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Full Length Research Paper

Response of germination, growth and yield of okra (*Abelmoschus esculentus*) to seed priming duration and p-sources in Northwest Pakistan

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An experiment was conducted at Horticulture Research Farm, KPK Agricultural University Peshawar during summer 2008 to evaluate the response of okra to phosphorus sources and soaking durations. The experiment was laid down in randomized block design with three replications. Four priming sources that is, distilled water, Diammonium phosphate (DAP), single super phosphate (SSP), SSP + Na_2CO_3 and 4 h durations up to 48 h seed soaking along with un-primed seed were studied. The results indicated that higher germination percentage (85.94%), survival percentage (94.05%), plant height (138.97 cm), number of leaves (26.69), pods (31.01) and seeds pod^{-1} (49.52), pod length (10.99 cm), pod yield (2702.69 kg ha^{-1}), early emergence (7.79) and flowering (33.65) was observed in plots in which seed soaked with SSP solution was used. The highest plant weight (433.36 g) was observed in plots in which seed soaked with DAP was used. Mean values of interactions result showed that the highest number of leaves (36.13) and pods plant^{-1} (45.26), and pod yield (5063.53 kg ha^{-1}) was produced in plots in which seeds were soaked for 24 h in SSP solution. Lengthy pods (12.60 cm) was noted with seeds soaked for 24 h in DAP solution. Number of seeds pod^{-1} (63.06) reached maximum when seeds were soaked for 20 h in SSP solution. The SSP solution performed best in most of the parameters while distilled water showed poor performance. It is concluded from the experiment that soaking okra seeds with SSP solution for 24 h could improve germination, stand establishment, growth and yield of okra in the study area.

Key words: Phosphorus sources, soaking duration, germination, yield, okra.

INTRODUCTION

Okra (*Abelmoschus esculentus*) belongs to Family Malvaceae. Okra originated in tropical Africa was grown in the Mediterranean region, 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. It is a good source of Vitamins A, B and C, and is also rich in protein, minerals and iodine. When ripe, the black or brown white-eyed seeds are sometimes roasted and used as a substitute for coffee. The stem of the okra plant provides fiber which is used in paper industry (Qayyum, 1990). The concept of priming is often familiar to farmers but generally they have primed only to catch up after better sowing conditions have passed or for gap filling. For example, priming is recommended practice but was not widely adopted. The farmers reported that they have primed seed in the past and they used it to gap-fill sowing conditions in perceived dry years. In recent years, the use of priming has grown following participatory methods in India, Pakistan and Bangladesh (Harris et al., 1999; Asgedom et al., 2001). The function of phosphorus in plant is that it gives important role in energy transfer and storage. Plant needs it during the rapid growth. Phosphorus is a structural component of macromolecules such as the nucleic acid (DNA and RNA) and ATP. Phosphorus is associated with root growth and root health, increase tolerance to root-rot disease, increase fruit quality, creates disease resistance, stimulates growth and gives early maturity.

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Table 1. Chemical characteristics of experimental field.

Electric conductivity	Organic matter	Nitrogen	P_2O_5	K_2O	PH
73.13 µs /cm	17.26%	1.03 mg L^{-1}	0.095 mg L^{-1}	71.26 mg L^{-1}	8.5

MATERIALS AND METHODS

An experiment to evaluate the "response of phosphorus sources and soaking durations on yield and yield component of okra seed" was conducted in Malakander Farm in summer 2008. In this experiment the okra seed (cv. Sabaz Pari) were primed in phosphorus solution.

Soil analysis

Before sowing of seeds soil samples up to 25 cm depth were taken randomly from different parts of the experimental field and analyzed in the soil science laboratory at Agricultural University Peshawar, Pakistan for different chemical characteristics (Table 1).

Experimental design

The experiment was laid in randomized block design (RBD) in split plot arrangement. There were two factors studied in this experiment.

Factor A: The following sources for seed soaking were kept in the main plot.

(1) Distilled water. (2) Diammonium Phosphate (DAP) solution. (3) Single super phosphate (SSP) solution (4) SSP + Na_2CO_3 solution.

Factor B: The soaking durations, with 4 h interval were kept in sub plots.

Soaking periods were from 0 to 48 h with 4 h intervals that is, (0, 4, 8, 12, 16, 20, 24, 28, 32, 36, 40, 44 and 48). There were 52 treatments and each was replicated 3 times to minimize the experimental error. The experimental data on the following parameters were studied during the course of study.

Germination percentage

The germination percentage was calculated by the following formulae:

$$\text{Germination percentage} = \frac{\text{Number of total germinated seeds}}{\text{Number of total seeds sown}} \times 100$$

Number of days to emergence

The data was recorded on the basis of number of days required from sowing to emergence and mean was computed.

