Comparative Evaluation of the Effects of Pre-Sowing Treatments on the Germination and Growth Parameters of *Abelmoschus esculenta* Linn.

ABSTRACT

A comparative study on the effects of pre-sowing treatments on the germination and growth of *Abelmoschus esculentus* was done by putting the seeds through three treatments at different durations before sowing. These treatments involved soaking the seeds in 30% H_2SO_4, vernalization and soaking in water (hydotreatment). Five polyethene bags were used for each replicate, 16 replicates of 10kg of soil were prepared for the plant according to the treatments and duration placement. Morphometric data such as germination percentage, plant height, stem girth and leaf area were collected and analyzed using mean, variance, standard deviation, variance of the mean, standard error and confidence limit. The results of the analysis showed the various treatments and the duration significance on percentage germination and growth parameters of *Abelmoschus esculentus* seeds. Data showed the effects of various treatments duration and their significance on percentage germination of *Abelmoschus esculentus* seeds. The result further showed that the treatment of seeds before cultivation increased the percentage germination in *A. esculentus* when compared with the control replicate. It was also revealed that the height readings of different treatment sources and treatment durations did significantly affect the height of *A. esculentus*. It was also observed that leaf Area and stem girth significantly increased in different treatment methods and durations as seen in treatment of *A. esculentus* respectively. This research showed that seed treatment resulted in early germination and high growth rate; hence seed treatment with either soaking in 30% sulphuric acid, vernalization or soaking in water should be used for enhancing emergence and better seedling growth in *Abelmoschus esculentus* but attention should be paid to the duration of exposure of seed to these treatments.

KEYWORDS: Germination, Growth, Vernalization, Sulphuric acid, Okra, Soak, Hydrotreatment.

INTRODUCTION

Seed treatment is simply the pre-sowing treatment that involves the controlled hydration of seeds, sufficient enough to allow radicle emergence through the seed coat. On the other hand, it can be explained as soaking seeds in solutions for a period of time and removing them so that germination does not continue once seeds are removed from the solution. The intent of seed treatment is to increase germination percentage, decrease mean of germination time and improve growth and vigor of seedling at a wider range of favorable and unfavorable climatic conditions [1].

There are reports that pre-sowing seed treatment permits early DNA replication, increases RNA and protein synthesis, promotes greater ATP availability and faster embryo growth as well as repairing deteriorated seed parts, and reducing leakage of metabolites compared with control [2]. Another effect of seed treatment is the better performance of seeds under adverse agronomic conditions and environmental stress such as salinity [2].

Seed treatment comprise of seed soaking or vernalization, followed by drying back to storage moisture. Water or chemicals are used for the soaking of the seed to split or soften the hard seed coat for speeding up and synchronizing the germination process in okra. This treatment practice is gaining popularity after the application of participatory approach in Africa, Nepal, India, Bangladesh and Pakistan [2].

Pre-sowing seed treatment allows some of the metabolic processes to occur originally for germination before actual germination start [2]. Seed treatment triggers the synthesis or activation of some enzymes that catalyze the mobilization of storage reserves in seed, while endosperm weakens by hydrolase activities. Besides, pre-sowing seed treatment increases the production of antioxidants like catalase, peroxidase, superoxide dismutase that help in temperature. According to Ashraf and Foolad [3], seed soaking might enhance the plant tolerance to salinity and may also overcome thermodormancy in lettuce by irreversible initiation of cell elongation.

Okra (*Abelmoschus esculentus*) is a tropical vegetable crop that grows up to 1.0-2.1m tall. It belongs to family Malvaceae, originated in tropical Africa, and wild forms are also found in India. Okra is a popular summer crop; the young tender pods are cooked in curries, stewed and used in soaps. Okra is also known in many English-speaking countries as lady's fingers, okra, or gumbo. The edible part of okra is the immature pod, which is harvested when tender. Young okra leaves are also edible.

Okra is a good source of vitamins A, B and C, and is also rich in protein, minerals and iodine. Okra is a warm season crop, requiring ample moisture for germination [4]. Okra seeds are sown in early April in plain areas and in last week of April at the higher elevations. It does not germinate below 20 ^{o}C. The slow and uneven germination of okra seed are the main hurdle in the early spring planting [5]. Thus, the aim of this study was to determine the effect of different pre-sowing treatments on the germination and growth of *Abelmoscus esculenta* at varying duration.

