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Response of custard apple (*Annona squamosa* L.) seedlings to seed soaking treatment and growing condition for germination, vigour and physiological attributes

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Abstract
The present investigation was carried out at Fruit Research Station, Imalia, JNKVV, Jabalpur during the year 2018-19 with a view to know the influence of pre–sowing seed treatment and growing condition on the germination, vigour and physiological attributes of custard apple (*Annona squamosa* L.) seedlings. The findings of the experiment showed that the growing condition of Poly house and Seed Treatment with GA_3 500 ppm have been proved superior with respect to germination, growth performance and physiological parameters of seedling among the various seed treatments and growing condition. Among various treatment combinations, the Poly house and GA_3 500 ppm (G_3S_3) was found best over the rest of the treatment combinations with respect to growth parameter like total length of seedling (40.26 cm), root length (15.13 cm), number of roots/seedling (45.12), fresh weight of shoots (4.66 g), dry weight of shoots (1.73 g), fresh weight of roots (1.88 g), dry weight of roots (0.65 g), Seedling vigour index I (3,107.52 cm), Seedling vigour index II (211.92), and physiological parameters like- Leaf Area Index (1.31), Leaf Area Duration (11,558.64 cm2. Day), Light Transmission ratio (30.67%) and Energy Interception (0.50 cal cm-2 Mn-1). The G_3S_4 (Poly house and KNO_3) was found next best treatment combination.

Keywords: Custard apple seedlings, growth and physiological parameters

Introduction
Custard apple (*Annona squamosa* L.), a tropical fruit tree native to the Americas, is esteemed for its sweet, custard-like pulp and aromatic flavour. This fruit with its diverse culinary uses holds great economic potential and nutritional value. Besides these, it has also a high medicinal value (Dhorajiya and Butani 2022) [4]. Custard apple appears to possess potent bioactive principles in most of its plant parts (Fruit, seed and leaves). The total area of custard apple fruit crop in India is about 40,000 ha with production of 3,38, 000MT (Anon. 2019) [2]. It is found growing almost in all the tropical and subtropical regions mostly in wild form. The custard apple orchards mostly occurred in the parts of Andhra Pradesh, Assam, Bihar, Karnataka, Maharashtra, Madhya Pradesh, Orissa, Rajasthan and Tamil Nadu as a shrub or hedge plant. Now days, it has gained commercial significance and exclusive orchards are emerging in Madhya Pradesh and Maharashtra. The successful cultivation and establishment of custard apple orchards significantly depend on the initial stages of seed germination and seedling growth. Seed germination and seedling vigour play pivotal roles in determining the overall health and productivity of the crop. The germination process in custard apple seeds is influenced by several factors, including genetic predisposition, seed quality, and environmental conditions. Seed soaking treatments, involving the immersion of seeds in various solutions have been a common practice to enhance germination rates and seedling vigour in many crop species. These treatments can stimulate the mobilization of reserves, reduce dormancy, and accelerate the germination process. However, the efficacy of specific soaking treatments may vary between plant species, and their interactions with different growing conditions may result in varying outcomes. Understanding the response of custard apple seedlings to different seed soaking treatments and growing conditions is of paramount importance for optimizing the germination and early growth of this valuable fruit tree. This research aims to investigate the effects of seed soaking treatments on custard apple seed germination, seedling vigour, and various physiological attributes. Additionally, it seeks to evaluate how the choice of growing conditions, such as temperature, humidity, and light can influence these processes.

By shedding light on these critical aspects, this study contributes to the knowledge base required for successful custard apple cultivation, ultimately benefiting horticulturists, farmers, and the broader agricultural community.

