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Impact of Seed Hydropriming Duration on Growth and Yield Parameter of Okra (*Abelmoschus esculentus* L. var. Punjab Suhawani)

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Abstract

To overcome the problem of seed germination in okra, can treated with water which are farmers friendly and cost effective. The objective of the experiment was to determine how long okra seeds should be hydroprimed in order to influence the growth and yield parameter of okra. There were eight treatments in which one is unprimed and other seven are primed with distilled water for different durations (T_0, unprimed; T_1, 2 hours hydroprimed seeds; T_2, seeds hydroprimed for 4 hours; T_3, seeds hydroprimed for 6 hours; T_4, seeds hydroprimed for 8 hours; T_5, seeds primed for 10 hours; T_6, seeds primed for 12 hours; T_7, seeds primed for 14 hours). The experiment was laid out in a randomized complete block design with three replications. Data of various parameter likes germination percentage and seedling parameters were recorded to find out the suitable duration of seed hydropriming in okra. Results showed that hydropriming duration of 14 hours recorded maximum plant height at 30, 45, 60 DAS (Days after sowing) and at the time of final harvesting (34.61 cm, 56.97 cm, 67.03 cm and 83.07 cm), maximum number of leaves on plant (9.06, 19.99, 21.00 and 22.61), maximum number of nodes on main plant (16.24), minimum number of days to 50% flowering (36 days), maximum number of fruiting nodes on main stem (11.30 cm) and yield parameter viz., maximum number of pods per plant (12.34), length of pod (11.64 cm), width of pods (1.53 cm), individual pod weight (9.20 g), pod yield per plant (113.47 g), pod yield kg/plot (3.42 kg) and pod yield tons/hectare (16.87) as compared to other hydro priming durations. Priming of okra seeds for different duration facilitates not only faster and uniform germination but also improved seedling vigor, increase nutrient uptake from soil which lead to enhance the crop yield. Therefore it is concluded that both 12 and 14 hours of hydropriming duration had positive effect on germination and seedling growth parameters of okra.

Keywords

Okra, Cost effective strategies, Hydropriming, Growth parameter, Yield parameter

Introduction

Okra (*Abelmoschus esculentus* L. moench), a member of the Malvaceae family [1], is also known as Lady's finger or bhindi in different parts of the world [2]. It is also known as "The ultimate villager's vegetable" [3]. In okra, young fruits are consumed, while dried seeds are roasted or powdered and used as a coffee ingredient or substitute. In medicine, it is used as a plasma replacement or blood volume expander. In the food sector, okra mucilage is often used to glaze some papers and in sweets [1]. India leads the world in okra production, with 6371 thousand metric tonnes produced on 534 thousand hectares (NHB, 2019-20). The main okra-growing states in India include Uttar Pradesh, Andhra Pradesh, West Bengal, Bihar, Maharashtra, and Karnataka [4]. Crops are grown during

the summer and rainy seasons in Himachal Pradesh's low and mid hills, covering 1.94 thousand hectares and yielding 14.61 thousand metric tons yearly (NHB, 2019-20).

Okra is a tropical and subtropical vegetable crop that is produced in Africa and Asia. During the hot, humid summer months, it thrives. It is predominantly grown in India during the summer and rainy seasons [5]. Okra seeds do not germinate below 20 degrees Celsius. The biggest challenge in early spring planting is the sluggish and inconsistent germination of okra seed [6]. Reduced, delayed, and inconsistent emergence is a key issue in okra crop cultivation, as it causes challenges with quick germination and uniform field stand [7].

Okra seeds germinate very slowly and unevenly although they are viable seeds. Reduced, delayed, and erratic emergence is a serious problem in okra cultivation caused by seed hardness as it creates problems in rapid germination and uniform field stand. The hard seed coat restricts the water imbibition and uniform growth and development of the embryo and as a result interferes with seed germination [8].

Seed priming is the process of hydrating seeds under controlled conditions in order to promote faster and more consistent seed germination and plant growth [9]. Seed priming increase the seed germination percentage [10]. Response of seed to priming is also affected by different priming duration [11], osmotic potential of seed priming solution [12].

Priming duration is an important factor in harnessing the beneficial effects of hydropriming. Each crop cultivar has a crucial soaking time that is smaller than the maximum allowable. Longer soaking times can have negative consequences, which could be due to a decrease in DNA repair activity [13]. So, the main aim of this study is to know how long seed should be primed to achieve optimum results.

Methodology

The experiment was conducted at main Agriculture Research Field, Lovely Professional University Phagwara, Punjab, located at 31° 15' N latitude, 75° 41'E longitude and at an altitude of 245 m above mean sea level. Jalandhar is situated between the intensively irrigated and very fertile agricultural land of river the Beas and the Satluej and spread over a huge area of 2624 sq.km, it occupies 5.3% of the total geographical area of the state. There were eight treatments in which one is unprimed and other seven are primed with distilled water for different durations [T_1, 2 hours hydroprimed seeds; T_2, seeds hydroprimed for 4 hours; T_3, seeds hydroprimed for 6 hours; T_4, seeds hydroprimed for 8 hours; T_5, seeds primed for 10 hours; T_6, seeds primed for 10 hours; T_7, seeds primed for 12 hours]. The experiment was laid out in a randomized complete block design with three replications. Data were recorded on following parameters:

Plant height (cm): Plant height was measured from sample plants in centimeter from the ground level to the tip of the longest stem and mean value was calculated. Plant height was also recorded at 30,45,60,75 days interval starting from 30 DAS up to harvesting time to observe the growth of plants.

