of seed germination and seedling growth in Rangpur lime is not satisfactory. The germination of Rangpur lime seeds sown without any pre-treatment is between 27-30 per cent (Singh *et al.*, 1970). The seeds take about 20-40 days to germinate and the seedling growth in the nursery stage is also very slow and hence, it takes longer time near about 18-24 months to attained budable size. In view of the above specific problems of Rangpur lime, regarding germination and poor seedling growth, it is felt necessary to undertake the following study under laboratory conditions.

MATERIALS AND METHODS

This experiment was conducted under laboratory conditions. From the single tree, uniformed sized, mature, healthy and true to type fruits of Rangpur lime were harvested. The seeds were extracted and washed in water several times

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and dried in shade for a day before sowing. The seeds were dipped in distilled water and allowed to settle at the bottom of the beaker for a few minutes. The seeds floating on the surface of the water were discarded and those, which settled at the bottom, were used for experiment. Selected seeds were divided in to 13 lots, each containing 150 seeds. The seed lots were treated with different concentrations of GA_3 (50, 100 and 150 ppm), NAA (50, 100 and 150 ppm), potassium nitrate (1.0, 1.5 and 2.0 %), thiourea (1.0, 1.5 and 2.0 %) and control (water soaked). The seeds were soaked for 24 hours in 100 ml of solutions. After imposing the treatments the seeds were made into 3 groups of 50 seeds each. The experiment was carried out adopting Complete Randomized Design with thirteen treatments replicated thrice. Fifty seeds were used per treatment. The treated seeds of Rangpur lime were placed on rolled towel paper and the paper was rolled and made sufficient wet. The rolled papers with seeds were kept in growth chamber, at 30 ± 2^0 C temperature. Light was provided for 8 hours a day by using 2 numbers of long fluorescent tube lights. As and when required, water was sprinkled on the paper to maintain sufficient quantity of moisture.

The emergence rate index was calculated by the formula of Evetts and Burnside (1972)

$$ERI = \frac{G_1}{T_1} + \frac{G_2}{T_2} + \frac{G_3}{T_3} + \ldots\ldots\ldots\ldots\ldots + \frac{G_n}{T_n}$$

where,

G_1 - Per cent of seed germinated at first count T_1, G_2 - Additional per cent of seeds germinated at second count T_2, G_3 - Additional per cent of seeds germinated at third count T_3, G_n - Additional per cent of seeds germinated at final count T_n, T_1 - Weeks from sowing to first count, T_2 - Weeks from sowing to second count, T_3 - Weeks from sowing to third count, T_n - Weeks from sowing to last count

The Barlett's rate index refers to earliness of germination and was worked out by the following formula (Bartlett, 1937)

$$BRI = \frac{P_1+(P_1+P_2)+ (P_1+P_2+P_3)+ \ldots\ldots\ldots + (P_1+P_2+P_3+\ldots\ldots P_n)}{N\ (P_1+P_2+P_3+\ldots\ldots\ldots+\ P_n)}$$

where,

$P_1, P_2, \ldots\ldots P_n$ = Germination per cent at 1,2,.....n weeks, respectively.

N = Total number of weeks in the test.

The vigour index was calculated by multiplying per cent germination by seedling length in cm.

Vigour index =Per cent germination X (root length (cm) +shoot length (cm)

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Germination of seeds under laboratory conditions:

Germination percentage (%):

In general pre-soaking treatment to the seeds with different growth regulator and chemical solutions were found to be beneficial to improve the germination percentage compared to control under laboratory conditions (Table 1).

Treatment $GA_3$150 ppm recorded higher germination (98.66 %) at the end of third week after sowing. This treatment was closely followed by GA_3 100 ppm (92.99 %). Treatments NAA 150 ppm (86.99 %), GA_3 50 ppm (84.83 %), NAA 100 ppm (81.66 %) and NAA 50 ppm (78.66 %) were found to be next best treatments. According to Shepley *et al.* (1973), GA_3 acts directly on embryo relieving them from dormancy through promoting protein synthesis and elongation of coleoptile and leaves and also helps in the production of ethylene. This ethylene invokes the synthesis of hydrolases, especially a-amylose, which favours the seed germination (Stewart and Freebairn, 1969).

