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Economic Performance of Primed Seeds of Some Cultivars of Okra (*Abelmoschus esculentus* (L.) Moench)

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ABSTRACT

The effect of seed priming on green pod and seed yield and economics of okra cultivation was evaluated for farmers practicability. Four seed priming methods *viz.* hydropriming, osmopriming, halopriming and solid matrix (SM) priming with different concentrations and durations were employed to 3 cultivars of okra namely A-4, Phule Utkarsha and VRO-6. Among 18 priming treatments of different priming durations along with control, 6 promising treatments in each cultivar resulting in higher vigour index were further selected for field evaluation of green pod and seed yield. All the field operations were kept constant for all treatments and hence variation in cost was only due to the cost of priming agents. Comparison of various treatments revealed that hydropriming for 18h in cv. A-4, halopriming with 1 per cent CaCl2 for 6h in VRO-6 and solid matrix priming for 48h in cv. Phule Utkarsha, were found to be the most beneficial economically for green pod and seed production with maximum benefit cost ratio (BCR) compared with rest of the treatments.

Key words: Economics, benefit cost ratio, germination, vigour index, fruit yield, seed yield, okra

INTRODUCTION

Okra (*Abelmoschus esculentus (L.*) Moench) belongs to the family *Malvaceae* and originated from tropical and subtropical Africa. Okra is also known in many English-speaking countries as lady's finger, okro, or gumbo. The tender pod is the edible part of okra (Dumisa *et al.* 2011) while roasted and ground seeds are good substitute for caffeine free coffee (Calisir and Yildiz 2005). In okra production, India possesses highest position with largest acreage (500,000 ha), maximum production (6000000 t) and productivity (12 t/ha) in the world (FAO, 2014). Besides, the yield of okra seed in India is 230.87 Kg/ha (Koundinya and Pradeep Kumar, 2014). The production of okra seeds by all organised sectors is 1350 t per annum, however, the requirement is 4250 t per annum (Malhotra, 2014). The seed production in India has become an important economic activity for the livelihood of the farm families which not only meets the domestic demands but also fetches foreign exchange for the country. The hard seed coat of okra is a major hindrance for synchronous germination, crop establishment and performance due to slow imbibition and insufficient water up-take. (Standifer *et. al.* 1989; Marsh, 1993). Various seed priming treatments have been observed to reduce this hard seededness and enhance the germinability of the seeds and may prove to be profitable to the farmers by overcoming the problem of delayed and non-synchronous germination (Ashraf and Foolad, 2005; Venkatasubramanian and Umarani, 2007). In developing countries, the data on economics of horticulture are very scarce because these are cultivated as minor crops by most of the farmers (Adeniyi, 2001). Therefore, attempts have rarely been made to assess the economic impact of the fruit and seed production of okra through different methods of seed priming. This study was undertaken to assess the economic impact of fruit and seed production of three cultivars of okra namely A-4, Phule Utkarsha and VRO-6 subjected to pre-sowing seed priming treatments adopting 4 different methods *viz.* hydropriming, osmopriming, halopriming, and solid matrix priming (Table1) for farmers practicability.

METHODOLOGY

The study was conducted in Laboratory and at Research Farm of ICAR-National Bureau of Plant Genetic Resources (NBPGR), New Delhi, for two consecutive years.

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Seed Priming

Healthy seeds of okra cvs. A-4, Phule Utkarsha and VRO-6, used in the present study, were obtained from Indian Agricultural Research Institute, Research Station, Karnal, Haryana; Mahatma Phule Krishi Vidyapeeth, Rahuri; Maharashtra and Indian Institute of Vegetable Research, Varanasi; Uttar Pradesh, India, respectively. The seeds in 19 lots of each cultivar, with each lot comprising of 900 seeds, were subjected to various priming treatments (Table 1). After priming, the seeds were washed 2-3 times and allowed to air dry in a thin layer to the original weight. The treated seeds were packed in laminated three layered aluminium foil pouches and stored in medium-term storage module at 40C and 30 ± 2 per cent relative humidity, until further used.