Material and Methods

The present investigation deals with the influence of pre–sowing seed treatment and growing condition on the germination, vigour and physiological attributes of custard apple (*Annona squamosa* L.) seedlings. The experiment was carried out at Fruit Research Station, Imalia, JNKVV, Jabalpur during the year 2018-19. The experiment comprised of Factor A (Three Growing conditions) Open condition G_1Net house, G_2Poly house and G_3. Factor B (Seed Treatment) Water Soaking (S_1), Cow Urine (S_2), GA_3 500 ppm (S_3), KNO_3 1% (S_4), Thiourea1% (S_5), Sodium Thiosulphate 250 ppm (S_6) having 18 treatment combinations. The experiment was laid out in Poly bags in factorial completely randomized design with three replications. Observations were recorded using standard procedure and statistically analysed. (Panse and Sukhatme (1963) [14].

1. Growth and Vigour Parameter

A. Percent of germination

The percentage of total seeds germination in each treatment was recorded at 60 days after sowing.

$$\text{Germination (\%)} = \frac{\text{No. of germinated seed}}{\text{Total no. of seeds sown}} \text{X } 100$$

B. Fresh Weight of Shoots and Roots (g)

The plants were carefully washed to remove the soil adhering to their roots and shoots. The fresh weight was taken separately with the help of electronic balance and average value was computed.

C. Dry Weight of Shoots and Roots (g)

For dry weight, shoot and roots were chopped separately and oven dried at 60±2 °C temperature till a constant weight. The weight was taken with the help of electronic balance and average value was computed.

D. Total Length of Seedling (cm)

The height of seedling is measured from root tip to the shoot tip and expressed in centimetre at 160 days after sowing.

E. Seedling Vigour Index I (cm)

It was calculated by adding the values of root length and shoot length at 160 days after sowing which was randomly selected and multiplying with their corresponding germination percentage and the values were recorded. (Abdulbaki and Anderson, 1973) [24].

Seedling vigour index I = Germination percentage x {root length (cm) +shoot length (cm)}.

F. Seedling Vigour Index II (g)

It was calculated by multiplying dry weight of seedlings with their corresponding germination percentage.

Seedling vigour index II = Dry weight of seedling (g) X Germination percentage.

Physiological Parameters

1. Leaf Area Index

LAI express the ratio of leaf surface considerably to the ground area occupied by the plant or a crop stand worked out as suggested by Gardner *et al*. (1985) [21],

$$\text{LAI} = \frac{\text{LA2} + \text{LA1/2}}{\text{P}} \text{X } 100$$

Where, the LA1 and LA2 represent the leaf area during the two consecutive intervals and "p" Ground area (Watson, 1952) [22].

2. Leaf Area Duration (LAD)

Leaf area duration expresses the magnitude and persistence of leaf area of leafiness during the period of crop growth at 160 DAS. It reflects the extent of seasonal integral of light interaction and corrected with yield. LAD was computed as suggested by Watson, 1952 [22].

$$\text{LAD} = \frac{\text{LA1} + \text{LA2 X (t2-t1)}}{2} \text{cm2-days}$$

3. Light Transmission Ratio (LTR %)

LTR was computed as suggested by Golingal and Mabbayad in 1969 [25].

$$\text{LAI} = \frac{\text{I}}{\text{I}_0} \text{X } 100$$

Where
I = Light intensity at the base of crop canopy and
I_o = Total incoming radiation
It was calculated by Lux meter. (Model LX-105)

4. Energy Interception (EI cal cm-2 Mn-1)

It can be calculated by Lux meter. Its values were converted in terms of energy as per constants given by Gaastra (1963) [23].

The values were recorded at 130 and 160 DAS and then the mean values were worked out.