Days taken to initiate germination:

The seeds treated with GA_3 required 5.16 to 5.83 days, NAA 5.50 to 6.16 days, KNO_3 6.33 to 6.50 days and thiourea 6.83 to 7.33 days for initiation of germination as compared to control (8.50 days) (Table 1). The GA_3 150 ppm germinated Rangpur lime seed 3.34 days earlier than control under laboratory conditions. Similar findings were reported by Jadhav (2003) in Rangpur lime, Yogananda *et al.* (2007) in bell papper.

Emergence rate index (ERI) and Bartlett's rate index (BRI):

Treatment GA_3 150 ppm recorded the highest ERI and BRI over rest of the treatments (Table 1). All concentrations of NAA, KNO_3 and thiourea increased the ERI and BRI values under laboratory conditions over control. Higher concentrations of growth regulators recorded higher ERI and BRI values as compared to lower concentrations. These results are in agreement with the findings of Tendolkar (1978), who obtained early germination of cracked sapota seeds by pre-soaking in 200 ppm GA_3. Somappa (1979) obtained higher ERI in case of rose wood seeds with GA_3 + ethrel each at 100 ppm.

Average number of seedlings per seed:

Seeds pre-soaked in GA_3 150 ppm produced higher number of seedlings per seed (Table 1). Range of seedlings per seed according to treatments are GA_3 (1.93 to 2.16), NAA (1.89 to 1.98), KNO_3 (1.80 to 1.85) and thiourea (1.72 to 1.78). Further, it is also observed that higher concentrations of growth regulator produced more number of seedlings per seed than lower concentrations under laboratory conditions.

This finding was supported by Achituv and Mendel (1973) who reported promotion of growth of developing embryos with pre-soaking treatment of GA_3 500 ppm in sweet lime. The promotive effect of GA_3 and NAA on seed germination might be due to enzyme alpha amylase is activated

which catalyses the starch conversion in simple carbohydrates and chemical energy is liberated which is used up in the activation of embryo (Shepley *et al.,* 1973).

Growth of seedlings under laboratory conditions:

Shoot and root length of seedling (cm):

A peep (Table 2) revealed that, different seed treatments under laboratory conditions increased the shoot and root length of Rangpur lime seedlings. Soaking of seeds in GA_3 150 ppm increased shoot (4.37cm) and root (2.82 cm) length significantly over control. This is close proximity with the results obtained by Chaudhari and Chakrawar (1981) with GA_3 40 ppm in Rangpur lime. Under laboratory conditions, Yogananda *et al.* (2007) observed higher root length with GA_3 200 ppm in bell papper. GA_3 might have promoted more root formation through root cell elongation and more nutrient uptake as suggested by Shanmugavelu (1970).

Seedling vigour index (SVI):

GA_3 150 ppm recorded maximum SVI (705.19) as compared

Table 1 : Effect of growth regulators and chemicals on germination percentage and earliness of germination in Rangpur lime seeds under laboratory conditions (2006-07 and 2007-08)

Treatments		Germination (%)	Days taken for germination	ERI	Bartlett's rate index (BRI)	Av. number of seedlings per seed
GA_3 50 ppm		84.83 (68.01)	5.83	51.490	0.593	1.93
GA_3 100 ppm		92.99 (74.98)	5.33	58.468	0.601	2.05
GA_3 150 ppm		98.66 (83.72)	5.16	67.711	0.619	2.16
NAA 50 ppm		78.66 (62.92)	6.16	47.988	0.590	1.89
NAA 100 ppm		81.66 (65.11)	6.16	48.901	0.592	1.94
NAA 150 ppm		86.99 (69.47)	5.50	53.507	0.598	1.98
KNO_3 1.0 %		66.66 (54.90)	6.50	42.474	0.586	1.82
KNO_3 1.5 %		68.33 (55.88)	6.66	43.703	0.588	1.80
KNO_3 2.0 %		71.33 (57.82)	6.66	45.684	0.588	1.85
Thiourea 1.0 %		57.16 (49.16)	7.33	39.610	0.577	1.72
Thiourea 1.5 %		58.99 (50.23)	7.16	39.854	0.584	1.77
Thiourea 2.0 %		62.16 (52.14)	6.83	41.384	0.585	1.78
Control		50.33 (45.19)	8.50	35.194	0.488	1.65
S.E.(m) ±	3.90		0.35	48.302	0.0072	0.069
C.D. (P=0.05)	10.79		1.12	13.368	0.0260	0.192

