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THE IMPACT OF SEED PRIMING TO ENHANCE GERMINATION, GROWTH AND YIELD OF OKRA (*ABELMOSCHUS ESCULENTUS* L.)

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ABSTRACT

During the 2022 kharif season, an empirical study was carried out at the Horticulture Farm, S.K.N. College of Agriculture, Jobner, Jaipur (Rajasthan). The experiment involved four different priming agents (distilled water, NaCl at 2%, PEG at 5%, and GA3 at 200 ppm, along with a control) and three durations (6, 12, and 24 hours), resulting in a total of 13 treatments. The study was conducted using a randomised block design (RBD) with three replicates to improve result reliability. The findings clearly indicated that soaking seeds in GA3 at 200 ppm for 24 hours significantly enhanced various yield parameters such as the number of pods per plant (16.03), pods per plant up to the third node (4.02), pod length (8.29 cm), pod diameter (2.13 cm), pod weight (7.13 g), pod yield per plant (86.73 g), pod yield per hectare (64.24 q), number of seeds per pod (35.89), seed test weight (67.72 g), seed yield per plant (6.30 g), and seed yield per hectare (458.77 kg) for okra.
***Keywords* :** Priming, replication, PEG, RBD, vigorous.

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is popularly known as "Lady Finger". This particular species is a member of the Malvaceae family, frequently cultivated in regions with tropical and subtropical climates around the globe and commercially cultivated in India, Iran, Pakistan, South Africa, Yugoslavia, Brazil, Thailand, Ethiopia, Malaysia, Myanmar, Afghanistan, Bangladesh, the United States, Turkey, and Cyprus (Qhureshi., 2007).

Okra bears self–fertile flowers, but up to 10 per cent of cross-pollination occurs by insects; thus, it is classified as an often-cross-pollinated crop. The edible part of okra is the immature pod (fruit), which is harvested when it is tender enough. Okra fruits comprise carbohydrates (6.4%), protein (1.9%), fat (0.2%), fibre (1.2%), minerals (0.7%), and moisture (89.6%) (Ofori *et al.*, 2020).

Good agricultural practices during seed sowing are vital for ensuring healthy crop growth and maximizing yield. Seed priming and seed coating are key factors for improving seed germination and promoting healthier plants. Seed priming is a pre-sowing treatment that enhances seed performance by increasing seed rate and uniformity of germination, leading to better seedling stand and crop establishment. It is simple, cost-effective, and efficient for achieving high germination rates, early seedling growth, and increased yield under both stressed and non-stressed conditions. Priming may also boost resistance to abiotic stresses (Farooq *et al.*, 2008). Seed pre-soaking hydrates membrane proteins and initiates several metabolic processes, but re-drying of seeds halts these processes. In seeds, priming treatment also elevates the activities of anti-oxidative enzymes (Wang *et al.*, 2003). The duration of priming affects seed response, along with the osmotic potential of the priming solution, the priming agent, and oxygen supply to the seed (Nascimento 2003).

Osmo priming with PEG solution enables the preparation of metabolic activities necessary for germination through water absorption and the initiation of membrane repair (Jisha *et al*., 2013).

PEG does not harm seed germination because these molecules do not penetrate the seed. Osmo priming enhances the antioxidant system and seed germination potential, leading to greater stress tolerance in sprouting seeds (Chen and Arora, 2011). The effects of gibberellic acid (hormonal priming) suggest that its primary site of action is significant. Cell division is stimulated in the shoot apex, particularly in the more basal meristematic cells, which develop the large files of cortex and pith cells. Gibberellic acid promotes cell division (growth) by increasing fructose and sucrose hydrolysis. Halopriming using NaCl involves immersing seeds in various saline solutions, which enhances germination and seedling growth, even under challenging environmental conditions. This technique primes seeds to better withstand stress factors, resulting in improved germination rates and stronger early seedling development. Halopriming is a simple and effective method to improve emergence and crop stand under various environmental circumstances (Sedghi *et al.*, 2010) and to enhance germination and seedling establishment in salt-tolerant melon plants (Sivritepe *et al.*, 2003). Reductions in the amounts of phytohormones, especially gibberellic acid, and increases in abscisic acid have been reported in several plant species under salt and drought stresses (Cao *et al.*, 2014). The primary purpose of this research was to address the problem of slow and unpredictable emergence in okra seeds by seed priming, and to determine the optimal seed priming time, osmotic potential, and priming agent for okra seeds. Consequently, the current study focused on the best priming and seed soaking times to improve germination, growth, pod yield, and seed production in okra plants.