Number of days to first flowering

Number of days to the first flowering was recorded by counting the number of day of sowing up to flowering in 50% of the sampled plants in each replication.

Plant height (cm)

The plant height of 15 randomly selected plants was recorded in each treatment from ground level to the tip of plants by mean of meter rod and average height of plant was calculated.

Number of pod plant^{-1}

The number of pod per plant were selected at random in each sub plot and tagged. The total number of pods obtained from selected plants was divided by randomly selected plant to get the average number of pods per plant.

Pod yield (kg ha^{-1})

The pod yield of subplot was recorded and the yield was computed using the following formula:

$$\text{Yield kg.ha}^{-1} = \frac{\text{Yield per sub plot (kg)}}{\text{Area of sub plot (m}^2\text{)}} \times 10000\ m^2$$

RESULTS AND DISCUSSION

Germination percentage

The data pertaining to germination percentage are presented in Table 2. According to statistical analysis of variance data showed that soaking of seeds with different sources of phosphate solutions and various soaking durations had a significant effect on germination percentage while their interaction had no significant effect on germination percentage. According to the mean values of the experimental results maximum (85.94%) germination percentage was recorded in plot in which seeds were soaked in SSP solution followed by (85.17%) germination percentage in plot in which seeds were soaked in DAP solution while minimum (81.58%) germination percentage was recorded in distilled water seed soaked plot. While results of various soaking durations showed that maximum germination percentage (91.57%) was recorded in plot in which seeds were soaked for 24 h followed by (89.83%) germination percentage in plot in which seeds were soaked for 20 h while minimum (75.83%) germination percentage was recorded in 48 h soaked seeds plot. However, in their interaction maximum (93.11%) germination percentage in plot in which seeds were soaked for 24 h in SSP solution followed by (91.59%) germination percentage in plot in

Table 2. Germination percentage (%) as affected by priming of okra with different sources at various soaking durations.

Soaking durations (h)	Sources				
	Distilled water	DAP	SSP	SSP +Na_2CO_3	Mean
0	77.86	79.29	79.31	77.59	78.51 F
4	80.70	79.85	81.03	81.10	80.67 EF
8	81.03	85.94	87.05	82.05	84.02 D
12	81.61	87.39	88.74	87.80	86.39 C
16	84.63	88.64	89.31	89.44	88.00 BC
20	87.73	90.47	91.47	89.66	89.83 AB
24	90.56	91.59	93.11	91.04	91.57 A
28	86.14	87.15	89.52	86.65	87.36 C
32	84.53	87.05	86.81	84.39	85.69 CD
36	82.21	84.53	86.16	83.08	83.99 D
40	79.29	84.00	82.76	77.59	80.91 E
44	77.31	81.97	81.03	76.04	79.09 EF
48	68.97	79.31	80.90	74.14	75.83 G
Mean	81.58 C	85.17 AB	85.94 A	83.12 BC	

LSD value for different sources = 2.080, LSD value for various soaking durations = 2.327, Means followed by the same letter are not significantly different using LSD test at 5% level of probability, Dist. water: Distilled water, DAP : Diammonium phosphate, SSP : Single super phosphate, SSP + Na_2CO_3: Single super phosphate + Sodium bicarbonate.

which seeds were soaked for 24 h in DAP solution and minimum (68.97%) germination percentage was recorded in plot in which seed were soaked for 48 h in distilled water seed soaked plot. The observed improvements were attributed to priming-induced quantitative changes in biochemical content of the seeds and membrane integrity and to enhanced physiological activities during seed germination. These findings are in agreement with the work of Ullah et al. (2002a) who reported benefical effects on emergence rate of seed treated with micronutrient. And also Rashid et al. (2004) reported that “On-farm” seed priming has been shown effective in producing earlier emergence, germination and increased yields in a range of crops in many diverse environments. Likewise Kurdikeri et al. (1995) recorded similar results due to maize seed priming in 2.5% solution of KH_2PO_4.