71 k. lux= 1 cal.cm - 2 /min -1
EI = Total incident energy – Transmitted energy

Results and Discussion

Growth and Vigour Parameter

Percentage of germination at 60 days

The percentage of germination as influenced by different growing conditions indicated that the G_3 (Poly house) recorded significantly more percentage of germination (83.66), whereas minimum percentage (61.50) were noted under G_1 (Open condition). Seed treatment also showed significant effect on percentage of germination at 60 DAS. The maximum germination percentage (78.11) was recorded with S_3 (GA_3 500 ppm) and the minimum germination (65.88) was recorded in S_1 (Water soaking). It might be due to GA_3 which accelerate the activity of specific enzyme such as α-amylase, which have brought an increase in availability of starch assimilation resulting in an early germination. Our results are also in the line of Mitra and Sanyal (2004) [9],

Pandey and Singh (2000) [12]. Interaction effect of growing conditions and seed treatment showed significant effect on seed germination percentage. The minimum (55.00) germination percentage was noted under the combination of growing condition and seed treatment G_1S_1 (Open condition and Water soaking). Whereas, the maximum germination percentage (88.66) was noted under the combination of growing condition and seed treatment G_3S_3 (Poly house and GA_3 500 ppm). It may be due to synergistic effect of both factors. Our results are also in the line of Verma *et al*. (2019) [17].

Seedling Vigour Index I (cm)

In the present study, significantly maximum seedling vigour index I (2,515.27 cm) at 160 days after sowing was computed under growing in G_3 (Poly house) and minimum in G_1 (Open condition) 1,330.17. All the treatments promoted significantly higher vigour of seedlings, when compared to control. The maximum seedling vigour index I (2,394.40 cm) was recorded with S3 (GA_3 500 ppm) and minimum (1,454.20 cm) was recorded in treatment S_1 (Water soaking). All the treatments promoted significantly higher vigour of seedlings. When compared to control. Our result are also in the line of Dhoran and Gudadhe (2012) [5], Gurung *et al*. (2014) [6]. The studies about interaction of growing conditions and seed treatment show significant effect on seedling vigour index I. The maximum seedling vigour index I (3,107.52) was recorded under interaction of G_3S_3 (Poly house and GA_3) and minimum (985.41) was recorded under G_1S_1 (Open condition and water soaking). Our results are also in the line of Verma *et al.* (2019) [17].

Seedling Vigour Index II (g)

In the present study, Significant maximum seedling vigour index II (199.44) at 160 days after sowing was computed under G_3 (Poly house) and minimum seedling vigour index II (89.96 g) was recorded under G_1 (Open condition). The maximum seedling vigour index II (165.89) was recorded with S_3 (GA_3 500 ppm), while minimum seedling vigour index II 122.75 was recorded in S_1 (Water Soaking). The seedling vigour significantly differed due to invigoration of seeds. The highest seedling vigour in GA_3 was attributed to enlarged embryos, higher rate of metabolic activity and respiration, better utilization and mobilization of metabolites to growth points and higher activity of enzymes. Enzymatic and hormonal mechanism stimulates metabolic process such as sugar mobilization, protein hydrolysis, oxidation etc. Our results are also in the line of Dhoran and Gudadhe (2012) [5], Chiranjeevi *et al* (2017) [3]. The studies about interaction effect of growing condition and seed treatment showed significant effect on seedling vigour index II. The maximum seedling vigour index II (211.92) was recorded under interaction of G_3S_3 (Poly house and GA_3 500 ppm) and minimum (69.48) was recorded under G_1S (Open condition and Water soaking). Our results are also in the line of Verma *et al*. (2019) [17].

Number of Roots/Seedling

In the present study, growing condition and seed treatment significantly influenced the number of roots/seedling at 160 DAS. Growing condition had significant effect on number of roots. Maximum total number of roots (40.34) was recorded under G_3 (Poly house). It was minimum (31.02) under G_1 (Open condition). Maximum number of roots/seedling (39.80) was recorded under seed treatment S_3 (GA_3 500 ppm) and minimum (32.89) under S_1 at 160 days after seed sowing. These findings are supported by Aatla *et al.* (2013) [1]. Interaction effect of growing condition and seed treatment had significant effect on number of roots/seedling. The maximum number of roots/seedling (45.12) was recorded under the combination of growing condition and seed treatment G_3S_3 (Poly house and GA_3 500 ppm). Whereas minimum number of roots/seedling (26.13) was recorded under the combination of growing condition and seed treatment G_1S_1 (Open condition and Water soaking). It may be due to synergistic effect of both factors.