Materials and Methods

The experiment was laid out at the Horticulture farm, S.K.N. College of Agriculture, Jobner, Rajasthan, in 2022. Geographically, Jobner is situated in the Jaipur district of Rajasthan at 26°05' North latitude and 75°58' East longitude and an altitude of 427 meters above mean sea level. The experiment consisted of four different priming agents (distil water, NaCl @ 2%, PEG @ 5% and GA_3 @ 200 ppm, including a control) and different durations (6, 12 and 24 hrs) with a total of 13 treatments *viz.* Control (T_0), Soaking in distilled water for 6 hrs (T_1), Soaking in distilled water for 12 hrs (T_2), Soaking in distilled water for 24 hrs (T_3), Soaking in NaCl 2% solution for 6 hrs (T_4), Soaking in NaCl 2% solution for 12 hrs (T_5), Soaking in NaCl 2% solution for 24 hrs (T_6), Soaking in PEG 5% solution for 6 hrs (T_7), Soaking in PEG 5% solution for 12 hrs (T_8), Soaking in PEG 5% solution for 24 hrs (T_9), Soaking in GA_3 200 ppm solution for 6 hrs (T_{10}), Soaking in GA_3 200 ppm solution for 12 hrs (T_{11}) and Soaking in GA_3 200 ppm solution for 24 hrs (T_{12}). The study was structured using a randomized block design, encompassing three distinct replications.

Field Experiment

The study was carried out in 2022 at the Horticulture Farm of S.K.N. College of Agriculture, Jobner, to study the role of seed priming in controlling the problem of slow emergence under field conditions and in enhancing the yield of okra. Seeds were primed in distilled water, NaCl @ 2%, PEG @ 5%, and GA_3 @ 200 ppm for 6, 12 and 24 hours while unprimed dry seeds were used as a control. After priming, the seeds were rinsed with water and dried to an initial moisture content at room temperature. After drying, seeds of each treatment were sown on July 6-7, 2022, in well-prepared plots of 4.05 m^2 with seed to seed distance of 30 cm and row to row distance of 45 cm. Data was recorded on Observation of yield attributes (No. of pods per plant, No. of pods per plant up to 3^{rd} node, Pod length (cm), Pod diameter (cm), Pod weight (g), Pod yield per plant (g), and per ha (q), No. of seeds per pod, Test weight of seed, Seed yield per plant (g), and ha (kg)).

Table 1 : Effect of seed priming on No. of pods per plant, No. of pod per plant up to 3rd node, Pod length, Pod diameter, Pod weight and Pod yield per plant.

Treatments	No. of pods per plant	No. of pods per plant up to 3rd node	Pod length (cm)	Pod diameter (cm)	Pod weight (g)	Pod yield per plant (g)
T_0	9.73	1.58	5.70	1.02	4.70	68.07
T_1	10.89	1.89	5.79	1.39	4.72	69.24
T_2	11.16	2.07	5.93	1.44	5.31	70.89
T_3	12.06	2.18	6.13	1.55	5.36	72.82
T_4	12.46	2.33	6.27	1.59	5.93	73.35
T_5	12.73	2.75	6.41	1.64	6.06	74.25
T_6	12.89	2.79	6.84	1.68	6.16	75.73
T_7	12.00	2.83	6.97	1.71	6.24	75.84
T_8	13.26	3.11	7.19	1.75	6.45	76.86
T_9	15.59	3.59	7.47	1.87	6.80	81.39
T_{10}	13.03	3.55	7.31	1.65	6.55	77.02
T_{11}	15.91	3.91	8.07	1.96	7.02	85.06
T_{12}	16.03	4.02	8.29	2.13	7.13	86.73
SEm$\pm$	0.61	0.15	0.32	0.12	0.16	2.82
CD (P=0.5%)	1.78	0.45	0.94	0.35	0.47	8.22
CV (%)	8.72	10.08	8.70	14.21	4.74	6.73

Table 2 : Effect of seed priming on Pod yield per ha, Number of seeds per pod, Test weight of seed, Seed yield per plant and Seed yield per ha.