Seed Germination, Seedling vigour and Vigour index

Four replicates of 50 primed and non-primed seeds of each cultivar were germinated between two germination papers (BP method) and incubated in a seed germinator (SANCO, India) at 25 ± 20C temperature in dark. Germination percentage was calculated following ISTA 1985. Similarly, for seedling vigour 10 seeds of each cultivar in 5 replicates each, were placed in a growth chamber (SANCO, India) at (25±20C) temperature and 90 to 100 per cent relative humidity. Seedling vigour was calculated as the average of sum of root length and shoot length (Srinivasan and Saxena 2007) after 7 days of seed sowing. Also, seedling vigour index was calculated as the product of seedling length (root length and shoot length) and germination percentage (Abdul-Baki and Anderson 1973).

Table 1: Priming treatments applied to seeds of okra cvs. A-4, Phule Utkarsha and VRO-6

Seed priming code	Duration (h)	Treatment substrate	Concentration
Control	-	-	-
Hydro-6	6	Distilled water	-
Hydro-12	12	Distilled water	-
Hydro-18	18	Distilled water	-
Osmo-24-1	24	Polyethylene glycol (PEG-6000)	13.5% (-0.25 MPa)
Osmo-48-1	48	Polyethylene glycol (PEG-6000)	13.5% (-0.25 MPa)
Osmo-24-2	24	Polyethylene glycol (PEG-6000)	20.2% (-0.50 MPa)
Osmo-48-2	48	Polyethylene glycol (PEG-6000)	20.2% (-0.50 MPa)
Osmo-24-3	24	Polyethylene glycol (PEG-6000)	25.2% (-0.75 MPa)
Osmo-48-3	48	Polyethylene glycol (PEG-6000)	25.2% (-0.75 MPa)
Halo-6-1	6	Calcium chloride	1.0%
Halo-12-1	12	Calcium chloride	1.0%
Halo-18-1	18	Calcium chloride	1.0%
Halo-6-2	6	Potassium nitrate	2.0%
Halo-12-2	12	Potassium nitrate	2.0%
Halo-18-2	18	Potassium nitrate	2.0%
SM-24	24	Calcium aluminium silicate	1 : 0.4 : 1 (Seed : SM : water)
SM-48	48	Calcium aluminium silicate	1 : 0.4 : 1 (Seed : SM : Water)
SM-72	72	Calcium aluminium silicate	1 : 0.4 : 1 (Seed : SM : Water)

Method for Hydropriming (Harris *et al.* 2001), Osmopriming (Michael and Kaufman 1973), Halopriming with calcium chloride (Kulkarni and Eshanna 1988) and potassium nitrate (Afzal et al. 2002) and Solid matrix priming (Khan 1992) were used

Field Evaluation

On the basis of the highest vigour index (Table 2), seeds of promising priming treatments in each cultivar were selected (Table 2) and subjected to field evaluation which was conducted at Research Farm of ICAR-National Bureau of Plant Genetic Resources (NBPGR), Pusa Campus, New Delhi. Entire quantity of farm yard manure (8t/ha) was applied in 54 sub-plots of 2.25 m x 2.10 m sizes. A total of 35 plants/plot in 3 replicates were spaced out at 45 cm x 30 cm in randomized block design for further observations. Full dose of phosphorus and potassium and one-third dose of nitrogen were applied as basal dose before sowing by following general package of practices for okra cultivation *i.e.* 100 kg nitrogen, 60 kg phosphorous and 60 kg potassium each per hectare. Remaining two-third nitrogen was applied in two split doses as top dressing at 30 and 60 days after sowing. Though, data on 15 agronomical traits were recorded, the data on days to flower (first flower appearance), days to marketable fruits, Number of fruits/plant and fruit length (cm) and fruit yield/plot (kg) were considered for the present study as they directly contribute to yield.

Data Analyses

Pooled data of two years, recorded on physiological and field evaluation, were analysed statistically using SPSS software (version 16.0). The data recorded as percentage were transformed to the respective angular (arcsine) values for statistical analyses. Differences in mean values due to treatments were compared by applying Duncan's multiple range test (DMRT) at 5 per cent probability.