Fresh and Dry Weight of Shoot and Root (g)

The maximum fresh and dry weight (4.389 and 1.68 g) of shoots and roots (1.80 and 0.60 g) respectively were obtained at 160 days after sowing under treatment G_3 (Poly house). Gibberellic acid showed significant effect on fresh and dry weight accumulation of shoot and root. Maximum fresh and dry weight of shoots (4.27 and 1.46 g) and roots (1.81 and 0.62 g) were observed under S_3 (GA_3 500 ppm) at 160 DAS. Increase in fresh weight of shoot and root is due to the influence of GA_3 on different plant parts, which could be due to its effect in stimulating cell division, cell membrane leading to enhanced growth. Increase in the dry weight of different plant parts due to improved mobilization of nutrients due to the application of GA_3, which promotes plant growth and development. Our results are also in the line of Ratan and Reddy (2004) [16], Gurung *et al*. (2014) [6], Verma *et al.* (2019) [17]. On the other hand, combined influence of different growing conditions and seed treatment showed that the fresh and dry (4.66 and 1.73 g) weight of shoot and roots (1.88 and 0.65 g) was increased maximum under G_3S_3 (Poly house and GA_3 500 ppm) and minimum fresh and dry (3.00 and 0.75 g) of shoot and root (1.68 and 0.50 g) under G_1S_1 (Open condition and Water soaking). This may be due to vigorous root system which increased nutrient uptake under the treatment. It may be due to synergistic effect of both factors. Our results are also in the line of Verma *et al*. (2019) [17].

Physiological Parameters:

Leaf Area Index (LAI) and Leaf Area Duration (LAD)

Growing condition significantly influenced the leaf Area Index (LAI) and leaf area duration (LAD). The leaf Area Index (1.17) and Leaf area duration (10,228.67 cm2 days was higher under treatment G_3 (poly house) at 160 days after sowing. The effect of seed treatment had significant impact on Leaf area index and Leaf area duration. Significantly maximum Leaf Area Index (1.15) and leaf area duration (10,063.92) was noted with S_3 (GA_3 500 ppm). This was higher ascribed to higher magnitude increases in parameter associated with the LA. The finding was supported by Munde and Gajbhiye (2010) [10], Roy and Shrivastava (2011) [18]. The treatment combination G_3S_3 (Poly house and GA_3 500 ppm) was recorded maximum leaf Area Index (1.31) and leaf area Duration (11,558.64). However, minimum Leaf Area Index and Leaf Area Duration were noted under treatment combination G_1S_1 (Open condition and Water soaking). The increase of Leaf Area Index may be due to rich source of nutrient and presence of 500 ppm GA_3. It may be due to synergistic effect of both factors. Our results are also in the line of Verma *et al.* (2019) [17].

Light Transmission Ratio (LTR %)

In the present study, significantly maximum Light transmission Ratio (59.16%) in seedling at 160 days after sowing was computed under G1 (poly house) and the minimum Light transmission Ratio (44.04%) was recorded under G_3 (Open condition). The maximum Light transmission Ratio (49.93%) was recorded with S_1 (Water Soaking) and minimum (42.75%) was recorded in treatment S_3 (GA_3 500 ppm). The findings are supported by Munde and Gajbhiye (2010) [10]. The interaction of growing condition and seed treatment showed significant effect on Light Transmission Ratio. The significantly maximum Light transmission Ratio (50.00%) was obtained under treatment combination of G_1S_1 (Open condition and Water soaking) and minimum Light Transmission Ratio (30.67%) was obtained under treatment combination of G_3S_3 (Poly house and GA_3 500 ppm).