Number of leaves per plant: The total number of leaves per plant was counted from each of selected plants. Data were recorded as the average of 5 plants selected at random from the inner rows of each plot from 30 DAS up to harvesting time at 15 days interval.

Number of days to 50% flowering: Days to first flower was recorded from the date of sowing to the date when at least when one flower appear in the 50% plant.

Yield Parameter

Number of nodes on main stem: Number of nodes on main stem was counted from the 5-sample plants.

Number of fruiting nodes on main stem: Number of fruiting nodes on main stem was counted from the 5-sample plants.

Number of pods per plant: The number of pods per plant was counted from the 5 sample plants and the total number of pods of the 5 plants were counted and average then to get number of pods per plant.

Pod length (cm): The length of green pod was measured with a scale from the neck of the fruit to the bottom of 5 selected marketable fruits from each plot and their average was taken and expressed in cm.

Width of the pods (cm): Diameter of green pod was measured at the middle portion of 5 selected marketable fruit from each plot with a digital vernier caliper and their average was taken and expressed in cm.

Individual weight of the pods (g): Individual weight of the pods can be measured by using digital balance. Five green pods from each plot are selected and their average was taken and expressed in grams.

Yield per plant (g): Picking of fresh pods was done from the tagged plants separately in separate polythene throughout the harvesting period and then the total average yield per plant was calculated for each treatment.

Pod yield per plot (kg): Picking of fresh pods was done from all the plots separately in separate polythene throughout the harvesting period and then the total average yield per plot was calculated from each treatment.

Pod yield (tons/ha): Picking of fresh pods were done from all the plots separately in separate polythene throughout the harvesting period and then the total average yield tons/ha was calculated from each treatment. Yield is the ultimate output of any crop under study and depends upon various factors such as soil types, environmental factor and genetic makeup. The increase in biological yield due to priming might be due to better early seedling growth and plant nutrition. The improved yield of primed seeds plots may be due to uniform and improved germination.

Statistical analysis

Obtain data were analyzed by using OPSTAT software, HAU and mean comparison were done by Duncan multiple range test at 0.05 level of significance.

Result and discussion

Plant height (cm)

The observation recorded on plant height of okra for the year 2021 and 2022 and in pooled analysis has been presented in table 1 (Figure 1). In seed hydropriming duration, remarkable difference was found because of different hydropriming duration on plant height at 30, 45, 60 DAS and at final harvesting. At 30, 45, 60 DAS and at harvest time, the tallest plant (34.60 cm, 56.97 cm, 67.03 cm and 83.07 cm, respectively) is recorded from T_7 (14 hours duration) treatment and that the smallest plant (25.86 cm, 45.81 cm, 56.13 cm and 69.18 cm, respectively) was found from T_0 (no priming) treatment at par with the 2 hours (2 hours duration i.e., 25.86, 45.81, 56.13 and 69.18 cm, respectively) [14] also suggested the same thing. Plant height was considerably higher in primed seed plots than in unprimed seed plots. This is consistent with the findings of [15, 16], who found that seed priming causes plant height to rise. On the basis of emergence, this can be explained.

Number of leaves per plant

In seed hydropriming treatment, remarkable difference is found in the year of 2021 and 2022 and also in pooled data as shown in table 2 (Figure 2). It is because of different priming duration on number of leaves per plant at 30, 45, 60 DAS and at harvest time. At 30, 45, 60 DAS and at harvest time, the maximum number of leaves (9.06, 19.69, 21.00 and 22.61) was recorded from T_7 (14 hours duration) and the minimum number of leaves (5.52, 14.20, 16.11 and 19.54 respectively) was found in T_0 (no priming) treatment. Hegazi [14] also suggested the same thing.

Table 1: Effect of different hydropriming duration on plant height at different days intervals.

	Plant height at 30 days (cm)			Plant height at 45 days (cm)			Plant height at 60 days (cm)			Plant height at final harvesting (cm)		
Duration	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
T_0 (0 hours)	25.7	26	25.86	45.3	46.3	45.81	55.6	56.7	56.13	68.8	69.6	69.18
T_1 (2 hours)	26.7	27.2	26.92	46.5	47.2	46.86	57.8	57.6	57.69	70.7	70	70.33
T_2 (4 hours)	28.9	8.77	28.82	47.7	48.7	48.23	57.8	60.5	59.15	71.6	70.3	70.96
T_3 (6 hours)	30.4	9.56	29.98	48.2	49.4	48.82	60.6	58.7	59.62	72.7	73	72.83
T_4 (8 hours)	29.6	30.6	30.09	50.8	48.7	49.76	58.4	62.6	60.48	75.3	75.3	75.33
T_5 (10 hours)	31.4	31.3	31.34	49.7	50.4	50.06	62.7	59.2	60.98	74.8	79.4	77.07
T_6 (12 hours)	32.7	33.8	33.24	54.7	54.6	54.65	64.5	66.4	65.46	82.5	81.3	81.94
T_7 (14 hours)	33.9	35.4	34.6	56.8	57.2	56.97	66.5	67.6	67.03	83.8	82.3	83.07
CD (P = 0.05)	1.43	1.99	1.25	1.92	2.17	1.47	1.55	2.21	1.33	1.97	2.17	1.65
SE_M (±)	0.47	0.65	0.4	0.63	0.72	0.48	0.4	0.7	0.44	0.66	0.71	0.54
CV (percent)	2.7	3.7	2.34	2.17	2.44	1.66	1.14	2.04	1.24	1.5	1.64	1.24