Economics of okra Cultivation

Cost of production of okra cultivars was calculated on the basis of market prices of inputs during the years under study. The gross return (Rs/ha) was obtained by multiplying the total produce (green fruit and seed separately) with the whole sale market price. Net return (₹/ha) was calculated by subtracting the cost of cultivation from the gross return. The benefit cost ratio was calculated with the formula used by Dash *et al.* (2013).

$$\text{Benefit cost ratio} = \frac{\text{Gross income}}{\text{Total cost of production}}$$

Table 2: Effects of seed priming treatments on germination, seedling vigour and vigour index in seeds of okra cultivars

Seed priming code	CV. A-4			CV. Phule Utkarsha			CV. VRO-6		
	G (%)	SV	VI	G (%)	SV	VI	G (%)	SV	VI
Control	88.0^{a}	23.1^{gh}	**2031.0^{de}**	93.3^{abcd}	36.5^{a}	**3407^{abc}**	86.0^{cd}	27.3^{i}	**2348.0^{fg}**
Hydro-6	82.7^{bc}	32.5^{b}	2686.0^{b}	85.3^{fg}	30.5^{e}	2603^{e}	88.0^{bc}	33.7^{bc}	**2968.0^{b}**
Hydro-12	84.0^{abc}	29.4^{c}	2469.0^{c}	93.3^{abcd}	35.6^{ab}	**3327^{abc}**	89.3^{bc}	30.8^{ef}	2755.0^{c}
Hydro-18	84.7^{abc}	38.0^{a}	**3212.0^{a}**	88.0^{efg}	33.7^{bcd}	2964^{d}	95.3^{a}	21.6^{k}	2058.0^{hi}
Osmo-24-1	77.3^{de}	27.5^{cd}	2126.0^{d}	95.3^{abc}	35.9^{a}	**3472^{ab}**	90.7^{b}	27.5^{hi}	2495.0^{ef}
Osmo-48-1	85.3^{abc}	29.1^{c}	**2485.0^{c}**	86.0^{fg}	30.4^{e}	2619^{e}	78.7^{b}	27.2^{i}	2141.0^{hi}
Osmo-24-2	72.0^{f}	26.4^{def}	1897.0^{ef}	97.3^{a}	32.9^{d}	3206^{bcd}	82.0^{ef}	35.1^{b}	**3190.0^{a}**
Osmo-48-2	54.0^{h}	22.6^{gh}	1223.0^{hi}	76.0^{h}	32.9^{d}	2502^{ef}	70.0^{g}	20.0^{l}	1398.0^{j}
Osmo-24-3	80.7^{cd}	21.9^{h}	1765.0^{fg}	94.7^{abc}	35.2^{abc}	3330^{abc}	90.7^{b}	11.5^{m}	1039.0^{k}
Osmo-48-3	75.3^{ef}	27.0^{cde}	2034.0^{de}	92.0^{bcde}	28.8^{e}	2646^{e}	82.7^{de}	32.5^{cde}	2686.0^{cd}
Halo-6-1	64.7^{g}	24.9^{efg}	1608.0^{g}	94.7^{abc}	33.4^{cd}	**3166^{cd}**	91.3^{b}	38.9^{a}	**3202.0^{a}**
Halo-12-1	84.7^{abc}	32.1^{b}	**2719.0^{b}**	88.7^{def}	33.8^{bcd}	2993^{d}	91.3^{b}	32.8^{cd}	2994.0^{b}
Halo-18-1	67.3^{g}	24.3^{fgh}	1634.0^{g}	84.7^{fg}	30.4^{e}	2577^{e}	72.0^{g}	31.1^{def}	2237.0^{gh}
Halo-6-2	76.0^{def}	18.3^{i}	**1392.0^{h}**	88.0^{efg}	33.4^{cd}	**2941^{d}**	88.7_{bc}	24.3^{j}	**2154.0^{hi}**
Halo-12-2	56.0^{h}	15.9^{j}	892.8^{k}	84.0^{fg}	28.7^{e}	2411^{ef}	87.3_{bc}	23.3^{j}	2031.0^{i}
Halo-18-2	76.7^{def}	13.1^{k}	1003.0^{jk}	88.0^{efg}	25.6^{f}	2250^{fg}	61.3_{h}	18.5^{l}	1133.0^{k}
SM-24	86.0^{ab}	14.3^{jk}	1228.0^{hi}	91.3^{cde}	36.9^{a}	3367^{abc}	91.3_{b}	29.6^{fg}	**2698.0^{cd}**
SM-48	83.3^{abc}	28.2^{cd}	**2345.0^{c}**	96.7^{ab}	37.1^{a}	**3535^{a}**	86.0_{cd}	29.0^{gh}	2493.0^{ef}
SM-72	72.7^{ef}	15.6^{j}	1134.0^{ij}	83.3^{g}	25.4^{f}	2117^{g}	82.0_{ef}	31.4^{de}	2570.0^{de}