MATERIALS AND METHODS

Study Area

This research was both a laboratory and field work investigation. Seed soaking was conducted in the laboratory of biotechnology, Ebonyi State and the field aspect of this experiment was carried out at the Ebonyi State University research field, located at Presco Campus. The area is at longitude 6°20' N 8°06' E and latitude 6.333 °N 8.1000 °E. The mean minimum and maximum temperature ranges from 25 °C to 38 °C. The area has an average altitude of 160 mm above sea level with an average rainfall of 720 mm.

Sample Collection

Two hundred grams (200g) of okra seeds were collected from Abakpa main market, Abakaliki, Nigeria.

Viability Test

A viability test was carried out on the seeds by soaking them in water for 3 min. The non viable seeds floated and were discarded. The viable seeds were later dried for planting.

Seed Treatment

About 135 seeds per treatment of each crop were soaked using a glass beaker. The seeds were re-weighed and sowed out in the soil prepared. Each experimental unit consisted of soil contained in a 1L black polythene bag.

The seeds were treated based on the levels of factors utilized in the study. Each seed lot per treatment was replicated five times. The vernalization treatments included the following: V_1= seeds treated by vernalization for 12 h; V_2 = seeds treated by vernalization for 24 h, V_3 = seed treated by vernalization for 36 h; V_4 = seeds treated by vernalization for 48 h, V_5 = seeds treated by vernalization for 72 h.

S= The seeds treated by soaking in water method was done as follows; S_1= seeds treated by soaking in water for 12 h; S_2 = seed treated by soaking in water for 24 h; S_3 = seed treated by soaking in water for 36 h; S_4 = seeds treated by soaking in water for 48 h; S_5 = seeds treated by soaking in water for 72 h.

The scarification or sulphuric acid seed treatment technique was done as follows: R_1 = seeds treated with sulphuric acid for 10 min; R_2 = seed treated with sulphuric acid for 20 min; R_3 = seed treated with sulphuric acid for 30 min; R_4 = seeds treated with sulphuric acid for 40 min; R_5 = seeds treated with sulphuric acid for 50 min. Two factors were studied in this experiment as:

Factor A: Three levels of sources of seed treatment.

i. Distilled water (DW).
ii. Laboratory refrigerator.
iii. 30 % solution of sulphuric acid (dissolved).

Factor B: Five levels of seed soaking periods utilized were 12 h, 24 h, 36 h and 72 h.

The control experiment was kept as untreated seeds. After treatment in different sources for various durations, the seeds were air dried at room temperature for at least 3 min close to original moisture level.

Field clearing and planting

The field was cleared manually by means of a cutlass. Soil was dug using a hoe. The dunged soil was filled in 160 polyethene bags of 10 kg each. Five polyethene bags each were kept as one replicate. With this arrangement, 16 replicates were gotten for each plant according to the treatment and duration placement. The bags were properly labeled using masking tape.

Germination and Measurement

Percentage germination was determined after one week of planting. It was done using the formula;

$$\text{Percentage germination} = \frac{\text{no of germinated seeds}}{\text{total seeds planted}} \times \frac{100}{1}$$

Percentage germination was taken for all the replicates. The measurements of the plant height and leaf area were measured using meter rule while the plant girth was measured using the combination of thread and meter rule.

Plant height was measured using the meter rule by measuring the distance between the upper part of the photosynthetic area and the ground level.

The leaf area was determined using the non destructive length and width; with the formula LA= Length × Width.

Plant girth was measured by using a thread to tie around the body of the plant. The length of the thread was then measured using a meter rule.

Statistical Analysis

Data collected were statistically analyzed using mean, variance, and standard deviation, as well as variance of the mean, standard error and confidence limit.

RESULT

Percentage Germination for Control Experiment

Table 1: Describes the percentage germination for control experiment in *Abelmoschus esculentus*.

Table 1: Percentage Germination for Control Experiment

Plant type	Treatment	Number of replicate	Total Number of Germination	Total number of seed sown	%Germination
Abelmoschus esculentus	Control	5	15	25	60 %

Table 2: Describes the plant height, plant girth, and plant leaf area for control experiment in *Abelmoschus esculentus*, the result showed that the plant height confidence interval ranges between (39.91±41.43), plant girth confidence interval ranges between (2.7±4.7) and plant leaf area confidence interval ranges between (186.92±198.24).