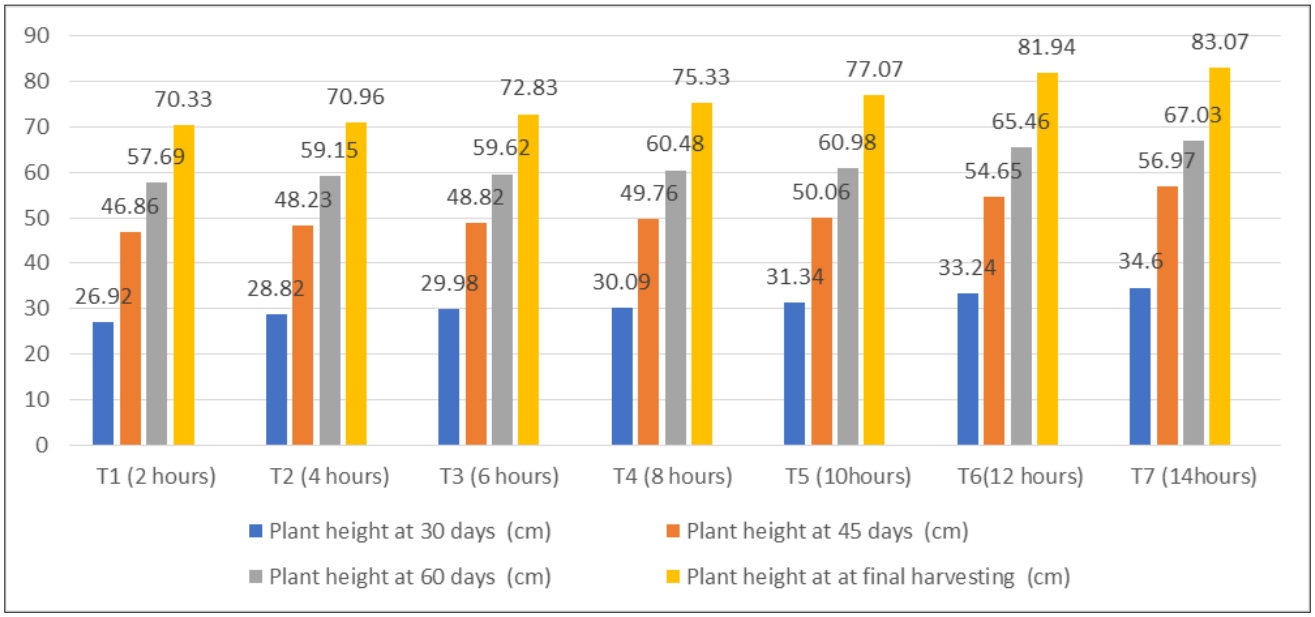

Figure 1: Plant height at different interval (cm).

Table 2: Effect of different hydropriming duration on number of leaves per plant at different intervals.

	Number of leaves per plant at 30 days			Number of leaves per plant at 45 days			Number of leaves per plant at 60 days			Number of leaves per plant at final harvesting		
Duration	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
T_0 (0 hours)	5.35	5.68	5.52	13.6	14.8	14.2	16.5	15.8	16.11	19.8	19.3	19.54
T_1 (2 hours)	5.95	6.13	6.04	14.8	15.3	15.04	17.5	16.5	16.98	18.8	20.7	19.73
T_2 (4 hours)	6.42	6.51	6.47	15.7	15.8	15.78	17.6	17.3	17.45	19.5	20.6	20.05
T_3 (6 hours)	6.81	6.56	6.69	16.9	16.7	16.77	18.5	17.8	18.11	20.6	20	20.3
T_4 (8 hours)	7.52	7.38	7.45	16.3	18.6	17.46	18.8	18.7	18.78	20.5	21.2	20.82
T_5 (10 hours)	7.35	7.81	7.58	17.6	17.7	17.66	19.3	19.6	19.45	21.4	20.8	21.06
T_6 (12 hours)	7.84	8.47	8.16	17.9	19.7	18.82	19.6	20.8	20.21	21.7	22.1	21.9
T_7 (14 hours)	8.76	9.35	9.06	18.6	20.7	19.69	20.5	21.5	21	22.7	22.5	22.6
CD (P = 0.05)	1.85	1.74	0.61	2.19	1.78	0.33	1.5	1.64	0.61	1.77	0.63	0.83
SE_M (±)	0.61	0.57	0.43	0.72	0.58	0.11	0.49	0.57	0.25	0.57	0.18	0.38
CV (percent)	12.7	13.5	10.47	7.51	5.81	2.18	4.58	5.28	2.34	4.8	1.73	2.23