(Figures in parenthesis are Arc sin values)

Table 2 : Effect of growth regulators and chemicals on growth of Rangpur lime seedling under laboratory conditions (2006-07 and 2007-08)

Treatments	Shoot length of seedling (cm)	Root length of seedling (cm)	Seedling vigour index (SVI)	Fresh weight of seedling (mg)	Dry weight of seedling (mg)
GA_3 50 ppm	3.77	2.32	517.42	50.85	9.80
GA_3 100 ppm	4.30	2.46	633.77	78.25	12.80
GA_3 150 ppm	4.37	2.82	705.19	96.25	14.68
NAA 50 ppm	3.34	2.05	420.93	52.25	7.80
NAA 100 ppm	3.47	2.17	461.49	53.60	8.70
NAA 150 ppm	4.01	2.46	562.83	70.80	11.50
KNO_3 1.0 %	2.52	1.47	266.88	43.05	6.50
KNO_3 1.5 %	2.65	1.50	283.71	46.25	6.70
KNO_3 2.0 %	2.92	1.52	317.61	50.95	7.25
Thiourea 1.0 %	2.15	1.25	194.33	23.72	5.93
Thiourea 1.5 %	2.35	1.30	215.40	25.10	4.85
Thiourea 2.0 %	2.42	1.32	233.32	30.35	5.40
Control	1.87	1.12	150.90	20.50	2.95
S.E.(m) ±	0.19	0.37	25.51	4.75	1.49
C.D. (P=0.05)	0.47	1.02	73.25	13.16	4.14

to other treatments. The fluctuation in SVI is (517.42 to 705.19) in GA_3, (420.93 to 562.63) in NAA 150 ppm (317.61 to 266.88) in KNO_3 and (233.32 to 194.33) in thiourea. Higher values indicate the good seedling growth.

This results are also in congruence with the findings of Tendolkar (1978) who recorded more SVI when seeds of sapota treated with GA_3 400 ppm under laboratory conditions. Similarly, Yogananda *et al.* (2007) got higher SVI (1174) in bell papper when seeds treated with GA_3 200 ppm. Higher seedling vigour index in GA_3 treated seeds might be due to the cumulative effect of higher shoot length, root length and germination percentage which were greatly influenced by gibberellic acid in Rangpur lime under laboratory conditions.

Fresh and dry weight of seedling:

Seeds pre-soaked in GA_3 150 ppm increased the fresh and dry weight of Rangpur lime seedlings considerably over rest of the treatments and control. Further, it is also found that the higher concentrations of growth regulators and chemicals increased the fresh and dry weight of Rangpur lime seedlings than lower concentrations; except in dry weight of seedling influenced by thiourea concentrations. Similar findings were observed by Gurav (2004) in Rangpur lime seedlings with GA_3 80 ppm. Tendolkar (1978) in sapota seedling with GA_3 400 ppm under laboratory conditions, Yogananda *et al.* (2007) also recorded more seedling dry weight with GA_3 200 ppm seed treatment in bell papper under laboratory conditions.

In the present study, the higher fresh and dry weight of shoot, root and seedling with GA_3 pre-soaking seed treatment can be correlated with higher overall growth in the corresponding treatment of GA_3. Hence, it can be stated that increase in overall growth of the seedling has lead to the overall assimilation and redistribution of food material with the seedling (Brian and Hemming, 1955) and hence, resulted in higher fresh and dry weight. Thus, increased growth is a consequence of increased dry matter accumulation.

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