Table 2: Plant Height, Plant Girth and Leaf Area of *Abelmoschus esculentus* Control Experiment

Parameters	Total height (cm)	Mean	Standard deviation	Variance	Standard error	Confidence limit	Confidence interval
Plant Height	203.36	40.67	0.86	0.75	0	0.76	39.91±41.43
Plant Girth	18.98	3.7	0.23	0.051	0	1	2.7±4.7
Leaf Area	962.9	192.58	6.46	41.76	2	5.66	186.92±198.24

The result of the average germination for H_2SO_4 30 % for *Zea mays* showed the highest germination percentage (92 %) in *Abelmoschus esculentus* treated for 50 minutes and the lowest percentage germination (68 %) in the *Abelmoschus esculentus* treated for 20 minutes.

Table 3: Percentage germination for *Abelmoschus esculentus* treated with H_2SO_4 (Dilute) 30 %

Plant type	Treatment	Duration	No of replicate	Total no seeds sown	Total no of seeds germinated	% germination
Abelmoschus esculentus	H_2SO_4	10 mins	5	25	19	76 %
Abelmoschus esculentus	H_2SO_4	20 mins	5	25	17	68 %
Abelmoschus esculentus	H_2SO_4	30 mins	5	25	20	80 %
Abelmoschus esculentus	H_2SO_4	40 mins	5	25	22	88 %
Abelmoschus esculentus	H_2SO_4	50 mins	5	25	23	92 %

The result of the percentage germination for vernalization (5 - 10^{o}C) showed the highest percentage germination (88 %) in the *Abelmoschus esculentus* treated for 72 hours and lowest percentage germination (56 %) in the *Abelmoschus esculentus* treated for 12 hours.

Table 4: Percentage germination for *Abelmoschus esculentus* treated by vernalization (5-10^{o}C)

Plant type	Treatment	Duration	No of replicate	Total no seeds sown	Total no of seeds germinated	% germination
Abelmoschus esculentus	Vernalization	12 hours	5	25	14	56 %
Abelmoschus esculentus	Vernalization	24 hours	5	25	17	68 %
Abelmoschus esculentus	Vernalization	36 hours	5	25	20	80 %
Abelmoschus esculentus	Vernalization	48 hours	5	25	16	64 %
Abelmoschus esculentus	Vernalization	72 hours	5	25	22	88 %

The result of the percentage germination for soaking in water (distilled) revealed the highest percentage germination (88 %) in *Abelmoschus esculentus* soaked for 48 hours and lowest percentage germination (64 %) in *Abelmoschus esculentus* soaked for both 36 and72 hours.

Table 5: Percentage germination for *Abelmoschus esculentus* treated with hydrotreatment (distilled)

Plant	Treatment	Duration	No of replicate	Total no seeds sown	Total no of seeds germinated	% germination
Abelmoschus esculentus	Hydrotreatment	12 hours	5	25	18	72 %
Abelmoschus esculentus	Hydrotreatment	24 hours	5	25	20	80 %
Abelmoschus esculentus	Hydrotreatment	36 hours	5	25	16	64 %
Abelmoschus esculentus	Hydrotreatment	48 hours	5	25	22	88 %
Abelmoschus esculentus	Hydrotreatment	72 hours	5	25	16	64 %

The result of the Height Readings of *Abelmoschus esculentus* treated with H_2SO_4 (30 %) dilute showed the highest mean value (46.55) in *Abelmoschus esculentus* treated for 40 minutes and the lowest mean value (38.31) in *Abelmoschus esculentus* treated for 10 minutes.

Table 6: Height Readings of *Abelmoschus esculentus* treated with H_2SO_4 (30 %) dilute

Replicates	Duration	Total height (cm)	Mean	Standard deviation	Variance	Standard error	Confidence limit	Confidence interval
R1	10 minutes	201.54	38.31	5.68	32.24	2	4.98	33.33±43.29
R2	20 minutes	216.32	43.26	1.62	2.61	0	1.42	41.84±44.68
R3	30 minutes	230	46	1.58	2.49	0	1.38	44.62±47.38
R4	40 minutes	232.74	46.55	1.58	2.51	0	1.39	45.16±47.94
R5	50 minutes	205.66	41.09	0.57	0.32	0	0.5	40.59±41.59

The table below showing the result of Height Readings of *Abelmoschus esculentus* treated by Vernalization between (5^oC to 10^oC) of temperature recorded the highest mean value (53.52) in *Abelmoschus esculentus* treated for 48 hours and the lowest mean value (43.4) in *Abelmoschus esculentus* treated for 24 hours.