G- Germination, SV-Seedling Vigour, VI-Vigour Index (bold faced value treatments were selected for biochemical analyses and field performance)
Values are rounded off to nearest integer up to one place of decimal
Values superscripted with different letter in same column are significantly different at $P \le 0.05$ (DMRT)

RESULTS AND DISCUSSION

The cost of production, yield response (fruit and seed) and economic performance (Benefit cost ratio) of okra cultivars at various seed priming treatments are shown in tables 1 (A-C), 2(A-C), 3(A-C) and 4 (A-C) respectively.

Fruit Yield

Table 3 showed that maximum pod yield and BCR was recorded in Phule Utkarsha (200.84 q/ha; 2.91) when the seeds were primed in solid matrix (calcium aluminium silicate) for 48h. Similarly, seeds of cv. A-4 hydroprimed for 18h, exhibited maximum fruit yield and BCR (215.64 q/ha; 3.51) and higher fruit yield and BCR (145.88 q/ha; 2.38) were recorded when the seeds of VRO-6 were primed in 1per cent $CaCl_2$ for 6h.

Table 3: Pod yield response and economic performance of okra cultivars in relation to various seed priming techniques

Seed priming code	Common Cost (field inputs) (₹/ha)	Variable Cost (Priming agents) (₹/ha)	Total cost (₹/ha)	Pod yield (q/ha)	Gross income (₹/ha)	Net income (₹/ha)	Benefit-Cost ratio
Cv. A-4							
Control	88776.00	3200.00	91976.00	105.70^{e}	158550.00^{e}	66574.00^{e}	1.72^{e}
Hydro-18	88776.00	3200.00	91976.00	215.64^{a}	323460.00^{a}	231480.00^{a}	3.51^{a}
Osmo-48-1	88776.00	6688.00	95464.00	137.42^{c}	206130.00^{c}	110670.00^{c}	2.16^{c}
Halo-12-1	88776.00	3262.20	92038.20	124.74^{d}	187110.00^{d}	95072.00^{d}	2.03^{cd}
Halo-6-2	88776.00	3483.20	92259.20	153.33^{b}	230000.00^{b}	137740.00^{b}	2.49^{b}
SM-48	88776.00	14554.80	103330.90	133.19^{c}	199780.00^{c}	96454.00^{d}	1.93^{d}
cv. Phule Utkarsha							
Control	88776.00	3200.00	91976.00	141.65^{c}	212480.00^{c}	120500.00^{c}	2.31^{c}
Hydro-12	88776.00	3200.00	91976.00	152.22^{bc}	228330.00^{bc}	136350.00^{bc}	2.48^{bc}
Osmo-24-1	88776.00	6688.00	95464.00	162.79^{b}	244180.00^{b}	148720.00^{b}	2.56^{bc}
Halo-6-1	88776.00	3262.20	92038.20	162.79^{b}	244180.00^{b}	152150.00^{b}	2.65^{b}
Halo-6-2	88776.00	3483.20	92259.20	147.99^{bc}	221980.00^{bc}	129730.00^{bc}	2.40^{bc}
SM-48	88776.00	14554.80	103330.90	200.84^{a}	301260.00^{a}	197930.00^{a}	2.91^{a}
cv. VRO-6							
Control	88776.00	3200.00	91976.00	122.62^{b}	183930.00^{b}	91954.00^{b}	2.00^{b}
Hydro-6	88776.00	3200.00	91976.00	118.39^{b}	177580.00^{b}	85609.00^{bc}	1.93^{b}
Osmo-24-2	88776.00	8419.60	97195.60	107.82^{c}	161730.00^{c}	64534.00^{d}	1.66^{d}
Halo-6-1	88776.00	3262.20	92038.20	145.88^{a}	218820.00^{a}	12678.00^{a}	2.38^{a}
Halo-6-2	88776.00	3483.20	92259.20	114.16^{bc}	171240.00^{bc}	78981.00^{bc}	1.86^{bc}
SM-24	88776.00	14554.80	103330.90	120.51^{b}	180760.00^{b}	77434.00^{cd}	1.75^{cd}