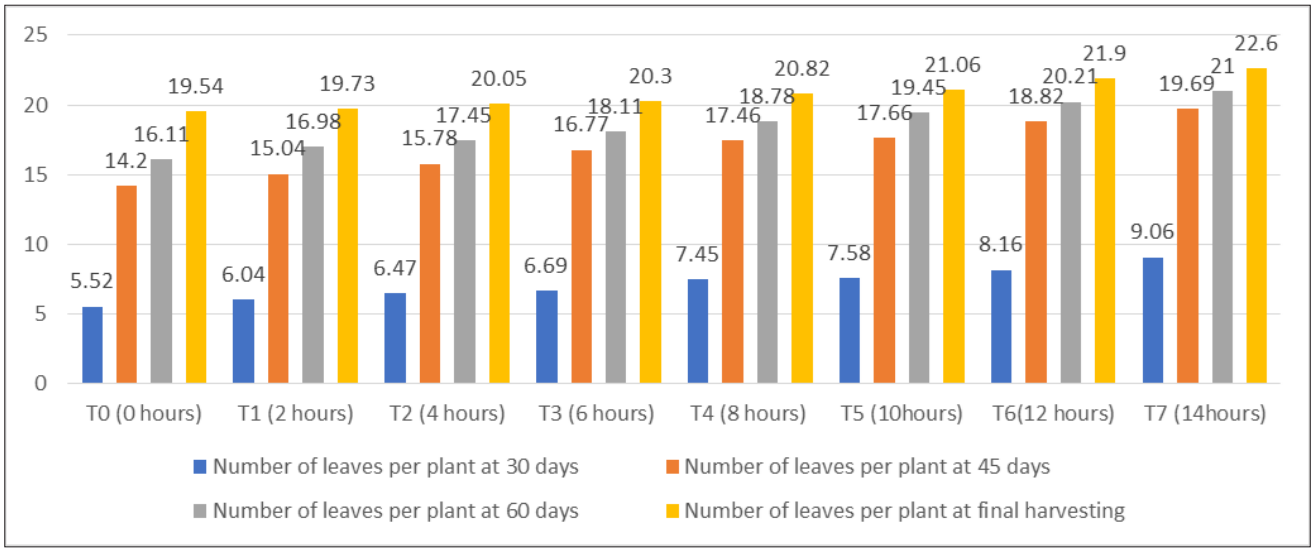

Figure 2: Number of leaves at different interval.

Number of nodes on main plant

Differences in the number of nodes per plant were significantly affected by different seed hydropriming duration in the year of 2021 and 2022 and also in pooled data as shown in table 3 (Figure 3). The values for number of nodes per plant at final harvest were ranged from 11.62 to 16.24. From the result, it should be noted that the highest number of nodes per plant i.e., 16.24 was observed in 14 hours duration at par with the 12 hours duration i.e., 15.04. Whereas the minimum value was noted in the 0 hours duration i.e., 11.62, at par with the 2 hours duration i.e., 12.67. The number of nodes per plant is a significant factor in determining the final yield. The number of nodes seen has a direct link with the number of leaves [17]. The priming impact on seed emergence, seedling growth, and vigor has resulted in more leaves. The variation in number of the nodes might be due to vigorous growth of the plant due to priming.

Number of days to 50% flowering

Statistical investigation demonstrated that soaking seeds for various lengths of time has a substantial impact on the number of days to 50% flowering. According to the mean values of the experimental data in the year of 2021 and 2022 and also in pooled data as shown in table 3 (Figure 3), the plots in which seeds were soaked for 0 hours have the most (43.33) days to 50 percent flowering, whereas plots in which seeds were soaked for 12 hours have the lowest (36.00) days to 50 percent flowering. Hegazi [14] also suggested the same thing.

Number of fruiting nodes on main stem

Differences in the number of fruiting nodes were significantly affected by different seed hydropriming duration in the year of 2021 and 2022 and also in pooled data as shown in table 3 (Figure 3). From the result, it should be noted that the highest number of fruiting nodes on main stem i.e., 11.30 was observed in 12 hours duration at par with the 14 hours dura-

Table 3: Effect of different hydropriming duration on number of nodes on main stem, number of days to 50% flowering, number of fruiting nodes on main stem, number of pods per plant, and length of pods.