Energy Interception (EI cal cm-2 Mn-1)

In the present study, all the growing condition had highly significant effect on Energy Interception Maximum EI (0.41) was recorded under G_3 (Poly house condition) and minimum (0.36) under G_1 (Open condition) at 160 days after seed sowing. The combination effect showed significant effect on the experiment concern. The probable reason may be that interception of light by a crop canopy is strongly related to total leaf area. A crop will thus intercept more PAR and hence grow faster if it develops leaf area rapidly. Our results are also in the line of Maddonni and Otegui (1996) [8].

The maximum Energy interception (0.47) was recorded with S_3 (GA_3 500 ppm) and minimum (0.32) was recorded in treatment S_1 (Water Soaking) The findings are supported by Verma *et al*. (2019) [17]. The interaction of growing condition and seed treatment showed significant effect on Light Transmission Ratio. The significantly maximum Energy interception (0.50) was obtained under treatment combination of G_3S_3 (Poly house and GA_3 500 ppm) and minimum Energy interception (0.30) was obtained under treatment combination of G_1S_1 (Open condition and Water soaking).

Table 1: Effect of Growing Conditions and Seed Treatment on Germination, Seedling Vigour Index-I & II and Number of Roots/Seedling in Custard Apple Seedlings.

	Treatments	Percentage of Germination at 60 DAS	Seedling Vigour Index - I at 160 DAS	Seedling Vigour Index -II at 160 DAS	No. of Roots/Seedling at 160 DAS
	Growing Condition				
G_1	Open condition	61.50	1,330.17	89.96	31.02
G_2	Net house condition	71.44	1,814.18	154.89	37.11
G_3	Poly house condition	83.66	2,515.27	191.44	40.34
	SE(m)±	0.26	8.50	0.82	0.060
	CD at 5% level	0.75	24.50	2.37	0.174
	Seed Treatment				
S_1	Water soaking	65.88	1,454.20	122.75	32.89
S_2	Cow urine	68.33	1,607.58	133.07	33.89
S_3	GA_3 500 ppm	78.11	2,394.40	165.89	39.80
S_4	$KNO_3$1%	75.77	2,153.19	156.94	38.32
S_5	Thiourea	73.66	1,954.95	150.64	36.91
S_6	Sodium Thiosulphate	71.44	1,754.93	143.30	35.14
	SE(m)±	0.37	12.032	1.16	0.08
	CD at 5% level	1.06	34.65	3.36	0.24
	Interaction				
G_1S_1	Open condition +Water soaking	55.00	985.41	69.48	26.13
G_1S_2	Open condition +Cow urine	59.00	1,116.30	83.48	28.14
G_1S_3	Open condition +GA_3 500 ppm	67.33	1,713.97	108.17	35.15
G_1S_4	Open condition +KNO_3 (1%)	65.00	1,569.31	99.01	34.13
G_1S_5	Open condition +Thiourea (1%)	62.66	1,387.85	94.00	32.46
G_1S_6	Open condition +Sodium Thiosulphate 250 ppm	60.00	1,208.20	85.60	30.13
G_2S_1	Net house +Water soaking	65.00	1,346.98	129.45	35.14
G_2S_2	Net house +Cow urine	65.66	1,453.64	136.79	35.11
G_2S_3	Net house +GA_3 500 ppm	78.33	2,361.7	177.56	39.14
G_2S_4	Net house +KNO_3 (1%)	75.33	2,093.79	168.24	39.050
G_2S_5	Net house +Thiourea (1%)	73.33	1,915.96	162.98	38.130
G_2S_6	Net house +Sodium Thiosulphate 250 ppm	71.00	1,712.99	154.31	36.117
G_3S_1	Poly house +Water soaking	77.66	2,030.20	169.31	37.41
G_3S_2	Poly house +Cow urine	80.33	2,252.81	178.93	38.41
G_3s_3	Poly house +GA_3 500 ppm	88.66	3,107.52	211.92	45.12
G_3S_4	Poly house +KNO_3 (1%)	87.00	2,796.47	203.58	41.79
G_3S_5	Poly house +Thiourea (1%)	85.00	2,561.05	194.93	40.15
G_3S_6	Poly house +Sodium Thiosulphate 250 ppm	83.33	2,343.61	189.99	39.17
	SE(m)±	0.64	20.84	2.02	0.14
	CD at 5% level	1.85	60.01	5.81	0.42