Values are rounded off to nearest integer up to two places of decimal
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The data presented in Table 4, it can be clearly observed that the maximum seed yield and BCR were recorded in VRO-6 (43.55 q/ha); 6.53), Phule Utkarsha (52.64 q/ha) ; 7.50) and A-4 (63.06 q/ha); 9.47) when the seeds were haloprimed with 1 per cent $CaCl_2$ solution for 6h, matrix primed (calcium aluminium silicate) for 48h and hydroprimed for 18h, respectively. This study indicates that priming treatments are specific to different cultivars; no treatment is common to all. Our findings reveal that hydropriming for 18h for the cultivar A-4; SM priming with calcium aluminium silicate for 48h in Phule Utkarsha and osmopriming with 1 per cent $CaCl_2$ for VRO-6 resulted in the best yield and proved to be economically beneficial with maximum benefit cost ratio. These are in line with the findings of Raza *et al.* (2013) who reported that hydropriming of okra seeds impressively improved growth, pigments and yield characters under normal and stress environment. Harris *et al.* (1999) also found that hydropriming enhanced maturity and higher yields in rice, maize and chickpea. According to Hegazi (2014) plant growth, seed yield and seed quality of okra could be improved by soaking okra seeds for 24h in water (hydropriming). Ogbuehi *et al.* (2013) observed hydropriming for 24h, a simple, low cost and environmentally friendly technique for improving seedling growth and yield of bambara groundnut. Harris *et al.* (2002) reported that 24h hydroprimed seeds of maize resulted in high photosynthetic activities leading to high yield. Matriconditioning with compost resulted in higher grain yield in hybrid maize (Afzal *et al.* 2002). The present results are in accordance with the observation of Bennet and Waters (1987) who reported higher grain yield in matriconditioned seeds of shunken-2 sweet corn. Pandita *et al.* (2010) also reported that final marketable pod yield of okra under sub-optimal temperature was improved by SMP alone or in combination with Trichoderma viride, but not under optimal temperatures. Rehman *et al.* (2015) reported that seeds of spring maize when osmoprimed with 2.2 per cent $CaCl_2$ showed an improvement in grain yield, biological yield and harvest index and attained a higher income and benefit-cost ratio. Farooq *et al.* (2006) also reported that osmohardening with CaCl2 improved germination and emergence in rice, while Rehman *et al.* (2011) reported better stand establishment and higher seedling vigor and yield in direct-seeded rice owing to osmopriming with $CaCl_2$. Khan *et al.* (2015) reported that osmopriming with $CaCl_2$ (-1.25 MPa) proved its supremacy for achieving maximum net income and benefit cost ratio (BCR) in hybrid maize production. Our results are in line with Aseefa and Hunje (2010) who reported 20.73 per cent increment in seed yield per hectare in soybean seeds when primed with $CaCl_2.2H_2O$.

Table 4: Seed yield response and economic performance of okra cultivars in relation to various seed priming techniques