	Number of nodes on main plant			Number of days to 50% flowering			Number of fruiting nodes on main stem			Number of pods per plant			Length of pods (cm)		
Duration	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
T_0 (0 hours)	11.5	11.7	11.62	35.3	36.7	36	7.42	7.54	7.48	8	8.67	8.34	7.54	7.58	7.56
T_1 (2 hours)	12.6	12.7	12.67	36	37.3	36.67	7.73	7.8	7.77	9	8.33	8.67	8.83	8.76	8.79
T_2 (4 hours)	12.7	13.5	13.1	38.7	38.3	38.5	8.46	8.59	8.53	9.5	9.84	9.67	9.28	9.57	9.43
T_3 (6 hours)	12.9	13.8	13.38	39.7	40.7	40.17	8.83	8.74	8.79	9.67	10.3	10	9.36	9.91	9.64
T_4 (8 hours)	13.7	14.1	13.89	40	41.3	40.67	8.52	9.68	9.1	10.3	11	10.67	9.52	10.37	9.94
T_5 (10 hours)	14.1	14.5	14.3	40.3	41.7	41	9.53	9.93	9.73	10.7	12	11.34	10.32	10.61	10.46
T_6 (12 hours)	14.8	15.2	15.04	43	43.7	43.33	10.9	11.7	11.3	12	12.7	12.34	11.48	11.8	11.64
T_7 (14 hours)	15.7	16.7	16.24	42.3	42.3	42.33	10.1	10.4	10.25	12	11.3	11.67	10.29	11.11	10.7
CD (P = 0.05)	1.34	1.41	1.37	2.21	2.43	2.04	1.13	1.43	1.23	1.34	1.47	1.25	1.39	1.41	1.32
SE_M (±)	0.39	0.52	0.45	0.79	0.93	0.67	0.59	0.46	0.4	0.48	0.45	0.41	0.41	0.49	0.43
CV (percent)	5.52	6.61	5.62	2.95	3.12	2.88	10.8	8.72	7.47	6.57	6.76	6.88	9.13	8.21	7.66

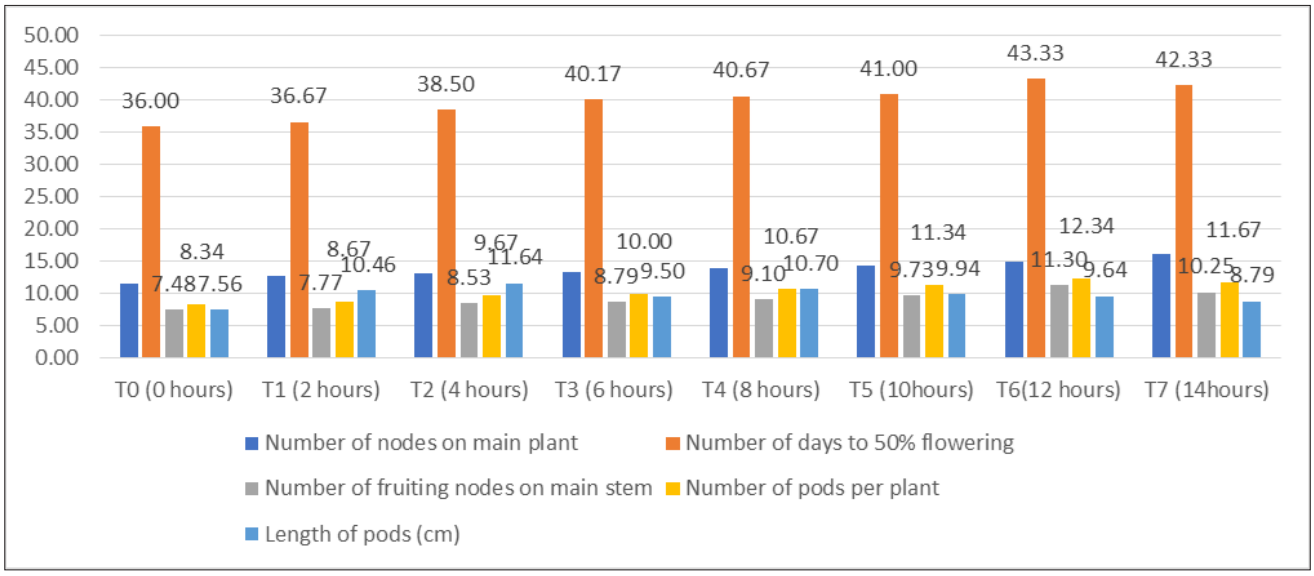

Figure 3: Effect of seed hydropriming on different parameter.

tion i.e., 10.79. Whereas the minimum value was noted in the control treatment i.e., 7.48 at par with the 2 hours duration i.e., 7.77. The number of fruiting nodes on the main stem is a key factor in determining the eventual yield. Arif et al. [17] discovered that the number of fruiting nodes is proportional to the number of leaves. Priming shows their effect on emergence of seed, seedling growth and vigor [18] has been move towards the higher number of leaves. The variation in number of nodes might be due to vigorous growth of the plant due to priming.

Number of pods per plant

Different hydropriming duration showed remarkable effect on number of pods per plant of okra in the year of 2021 and 2022 and also in pooled data as shown in table 3 (Figure 3). The most number of pods per plant (12.34) was recorded from T_6 (12 hours duration) treatment at par with the T_6 (11.67 hours duration) and T_5 (10 hours duration i.e., 11.33), on the other hand the minimum number of pods per plant (8.34) is found from T_0 (un-primed) at par with the 2 hours duration i.e., 8.67. According to Ghassemi-Golezani et al. [19], hydropriming enhanced the number of heads per plant, the number of seeds per head, and the seed thousand weight and yield in safflower. Furthermore, changes in the quantity of pods in a plant could be related to a longer bloom period and pod development at the appropriate time. Because hydropriming influenced the phenological stages of growth, the role of indeterminate chickpea growth in this case was limited; however, flowering in the right conditions can result in more viable flowers and, as a result, more pods. Nonetheless, Zare et al. [20] claimed that lateral branches had a significant role in pod development.