Table 2: Effect of Seed Treatment and Growing Condition on Fresh Weight of Shoot (g), Dry Weight of Shoot (g), Fresh Weight of Root (g) and Dry Weight of Root (g) Custard Apple Seedlings at 160 DAS.

	Treatments	Fresh Weight of Shoot (g)	Dry Weight of Shoot (g)	Fresh Weight of Root (g)	Dry Weight of Root (g)
	Growing Condition				
G_1	Open condition	3.41	0.89	1.72	0.53
G_2	Net house condition	3.99	1.58	1.76	0.58
G_3	Poly house condition	4.38	1.68	1.80	0.60
	SE(m)±	0.007	0.003	0.003	0.002
	CD at 5% level	0.021	0.007	0.009	0.005
	Seed Treatment				
S_1	Water soaking	3.56	1.28	1.71	0.54
S_2	Cow urine	3.71	1.34	1.72	0.55
S_3	GA_3 500 ppm	4.27	1.46	1.81	0.62
S_4	$KNO_3$1%	4.18	1.43	1.79	0.60
S_5	Thiourea	4.01	1.41	1.78	0.58
S_6	Sodium thiosulphate	3.83	1.38	1.75	0.57
	SE(m)±	0.010	0.004	0.004	0.002
	CD at 5% level	0.029	0.010	0.012	0.007
	Interaction				
G_1S_1	Open condition +Water soaking(24 hrs)	3.00	0.75	1.68	0.50
G_1S_2	Open condition +Cow urine	3.10	0.85	1.69	0.53
G_1S_3	Open condition +GA_3 500 ppm	3.86	1.02	1.76	0.58
G_1S_4	Open condition +KNO_3 (1%)	3.80	0.95	1.75	0.57
G_1S_5	Open condition +Thiourea	3.50	0.93	1.73	0.57
G_1S_6	Open condition +Sodium Thiosulphate 250 ppm	3.20	0.88	1.72	0.54
G_2S_1	Net house +Water soaking	3.70	1.50	1.74	0.54
G_1S_2	Net house +Cow urine	3.80	1.53	1.75	0.55
G_2S_3	Net house +GA_3 500 ppm	4.16	1.65	1.78	0.61
G_2S_4	Net house +KNO_3 (1%)	4.10	1.62	1.77	0.61
G_2S_5	Net house +Thiourea (1%)	3.90	1.61	1.77	0.58
G_2S_6	Net house +Sodium Thiosulphate 250 ppm	4.00	1.58	1.73	0.58
G_3S_1	Poly house +Water soaking	4.00	1.59	1.72	0.58
G_3S_2	Poly house +Cow urine	4.23	1.65	1.74	0.58
G_3S_3	Poly house +GA_3 500 ppm	4.66	1.73	1.88	0.65
G_3S_4	Poly house +KNO_3 (1%)	4.60	1.72	1.86	0.62
G_3S_5	Poly house +Thiourea (1%)	4.43	1.69	1.83	0.59
G_3S_6	Poly house +Sodium thiosulphate 250 ppm	4.40	1.68	1.79	0.59
	SE(m)±	0.01	0.00	0.007	0.004
	CD at 5% level	0.05	0.01	0.02	0.01

Table 3: Effect of Seed Treatment and Growing Condition on LAI, LAD, LTR and EI Custard Apple Seedlings at 160 DAS.