Seed priming code	Common cost (field inputs) (₹/ha)	Variable cost (Priming agents) (₹/ha)	Total cost (₹/ha)	Seed yield (q/ha)	Gross income (₹/ha)	Net income (₹/ha)	Benefit-Cost ratio
cv. A-4							
Control	96676.00	3200.00	99876.00	30.66^{e}	459900.00^{e}	360000.00^{e}	4.60^{e}
Hydro-18	96676.00	3200.00	99876.00	63.06^{a}	946000.00^{a}	846100.00^{a}	9.47^{a}
Osmo-48-1	96676.00	6688.00	103364.00	35.94^{c}	539100.00^{c}	435700.00^{c}	5.21^{c}
Halo-12-1	96676.00	3262.20	99938.20	34.67^{d}	520100.00^{d}	420100.00^{d}	5.20^{c}
Halo-6-2	96676.00	3483.20	100159.20	50.10^{b}	751500.00^{b}	651300.00^{b}	7.50^{b}
SM-48	96676.00	14554.80	111230.90	36.15^{c}	542200.00^{c}	441500.00^{c}	4.87^{d}
cv. Phule Utkarsha							
Control	96676.00	3200.00	99876.00	31.50^{d}	472500.00^{d}	372600.00^{d}	4.73^{d}
Hydro-12	96676.00	3200.00	99876.00	32.98^{cd}	494700.00^{cd}	394800.00^{cd}	4.95^{cd}
Osmo-24-1	96676.00	6688.00	103364.00	42.71^{b}	640700.00^{b}	537300.00^{b}	6.19^{b}
Halo-6-1	96676.00	3262.20	99938.20	41.65^{b}	624800.00^{b}	524800.00^{b}	6.25^{b}
Halo-6-2	96676.00	3483.20	100159.20	36.15^{c}	542300.00^{c}	442100.00^{c}	5.41^{c}
SM-48	96676.00	14554.80	111230.90	52.64^{a}	789600.00^{a}	688800.00^{a}	7.50^{a}
cv. VRO-6							
Control	96676.00	3200.00	99876.00	31.92^{b}	478800.00^{b}	378900.00^{b}	4.79^{bc}
Hydro-6	96676.00	3200.00	99876.00	33.40^{b}	501000.00^{b}	401100.00^{b}	5.02^{b}
Osmo-24-2	96676.00	8419.60	105095.60	31.29^{b}	469400.00^{b}	364300.00^{b}	4.46^{c}
Halo-6-1	96676.00	3262.20	99938.20	43.55^{a}	653200.00^{a}	553300.00^{a}	6.53^{a}
Halo-6-2	96676.00	3483.20	100159.20	31.29^{b}	469400.00^{b}	369200.00^{b}	4.68^{bc}
SM-24	96676.00	14554.80	111230.90	33.19^{b}	497800.00^{b}	397100.00^{b}	4.47^{c}

Values are rounded off to nearest integer up to two places of decimal
Values superscripted with different letter in same column are significantly different at $P \leq 0.05$ (DMRT)

Table 5: Cost of production of okra fruit and seed yield of primed seeds of okra cultivars

Operations	Frequency	Rate/ha	Cost (₹/ha)	Remarks
Land rental value	-	₹40000/ha/annum	20000.00	(for 6 month of cropping season)
Field preparation				
Harrowing	Two times	₹1250/ha	2500.00	-
Bunding for pre-sowing Irrigation	Once	₹. 750/ha	750.00	-
Pre-sowing irrigation	Once	₹1000/ha	1000.00	(Time : 20h/ha; Rate : ₹ 50/h)
Cultivation with patta	Once	₹750/ha	750.00	-
Manures and fertilizers				
FYM	Once	₹300/ton	6000.00	(FYM @20 ton/ha)
Transportation of FYM including labour	Once	₹150/ton	3000.00	(FYM @20 ton/ha)
Fertilizers				N: P:K (100:60:60) per hectare Cost:
Urea (46% N)	Once	166.36 kg /ha	₹ 891.69	Urea (@₹ 536/q)
DAP (18% N; 46% P)	Once	130.43kg /ha	₹ 2934.68	DAP(@₹ 2250/q)
MOP (50% K)	Once	120 kg /ha	₹2400.00	MOP@₹ 2000/q) Nitrogen obtained from DAP = 23.47 Kg Nitrogen obtained from Urea =(100-23.47) =76.53Kg N

Broad casting of Chemical fertilizers	Once	2 labourers	₹600.00	@₹300 per man labourer
DAP+ MOP (at sowing time) Urea in three split dozes	Twice	4 labourers	₹1200.00	
Row sowing	Once	8 labourers	₹ 2400.00	-
Weedicide application (stomp 30 EC)	Once	2.5 litre/ ha	₹ 1200.00	Cost : ₹ 480/litre
		4 labourers	₹ 1200.00	(01 sprays @ ₹ 300/labourer)
Hand hoeing	Twice	a) 24 labourers b) 12 labourers	₹ 7200.00 ₹ 3600.00	
Irrigation				Cost of water : ₹ 50/hour
Water	8 irrigations	160 hours	₹ 8000.00	(8 irrigations (@20hour/ha)
Labour		16 labourers	₹. 4800.00	20x8=160 hours during the whole crop season
Plant Protection				Cost : ₹ 760/litre
Insecticide spray (jassids & whitefly)	4 sprays	1.25litres	₹ 950.00	
Labour charges		10 labourers	₹ 3000.00	
Picking green pod				4 woman labourers per picking (₹ 250/women labourers)
Green pod (10 women labour per picking)	8 pickings	32 woman labourers	₹ 8000.00	
Sorting/grading				
Local Transportation	8 times	16 woman labourers	₹ 4000.00	2 woman labourers per grading
	8 times	Rs.300/trip	₹ 2400.00	
Total expenditure-A (fixed)			**₹ 88776.37**	
Picking mature pod for seed	4 pickings	16 women labourers	₹ 4000.00	4 woman labourers per picking
Threshing /cleaning (manual)	Once	12 labourers	₹ 3600.00	
Transportation (local)	Once	One trip	₹ 300.00	₹ 300/trip
Total expenditure-B (fixed)			**₹7900.00**	
Grand total (A+B)			**₹96676.37**	