Length of pods

Seed treatments with hydropriming has remarkable difference in the year of 2021 and 2022 and also in pooled data as shown in table 3 (Figure 3) that were observed because of different hydropriming duration on length of pod of okra. The longest pod length (11.64 cm) was recorded from 12 hours duration at par with the 14 hours duration i.e., 10.70 cm that is statistically look similar to T_6 duration, and the shortest pod (7.56 cm) was observed from T_0 (control) in 0 hours duration.

Width of pods (cm)

Individual fruit widths in the center section of the fruit were measured for different durations. Result to obtain in the year of 2021 and 2022 and also in pooled data as shown in table 4 (Figure 4). Maximum fruit width was 1.53 cm (14 hours duration) as compared to 12 hours, 10 hours, 8 hours, 6 hours, and 4 hours, whereas the minimum was 0.63 cm in control T_0 treatment *at par* with the 2 hrs i.e. 0.69 cm respectively.

Individual pod weight (g)

Seed hydropriming duration had remarkable difference on individual pod weight of okra in the year of 2021 and 2022 and also in pooled data as shown in table 4 (Figure 4). T_6 (12 hours duration) showed the maximum individual pod weight of okra (9.20 g) at par with the 12 hours (8.99 g) duration, which was statistically higher apart from of other priming duration. The minimum individual weight of pod of okra (7.73 g) was found from treatment T_0 (control) at par with the 2 hours duration (i.e., 7.96 g).

Pod yield per plant (g)

Different hydropriming duration showed significant effect on pod yield per plant in okra in the year of 2021 and 2022 and also in pooled data as shown in table 4 (Figure 4). The highest pod yield per plant (g) is observed in 12 hours duration (i.e., 113.47 g) at par with the 14 hours (104.84 g), and lowest yield kg per plot is observed in un-primed i.e., 64.42 g/plant in T_0 (0 hours) at par with the 2 hours duration i.e., (68.99 g/plant). The beneficial effects of hydropriming and different hydropriming duration on yield of grain were also reported in sunflower [21].

Pod yield kg/plot

Different hydropriming duration showed significant effect on pod yield kg/plot in okra in the year of 2021 and 2022 and also in pooled data as shown in table 4 (Figure 4). The highest pod yield kg per plot is observed in 12 hours duration (i.e., 3.42 kg/plot) at par with the 14 hours (3.13 kg/plot), and lowest yield kg per plot is observed in un-primed i.e., 1.91 kg/plot in T_0 (0 hours) at par with the 2 hours duration (i.e., 2.06 kg/plot). The beneficial effects of hydropriming and different hydropriming duration on yield of grain were also reported in sunflower [21].

Pod yield tons/hectare

Different hydropriming duration showed significant effect on pod yield tons/hectare in okra in the year of 2021 and 2022 and also in pooled data as shown in table 4 (Figure 4). The highest pod yield is observed in 12 hours duration i.e., 16.89 tons at par with the 14 hours (15.43 tons) per hectare, and lowest yield kg per plot is observed in un-primed i.e., 9.43 tons per hectare in T_0 (0 hours) treatment at par with the 2 hours duration (i.e., 10.17 tons per hectare). The beneficial effects of hydropriming and different hydropriming duration on yield of grain were also reported in sunflower [21].

Table 4: Effect of different hydropriming duration on width of pods, individual pod weight, pod yield/plant, pod yield kg per plot and yield tons/hectare.

	Width of pods (cm)			Individual pod weight (g)			Pod yield/plant (g)			Pod yield kg/plot			Pod yield tons/hectare		
Duration	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**	**2021**	**2022**	**Pooled**
T_0(0 hours)	0.65	0.61	0.63	7.49	7.97	7.73	63.78	65.06	64.42	1.62	2.2	1.91	8	10.86	9.43
T_1 (2 hours)	0.73	0.74	0.74	7.84	8.08	7.96	68.11	69.87	68.99	1.84	2.28	2.06	9.09	11.26	10.17
T_2 (4 hours)	0.77	0.85	0.81	8.03	8.29	8.16	77.96	79.74	78.85	2.13	2.55	2.34	10.52	12.59	11.56
T_3 (6 hours)	0.85	0.86	0.86	8.23	8.42	8.33	84.15	82.53	83.34	2.22	2.68	2.45	10.96	13.23	12.1
T_4 (8 hours)	0.91	0.94	0.93	8.31	8.46	8.39	89.15	89.92	89.54	2.48	2.86	2.67	12.25	14.12	13.19
T_5 (10 hours)	1.06	1.08	1.07	8.53	8.79	8.66	97.75	98.55	98.15	2.69	3.17	2.93	13.28	15.65	14.47
T_6 (12 hours)	1.22	1.39	1.31	9.08	9.32	9.2	112.5	114.5	113.47	3.12	3.72	3.42	15.41	18.37	16.89
T_7 (14 hours)	1.38	1.67	1.53	8.87	9.11	8.99	104.1	105.5	104.84	3.06	3.19	3.13	15.11	15.75	15.43
CD (P = 0.05)	0.21	0.22	0.14	0.41	0.53	0.36	11.25	10.86	10.7	0.29	0.41	0.35	1.79	1.86	1.7
SE_M (±)	0.07	0.08	0.05	0.16	0.24	0.12	3.76	3.97	3.49	0.17	0.21	0.11	0.61	0.53	0.56
CV (percent)	12.34	12.87	7.96	2.54	2.93	2.41	5.89	6.18	6.89	7.12	7.34	7.48	5.13	4.63	4.67