Table 7: Height Readings of *Abelmoschus esculentus* treated by Vernalization between (5^oC to 10^oC) of temperature

Replicates	Duration	Total height (cm)	Mean	Standard deviation	Variance	Standard error	Confidence limit	Confidence interval
R1	12 hours	230.77	46.15	0.61	0.38	0	0.54	45.61 ± 46.69
R2	24 hours	217	43.4	2.09	4.39	0	1.84	41.56 ± 44.19
R3	36 hours	238.9	47.22	0.9	0.8	0	0.79	46.4 ± 48.01
R4	48 hours	227.6	53.52	17.52	307.01	7	15.36	38.1 ± 68.88
R5	72 hours	226.94	45.39	0.93	0.86	0	0.81	44.58 ± 46.2

The table below showing the result of Height Readings of *Abelmoschus esculentus* treated by soaking in water method distilled recorded the highest mean value (49.26) in *Abelmoschus esculentus* treated for 12 hours and the lowest mean value (47.30) in *Abelmoschus esculentus* treated for 48 hours.

Table 8: Height Readings of *Abelmoschus esculentus* treated with hydrotreatment method (distilled)

Replicates	Duration	Total height (cm)	Mean	Standard deviation	Variance	Standard error	Confidence limit	Confidence interval
R1	12 hours	246.26	49.25	0.91	0.82	0	0.8	48.45±50.05
R2	24 hours	238.76	48.15	1.27	1.62	0	1.12	47.03±49.27

R3	36 hours	240.06	48.01	1.86	3.46	0	1.63	46.38±49.64
R4	48 hours	236.52	47.30	1.17	1.37	0	1.03	46.27±48.33
R5	72 hours	237.08	47.42	0.69	0.48	0	0.6	46.82±48.02

The table below showing the result of Girth Readings of *Abelmoschus esculentus* treated H_2SO_4 (30 %) recorded the highest mean value (5.13) in *Abelmoschus esculentus* treated for 10 minutes and the lowest mean value (4.76) in *Abelmoschus esculentus* treated for 30 minutes.

Table 9: Plant Girth Readings of *Abelmoschus esculentus* treated with H_2SO_4 (30 %) dilute

Replicates	Duration	Total Girth (cm)	Mean	Standard deviation	Variance	Standard error	Confidence limit	Confidence interval
R1	10 minutes	24.92	5.13	0.44	0.19	0	0.38	4.75 ± 5.51
R2	20 minutes	24.32	4.86	0.39	0.16	0	0.35	4.51 ± 5.21
R3	30 minutes	23.78	4.76	0.25	0.06	0	0.22	4.54 ± 4.98
R4	40 minutes	24.18	4.84	0.31	0.1	0	0.28	4.56 ± 5.12
R5	50 minutes	25.02	5	0.14	0.02	0	0.12	4.88 ± 5.12

The table below showing the result of Plant Girth Readings of *Abelmoschus esculentus* treated by Vernalization between (5^oC to 10^oC) of temperature recorded the highest mean value (8.46) in *Abelmoschus esculentus* treated for 36 hours and the lowest mean value (4.58) in *Abelmoschus esculentus* treated for 72 hours.

Table 10: Plant Girth Readings of *Abelmoschus esculentus* treated by Vernalization between (5^oC to 10^oC) of temperature

Replicates	Duration	Total Girth (cm)	Mean	Standard deviation	Variance	Standard error	Confidence limit	Confidence interval
R1	12 hours	23.78	4.87	0.27	0.07	0	0.23	4.64 ± 5.1
R2	24 hours	24.94	5	0.25	0.06	0	0.22	4.76 ± 5.22
R3	36 hours	25.58	8.46	7.29	53.21	3	6.39	2.07 ± 14.85
R4	48 hours	24.04	4.81	0.37	0.14	0	0.32	4.49 ± 5.13
R5	72 hours	22.92	4.58	0.47	0.22	0	0.41	4.17 ± 4.99

The table below showing the result of Plant Girth Readings of *Abelmoschus esculentus* treated by soaking in water method distilled recorded the highest mean value (5.46) in *Abelmoschus esculentus* treated for 24 hours and the lowest mean value (4.73) in *Abelmoschus esculentus* treated for 48 hours.