Table 6. Variable cost of priming seed treatment of okra cultivars

Treatment	Quantity Seed per hectare (Kg)	Cost of seed per hectare (₹)	Priming agent	Quantity of priming agent per hactare	Cost of priming agent per hectare (₹)	Total Cost (Cost of seed + cost of priming agents) ₹.	Remarks	
							Chemical	Cost
cv. A-4							$CaCl_2$ (SD Fine, 2014-15, Code no. 37585 K10 pp.35)	₹ 311/1000g
Control	8.00	3200.00	control	-	0.00	3200.00		
Hydro-18	8.00	3200.00	water	20 L	0.00	3200.00		
Osmo-48-1	8.00	3200.00	Polyethylene glycol	2700 g	3488.40	6188.40	KNO_3 (SD Fine, 2014-15, Code no. 20214 K05 pp.135)	₹ 354/500g
Halo-12-1	8.00	3200.00	Calcium chloride	200 g	62.20	3262.20		
Halo-6-2	8.00	3200.00	Potassium nitrate	400 g	283.20	3483.20	PEG (SD Fine, 2013-14, Code no. 39573 L05 pp.131)	₹ 646/500g
SM-48	8.00	3200.00	Calcium aluminium silicate	3200 g	11354.88	14554.88		
cv. Phule Utkarsha							Calcium aluminium silicate/ molecular sieve 4 A pure (Fisher Scientific, 2013-14)	₹ 8871/ 2.5Kg
Control	8.00	3200.00	control	-	0.00	3200.00		
Hydro-12	8.00	3200.00	water	20 L	0.00	3200.00		
Osmo-24-1	8.00	3200.00	Polyethylene glycol	2700 g	3488.40	6188.40		
Halo-6-1	8.00	3200.00	Calcium chloride	200 g	62.20	3262.20		
Halo-6-2	8.00	3200.00	Potassium nitrate	400 g	283.20	3483.20		
SM-48	8.00	3200.00	Calcium aluminium silicate	3200 g	11354.88	14554.88		

cv. VRO-6						
Control	8.00	3200.00	water	20 L	0.00	3200.00
Hydro-6	8.00	3200.00	Polyethylene glycol	4040 g	5219.68	8419.68
Osmo-24-2	8.00	3200.00	Calcium chloride	200 g	62.20	3262.20
Halo-6-1	8.00	3200.00	Potassium nitrate	400 g	283.20	3483.20
Halo-6-2	8.00	3200.00	Calcium aluminium silicate	3200 g	11354.88	14554.88

CONCLUSION

The economic analysis revealed that fruit and seed production of okra was renumerative on the economic indicators tested in these analyses-net return and BCR indicating promising results for seed priming treatments with certain concentration and durations specific to okra cultivars. SM priming with calcium aluminium silicate (1:0.4:1; seed: SM: water) for 48h for cv. Phule Utkarsha, 1% CaCl2 for 6h for cv. VRO-6 and hydropriming for 18h for cv. A-4 are the most economic and beneficial treatments.

Although, there are many reports on the positive effects of priming on seed or grain yield in various crops, the studies pertaining to economics of priming are limited. The present study would facilitate the okra growers to adopt the suitable and most profitable priming methods for attaining maximum benefits in these cultivars.

Hydropriming is a simple technique which even the marginal and small farmers can practice without much difficulty since it involves only soaking of seeds in water for a certain duration. But a training to the farmers through scientific participatory efforts would help the farmers in treating the seeds using other priming agents.

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