	Treatments	LAI	LAD	LTR	EI
	Growing Condition				
G_1	Open condition	0.83	7,399.25	46.97	0.36
G_2	Net house condition	1.10	9,589.11	45.21	0.38
G_3	Poly house condition	1.17	10,228.67	44.04	0.41
	SE(m)±	0.005	46.70	0.12	0.01
	CD at 5% level	0.013	134.49	0.34	0.03
	Seed Treatment				
S_1	Water soaking	0.88	7,790.72	49.93	0.32
S_2	Cow urine	0.97	8,712.76	47.58	0.39
S_3	GA_3 500 ppm	1.15	10,063.92	42.75	0.47
S_4	KNO_3 (1%)	1.10	9,645.32	43.23	0.38
S_5	Thiourea (1%)	1.05	9,181.86	44.41	0.35
S_6	Sodium Thiosulphate 250 ppm	1.03	9,039.47	44.50	0.38
	SE(m)±	0.00	66.04	0.16	0.01
	CD at 5% level	0.01	190.20	0.48	0.04
	Interaction				
G_1S_1	Open condition +Water soaking	0.81	6,842.77	50.00	0.30
G_1S_2	Open condition +Cow urine	0.88	7,570.72	45.25	0.38
G_1S_3	Open condition +GA_3 500 ppm	0.86	7,793.96	46.47	0.44
G_1S_4	Open condition +KNO_3 (1%)	0.83	7,619.25	40.92	0.44
G_1S_5	Open condition +Thiourea (1%)	0.83	7,289.24	42.09	0.38
G_1S_6	Open condition +Sodium Thiosulphate 250 ppm	0.83	7,279.54	45,51	0.34
G_2S_1	Net house +Water soaking	0.88	7,793.96	42.98	0.33
G_2S_2	Net house +Cow urine	1.01	8,822.80	49.37	0.44

G_2S_3	Net house +GA_3 500 ppm	1.25	10,839.14	44.00	0.46
G_2S_4	Net house +KNO_3 (1%)	1.20	10,482.54	49.37	0.40
G_2S_5	Net house +Thiourea (1%)	1.14	9,851.44	47.83	0.43
G_2S_6	Net house +Sodium Thiosulphate 250 ppm	1.11	9,744.77	46.21	0.38
G_3S_1	Poly house Water soaking	1.10	8,735.45	42.70	0.32
G_3S_2	Poly house +Cow urine	1.11	9,744.77	42.71	0.35
G_3s_3	Poly house +GA_3 500 ppm	1.31	11,558.64	30.67	0.50
G_3S_4	Poly house +KNO_3 (1%)	1.25	10,834.19	42.71	0.28
G_3S_5	Poly house +Thiourea (1%)	1.19	10,404.89	43.31	0.33
G_3S_6	Poly house +Sodium Thiosulphate 250 ppm	1.15	10,094.10	41.91	0.35
	SE(m)±	0.02	114.39	0.28	0.02
	CD at 5% level	0.07	329.44	0.83	0.07

Conclusion

On the basis of result obtained, it is concluded that the growing condition of poly house and seed treatment with $GA_3$500 ppm have been proved superior with respect to germination, growth performance and physiological parameters of seedling among the various seed treatments and growing condition. Among various treatment combinations, the Poly house and GA_3 500 ppm (G_3S_3) was found best over the rest of the treatment combinations with respect to growth parameter like total length of seedling (40.26 cm), root length (15.13 cm), number of roots/seedling (45.12), fresh weight of shoots (4.66 g), dry weight of shoots (1.73 g), fresh weight of roots(1.88 g), dry weight of roots (0.65 g), Seedling vigour index I (3,107.52 cm), Seedling vigour index II (211.92), and physiological parameters like- Leaf Area Index (1.31), Leaf Area Duration (11,558.64 cm2.Day), Light Transmission ratio (30.67%) and Energy Interception (0.50 cal cm-2 Mn-1). The G_3S_4 (Poly house and KNO_3) was found next best treatment combination.

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