Table 11: Plant Girth Readings of *Abelmoschus esculentus* treated with hydrotreatment method (distilled)

Replicates	Duration	Total Girth (cm)	Mean	Standard deviation	Variance	Standard error	Confidence limit	Confidence interval
R1	12 hours	26.54	5.31	0.27	0.07	0	0.24	5.19 ± 5.55
R2	24 hours	27.1	5.46	0.31	0.1	0	0.27	5.19 ± 5.73
R3	36 hours	25.68	5.14	0.46	0.21	0	0.4	4.74 ± 5.54
R4	48 hours	23.64	4.73	0.79	0.62	0	0.69	4.04 ± 5.42
R5	72 hours	25	5	0.36	0.13	0	0.32	4.68 ± 5.32

The table below showing the result of Leaf area Readings of *Abelmoschus esculentus* treated H_2SO_4 (30 %) recorded the highest mean value (337.18) in *Abelmoschus esculentus* treated for 30 minutes and the lowest mean value (167.59) in *Abelmoschus esculentus* treated for 10 minutes.

Table 12: Leaf Area of *Abelmoschus esculentus* treated with H_2SO_4 (30 %) dilute

Replicates	Duration	Total Leaf area (cm^2)	Mean	Standard deviation	Variance	Standard error	Confidence limit	Confidence interval
R1	10 minutes	837.96	167.59	14.15	200.23	6	12.4	155.19 ±179.99
R2	20 minutes	980.74	196.15	101.86	10375.25	45	89.28	106.87±285.43
R3	30 minutes	1685.3	337.18	26.25	689.19	11	23.01	314.17±360.19
R4	40 minutes	1566.55	312.71	15.98	255.22	7	14	298.71±326.71
R5	50 minutes	1278.5	255.7	92.04	8471.79	41	80.68	175.02±336.38

The table below showing the result of Leaf Area Readings of *Abelmoschus esculentus* treated by Vernalization between (5^oC to 10^oC) of temperature recorded the highest mean value (281.47) in *Abelmoschus esculentus* treated for 12 hours and the lowest mean value (151.41) in *Abelmoschus esculentus* treated for 48 hours.

Table 13: Leaf Area of *Abelmoschus esculentus* treated by Vernalization between (5^oC to 10^oC)

Replicates	Duration	Total Leaf area (cm^2)	Mean	Standard deviation	Variance	Standard error	Confidence limit	Confidence interval
R1	12 hours	1407.36	281.47	141.3	19965.28	63	123.85	157.62 ± 405.32
R2	24 hours	799.97	199.95	15.45	238.56	6	13.54	186.41 ± 213.49
R3	36 hours	1016.24	203.25	19.91	396.31	8	17.45	185.8 ± 220.7
R4	48 hours	757.07	151.41	17.1	292.36	7	14.99	136.42 ± 166.4
R5	72 hours	870.7	174.14	48.01	2305.39	21	42.09	132.05 ± 216.23

The table below showing the result of Leaf area Readings of *Abelmoschus esculentus* treated by soaking in water method distilled recorded the highest mean value (278.12) in *Abelmoschus esculentus* treated for 72 hours and the lowest mean value (242.28) in *Abelmoschus esculentus* treated for 48 hours.

Table 14: Leaf Area of *Abelmoschus esculentus* treated by hydrotreatment method (distilled)

Replicates	Duration	Total Leaf area (cm^2)	Mean	Standard deviation	Variance	Standard error	Confidence limit	Confidence interval
R1	12 hours	1366.25	273.25	17.02	289.68	7	14.92	258.33 ± 288.17
R2	24 hours	1292.09	258.42	34.94	1221.12	15	30.63	227.79 ±289.05
R3	36 hours	1211.4	242.28	36.19	1309.93	16	31.72	210.56 ± 274
R4	48 hours	1303.99	260.8	9.096	82.73	4	7.97	252.83 ±268.77
R5	72 hours	1390.6	278.12	12	144.08	5	10.52	267.6 ± 288.64