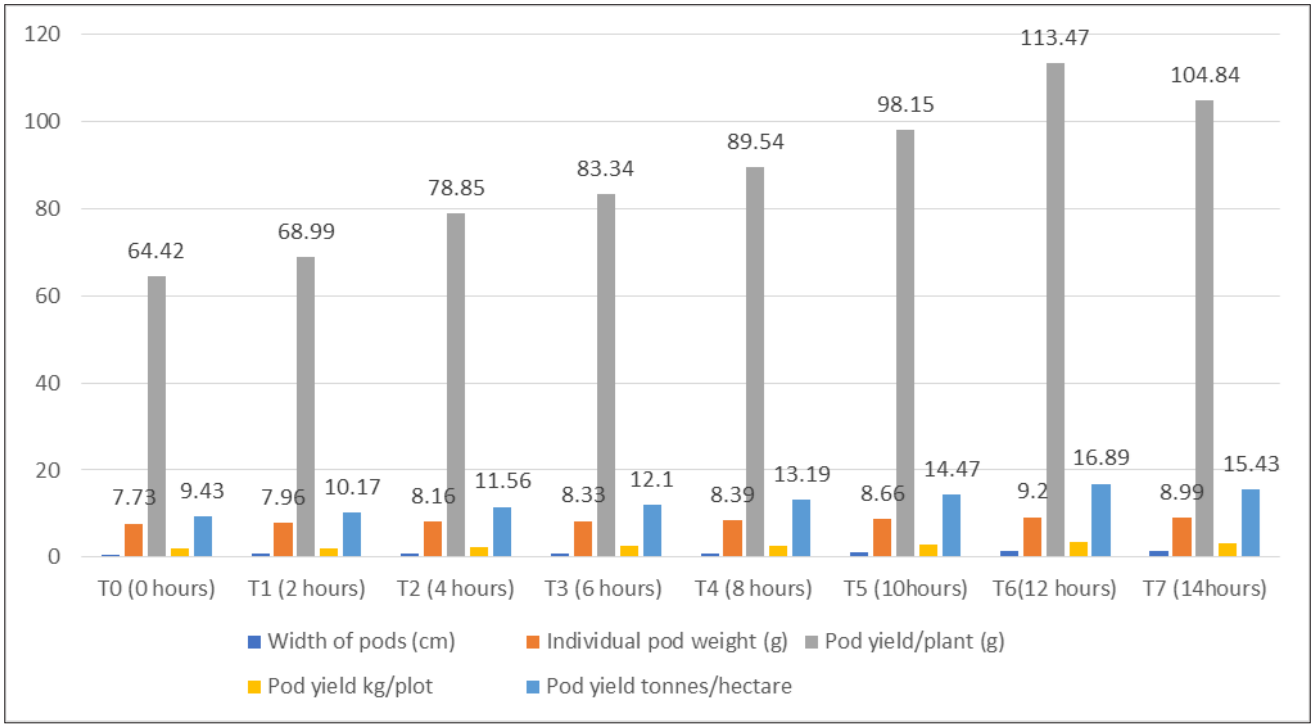

Figure 4: Effect of seed hydropriming on different parameter.

Conclusion

The findings of this study showed that hydro-priming is a cost effective technique for improving seed germination and emergence of okra (*Abelmoschus esculentus* (L.) moench). All the hydro-primed okra seeds performed better than the unprimed ones. Priming of okra seeds facilitates not only germination even also growth and yield of the crop can also be enhanced.

Okra seed hydropriming with different duration on various parameters revealed that the 12 hours and 14 hours was most effective hydropriming duration than the other hydropriming duration. So, seed hydropriming is a useful technique for improving plant height at different days intervals, number of leaves at different days interval, number of nodes on main plant, number of fruiting nodes on main stem, number of days to 50% flowering, number of pods per plant, length of pods, width of pods, individual pod weight, pod yield per plant, pod yield kg per plot, pod yield tons per hectare. However, further extensive researches are required in selecting specific hydropriming duration for different crops in order to ensure a higher yield.

The positive effects of different duration of hydroprimings can help to soften the seed coat and allow for easier water absorption, which can promote faster and more uniform germination. Second, hydropriming can activate enzymes and metabolic processes within the seed that are necessary for growth and development. Finally, the increased water uptake during hydropriming can provide the seed with necessary nutrients and energy for early growth stages. Overall, hydropriming can be an effective technique for improving plant growth factors in various crops. However, the optimal duration of hydropriming may vary depending on the specific plant species and environmental conditions, if specific duration is not followed then seed can be deteriorate due to embryo protrusion.