Treatments	Pod yield per ha (q)	Number of seeds per pod	Test weight of seed (g)	Seed yield per plant (g)	Seed yield per ha (kg)
T_0	50.42	26.50	57.39	5.39	401.48
T_1	51.29	28.08	60.72	5.47	408.15
T_2	52.51	29.56	58.09	5.56	410.10
T_3	53.94	29.30	58.40	5.70	413.33
T_4	54.33	30.35	59.33	5.68	411.93
T_5	55.00	31.05	59.38	5.74	416.05
T_6	56.10	31.75	60.07	5.81	418.02
T_7	56.18	31.93	62.28	5.78	418.27
T_8	56.93	31.97	63.42	5.79	420.25
T_9	60.29	33.65	64.10	5.97	432.59
T_{10}	57.05	31.42	63.64	5.81	422.44
T_{11}	63.01	35.32	66.37	6.16	441.48
T_{12}	64.24	35.89	67.72	6.30	458.77
SEm$\pm$	2.05	0.90	1.27	0.14	10.45
CD (P=0.5%)	5.99	2.62	3.71	0.42	30.50
CV (%)	6.61	5.10	3.55	4.32	4.30

Results and Discussion

A review of the data in Tables 1 & 2 reveals that plants from GA_3-primed seeds produced the greatest number of seeds per plant, exhibiting a statistically significant increase over all other treatments. The table revealed that soaking the seeds in a GA_3 solution at 200 ppm for 24 hours (T_{12}) had the significantly highest Number of pods per plant (16.03), No. of pods per plant up to 3rd node (4.02), Pod length (8.29 cm), Pod diameter (2.13cm), Pod weight (7.13 g), Pod yield per plant (86.73 g), Pod yield per ha (64.24 q), Number of seed per pod (35.89), Test weight of seed (67.72 g), Seed yield per plant (6.30 g), Seed yield per ha (458.77 kg)), over rest of the treatments except treatment T_9 and T_{11} which were statistically at par with T_{12}. GA_3 promotes hydrolytic enzyme activity (e.g., α-amylase), faster mobilisation of seed reserves and earlier seedling vigour; stronger early growth often translates into improved vegetative canopy and higher capacity to support reproductive organs later in development. Better resource capture by GA_3-primed plants likely supported enhanced pod growth and seed set. Dhakal *et al.*, (2023) proved that the GA_3 priming produced the longest pods on average; increases in pod length by Gibberellins to affect flowering processes, ovule development and fruit set in many species; seed priming with GA_3 can therefore have carry-over effects that increase ovule fertility, fruit expansion and final seed number and size. This hormonal modulation explains concurrent increases in pod length, diameter and seed number (Ghosh *et al*., 2025). Osmo priming (PEG), hydropriming, and halopriming can positively influence early seedling growth, plant stand, flowering, fruiting, and root morphological traits (Krishna *et al*., 2022).

Individual pod weight was highest in the GA_3 treatment, with PEG showing a moderate but significant increase over the control. The increased pod weight under GA_3 was consistent across harvests and was reflected in greater per-plant productivity (Anghla *et al*., 2025).

Conclusion

The findings of this study clearly demonstrate that seed priming with gibberellic acid (GA_3), especially at a concentration of 200 ppm for 24 hours (T_{12}), is highly effective in enhancing the growth, yield attributes, and overall productivity of the crop. Among all treatments, GA_3-primed seeds produced the highest number of pods per plant, larger pod dimensions, increased pod and seed yield per plant, and superior yield per hectare. Treatments T_9 and T_{11} performed similarly to T_{12} in several aspects, yet T_{12} consistently recorded the highest statistically significant values.

Overall, GA_3 priming especially at 200 ppm for 24 hours—proved to be a highly effective, low-cost, and practical agronomic intervention that significantly improved pod formation, seed set, and final yield. These findings highlight the potential of GA_3 seed priming as an efficient pre-sowing technique to boost crop productivity and can be recommended for use in similar agro-ecological conditions.

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Conflict of interest statement

The author declares that there is no conflict of interest.

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