DISCUSSION

The effects of pre-sowing treatment on the germination and growth development of the seeds of *Abelmoschus esculentus* was carried out under three treatments which includes soaking in H_2SO_4, vernalization and hydrotreatment. Results showed that maximum (92 %) percentage germination was recorded in *Abelmoschus esculentus* in which seeds were soaked in 30% H_2SO_4 for 50 minutes, and minimum (68 %) percentage germination for *Abelmoschus esculentus* seeds which were soaked in 30% H_2SO_4 for 20 minutes. Maximum (88 %) percentage germination was recorded in *Abelmoschus esculentus* seeds treated with vernalization for 72 hours, minimum (56 %) percentage germination was recorded for *A. esculentus* seeds treated with vernalization for 12 hours. On the other hand, there was maximum (88 %) percentage germination recorded for *Abelmoschus esculentus* seeds that were soaked in distilled water for 48 hours and a minimum (64 %) percentage germination for *Abelmoschus esculentus* soaked in distilled water for 36 hours and 72 hours respectively. The control experiment had (60 %) percentage germination recorded in *Abelmoschus esculentus*. The results revealed that longer exposure of okro seeds in 30% sulphuric acid and cold treatment gave a higher germination percentage; whereas, 36 h of soaking in water gave the highest germination percentage as against the longer 72 h soaking period. Treatment of seeds such as exposure to controlled temperature or soaking in solution at different durations plays significant role in metabolic activities of plants. In view of this study as observed from the vernalization treatment of the okro seeds, previous studies have shown that temperature is one of the important factors determining the distribution and thriving of plants. Temperature also plays vital role in the germination of seeds and subsequent flowering of plants [6]. Also, this increase in germination rate may be correlated with treatment that switched on a number of biochemical and physiological processes necessary for seed germination. Thus, this study proves that seed treatment enhances the percentage germination of plants, as was also reported by Pandita *et al.* [7] for many field crops.

Results further revealed the height readings of the various treatment sources and treatment durations as well as how significantly it affected the height of *Abelmoscus esculentus*. The maximum height confidence interval ranged between 45.16 to 47.94 cm as observed in *Abelmoschus esculentus* seeds soaked in 30% H_2SO_4 for 40 minutes. The maximum height confidence interval ranged between 46.43 to 48.01 cm as observed in *Abelmoschus esculentus* seeds treated by vernalization for 36 hours. The maximum height confidence interval was at 48.45 to 50.05 cm as observed in *Abelmoschus esculentus* seeds soaked in distilled water for 12 hours while, the maximum height confidence interval ranged between 39.91 to 41.43 cm as recorded in seed of *Abelmoschus esculentus* in control replicate; this is in agreement with the studies of Ashraf and Foolad [3], who observed that seedlings grown from seed treatment at different duration and different field crops showed height growth strength than untreated seeds.

In *A. esculentus*, the maximum girth confidence interval for seeds soaked in 30% H_2S0_4 for 50 minutes and seeds treated by vernalization for 24 hours ranged between 4.88 to 5.12 and 4.76 to 5.22 respectively. For the maximum girth confidence interval, seeds soaked in distilled water for 24 hours were between 5.19 to 5.73 and the control replicate had a maximum girth confidence interval of 2.7 to 4.7. The observations on leaf area of the treated seeds showed that 30 min treatment of seeds with sulphuric acid gave the highest leaf area in all treatments including vernalisation and hydrotreament; hence, result of this study has further proved that treated seeds as reported by previous studies, give rise to crops which matured earlier and gave higher yields. As reported by FAO [8], studies conducted in Zimbabwe, Pakistan and India reported that treated corn seeds emerged earlier, flowered sooner, required less cultivation and less weeding, produced grain faster and matured earlier than the same crops sown at the same time using dry seeds. Farmers reported better drought tolerance and higher yields using treated seeds with yield increase of 10-30 %. Less seeds per unit area were needed; for example, 19 kg per hectare of corn was needed instead of 25 kg [8]. Study by Tzortzakis [9], showed that the pre-sowing treatment of *Amaranthus* seeds with KNO_3 significantly enhanced plant growth (shoot and root fresh weight) of both species, whereas no differences were observed for leaf number and leaf size. In previous studies, germination of Amaranthus (*Amaranthus cruentus* L.) seeds at 20 °C was promoted by treatment in 3 % KNO_3 but not in KH_2PO_4 solutions. Inclusion of spermine into treatment solution further improved germination [10]. Similarly, employment of gibberellic acid and/or glycinebetaine enhanced rice seed emergence and seedling growth [11].

CONCLUSION

It can be concluded from this research, that seed treatment resulted in early germination and high growth strength than in untreated seeds, hence seed treated with H_2SO_4, vernalization or soaking in water can be used for enhancing emergence and better seedling growth in *Abelmoschus esculentus* but attention must be paid on the duration of exposure to treatment because there lies the distinguishing factor in performance of the seed as proved by this study. Although, previous studies indicated that some benefits are associated with pre-sowing treatments for seed vigor enhancement, but there is dearth of information about the germination performance of treated seeds of okra. So it was imperative to develop suitable techniques in order to improve okro seed germination capacity with proper growth and development, which will in turn, bring about bountiful yield.

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