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Conflict of Interest

None.

References

1. Benchasri S. 2012. Okra (*Abelmoschus esculentus* (L.) Moench) as a valuable vegetable of the world. *Ratar Povrt* 49(1): 105-112. https://doi.org/10.5937/ratpov49-1172
2. Jain N, Jain R, Jain V, Jain S. 2012. A review on: *Abelmoschus esculentus*. *Pharmacia* 1(3): 84-89.
3. Barupal S, Sharma R, Kumar M, Dilta BS, Sharma CL, et al. 2022. Seed priming: a effective method for enhancing seed quality and plant stand establishment in okra (*Abelmoschus esculentus* L.). *Pharma Innov* 11(2): 1359-1364.
4. Chittora A, Singh N, Singh DK. 2016. Production technology of okra. *Marumegh* 1(1): 48-51.
5. Singh S. 2018. Agrometeorological requirements for sustainable vegetable crops production. *J Food Prot* 2: 1-22.
6. Basit A, Zahid A, Shah ST, Ullah I, Ullah S, et al. 2021. Effect of sowing methods and picking intervals on the fresh yield and seed production of okra (*Abelmoschus esculentus* L.). *Pak J Weed Sci Res* 27(3): 407-418. https://doi.org/10.28941/pjwsr.v27i3.885
7. Devi LA, Selvam S. 2022. Efficacy of seed priming using potassium silicate on okra's (*Abelmoschus esculentus* var. Raadhika) germination performance. *Biochem Cell Arch Vol* 22(2): 4321-4325.

8. Mereddy R, Wu L, Hallgren SW, Wu Y, Conway KE. 2015. Solid matrix priming improves seedling vigor of okra seeds. *Proc Okla Acad Sci* 80: 33-37.
9. Sharma AD, Rathore SVS, Srinivasan K, Tyagi RK. 2014. Comparison of various seed priming methods for seed germination, seedling vigour and fruit yield in okra (*Abelmoschus esculentus* L. Moench). *Sci Hortic* 165: 75-81. https://doi.org/10.1016/j.scienta.2013.10.044
10. Sadeghi H, Robati Z. 2015. Response of *Cichorium intybus* L. to eight seed priming methods under osmotic stress conditions. *Biocatal Agric Biotechnol* 4(4): 443-448. https://doi.org/10.1016/j.bcab.2015.08.003
11. Lal SK, Kumar S, Sheri V, Mehta S, Varakumar P, et al. 2018. Seed Priming: An Emerging Technology to Impart Abiotic Stress Tolerance in Crop Plants. In Rakshit A, Singh H (eds) Advances in Seed Priming. Springer, Singapore, pp 41-50.
12. Yari L, Aghaalikani M, Khazaei F. 2010. Effect of seed priming duration and temperature on seed germination behavior of bread wheat (*Triticum aestivum* L.). *ARPN J Agric Biol Sci* 5(1): 1-6.
13. Carrillo-Reche J, Newton AC, Quilliam RS. 2021. Using seed respiration as a tool for calculating optimal soaking times for 'on-farm' seed priming of barley (*Hordeum vulgare*). *Seed Sci Res* 31(2): 116-124. https://doi.org/10.1017/S0960258521000039
14. Hegazi AZ. 2014. Influence of seed priming on growth and seed yield of okra under water stress. *Egypt J Agric Res* 92(1): 197-217.
15. Mohammadi GR. 2009. The influence of NaCl priming on seed germination and seedling growth of canola (*Brassica napus* L.) under salinity conditions. *Am Eurasian J Agric Environ Sci* 5(5): 696-700.
16. Rahman IU, Ali S, Rahman IU, Adnan M, Ibrahim M, et al. 2016. Effect of seed priming on growth parameters of okra (*Abelmoschus esculentus* L.). *Pure Appl Biol* 5(1): 165-171. http://doi.org/10.19045/bspab.2016.50021
17. Arif M, Ali S, Shah A, Javed N, Rashid A. 2005. Seed priming maize for improving emergence and seedling growth. *Sarhad J Agric* 21(4): 539-543.
18. Limba V, Dhillon BS, Singh H. 2020. Effect of seed priming and urea foliar application on the performance of soybean (*Glycine max* L. Merrill). *J Pharmacogn Phytochem* 9(6): 1270-1274.
19. Ghassemi-Golezani K, Chadordooz-Jeddi A, Nasrollahzadeh S, Moghaddam M. 2010. Effects of hydro-priming duration on seedling vigour and grain yield of pinto bean (*Phaseolus vulgaris* L.) cultivars. *Not Bot Horti Agrobot Cluj Napoca* 38(1): 109-113.
20. Zare I, Mohammadi G, Sohrabi Y, Kahrizi D, Khah EM, et al. 2011. Effect of different hydropriming times on the quantitative and qualitative characteristics of chickpea (*Cicer arietinum* L.). *Afr J Biotechnol* 10(66): 14844-14850. https://doi.org/10.5897/AJB11.1283
21. Hussain M, Farooq M, Basra SM, Ahmad N. 2006. Influence of seed priming techniques on the seedling establishment, yield and quality of hybrid sunflower. *Int J Agric Biol* 8(1): 14-18.