Number of days to emergence

The data regarding number of day to emergence are presented in Table 3. Statistical analysis revealed that the soaking of seeds with different sources of phosphate solutions and various soaking durations had a significant effect on number of days to emergence while their interaction had no significant effect on number of day to emergence. The mean values indicate that maximum (8.78) (number of days may be restricted to two digit) days to emergence were recorded in plots in which seed were soaked in distilled water, followed by (8.38) days to emergence taken by plot in which seeds were soaked in SSP+Na_2CO_3 solution and minimum numbers of days (7.80) were taken by plots in which seeds were soaked in SSP solution. While results of various soaking durations showed that maximum number of days to emergence (9.88) was recorded in un-primed seed plot followed by (9.53) number of days to emergence was recorded in plot in which seeds were soaked for 48 h while minimum number of days to emergence (6.65) was recorded in 24 h soaked seeds plot. However, in their interaction maximum days (10.97) to emergence were recorded in un-primed seed plot followed by (10.13) days to emergence taken by plot in which seed were soaked for 48 h in distilled water while minimum (6.13) days to emergence were taken by plot in which seeds were soaked for 24 h in SSP solution. Emergence is a key component for the success of crops. For adequate emergence, proper amount of water, oxygen, temperature and types of soil etc are essential. Besides, these external factors, the viability of the seeds play a key role in the emergence. These results are in agreement with work of Arif et al. (2005) who reported that the probable reason for early emergence of the water primed seeds may be the completion of pre-germinative metabolic activities during priming process, making the seed ready for radical emergence and the seeds germinated soon after planting compared with untreated dry seeds. Similarly Bradford (1990) recorded that when seed imbibe, water contents reaches a plateau and changes little until radical emerge. These results are also in line with work of Brocklehurst et al. (1987) and Harris et al. (2001) who reported faster emergence of primed seed.

Number of days to first flowering

The data indicating number of days to first flowering are

Table 3. Number of days to emergence as affected by Priming of Okra with different sources at various soaking durations.

Soaking durations (h)	Sources				
	Distilled water	DAP	SSP	$SSP+Na_2CO_3$	Mean
0	10.97	9.70	9.73	9.13	9.88 A
4	8.50	7.98	7.70	8.20	8.10 EF
8	8.17	7.53	7.53	7.90	7.78 FG
12	7.82	6.97	6.87	7.77	7.35 GH
16	7.70	6.72	6.47	7.60	7.12 HI
20	7.40	6.40	6.20	7.37	6.84 I
24	7.10	6.23	6.13	7.13	6.65 I
28	8.83	7.80	7.53	8.50	8.20 EF
32	8.84	8.03	8.03	8.67	8.39 DE
36	9.17	8.57	8.45	8.83	8.753 CD
40	9.58	8.97	8.54	9.23	9.10 BC
44	9.97	9.13	8.97	9.35	9.35 B
48	10.13	9.52	8.97	9.48	9.53 AB
Mean	8.78 A	7.97 BC	7.78 C	8.38 B	

LSD value for different sources = 0.2453, LSD value for various soaking durations = 0.4876, Means followed by the same letter are not significantly different using LSD test at 5% level of probability.

Table 4. Number of days to first flowering as affected by priming of okra with different sources at various soaking durations.

Soaking durations (h)	Sources				
	Distilled water	DAP	SSP	$SSP+Na_2CO_3$	Mean
0	44.76	45.93	43.60	45.41	44.93 A
4	38.05	35.87	35.90	39.80	37.40 D
8	38.82	34.41	33.63	36.81	35.92 E
12	35.10	32.08	30.55	34.78	33.13 G
16	32.07	30.75	29.04	32.55	31.10 H
20	31.55	29.60	28.20	31.61	30.24 HI
24	30.12	28.87	27.73	30.55	29.32 I
28	35.98	31.85	29.77	33.76	32.84 G
32	35.86	32.65	32.40	36.47	34.35 F
36	37.47	34.83	34.47	37.03	35.95 E
40	38.05	35.87	35.90	39.80	37.40 D
44	41.06	37.43	37.55	40.88	39.23 C
48	41.78	40.19	38.72	41.61	40.57 B
Mean	36.97 A	34.64 B	33.65 B	36.66 A	

LSD value for different sources = 1.565, LSD value for various soaking durations = 1.065, Means followed by the same letter are not significantly different using LSD test at 5% level of probability.

presented in Table 4. Statistical analysis revealed that number of days to first flowering was significantly affected by soaking of seeds with different sources of phosphate solutions and various soaking durations, while their interaction had no significant effect on number of day to first flowering. According to the mean values of the experimental results maximum (36.97) days to first flowering were recorded in plots in which seed were soaked in distilled water seed soaked plot, followed by (36.66) days to first flowering taken by plot in which seeds were soaked in $SSP+Na_2CO_3$ solution and minimum (33.65) days to first flowering were taken by plots in which seeds were soaked in SSP solution, While results of various soaking durations showed that maximum (44.93) days to first flowering was recorded in un-primed seed plot followed by (40.57) number of days to first flowering was recorded in plot in which seeds were soaked for 48 h, while minimum number of days to first flowering (29.32) was recorded in 24 h soaked seeds plot. And in their interaction maximum days (45.93) to

Table 5. Plant height (cm) as affected by priming of okra with different sources at various soaking durations.

Soaking durations (h)	Sources				
	Distilled water	DAP	SSP	SSP+Na_2CO_3	Mean
0	108.46	115.47	120.43	110.90	113.81 G
4	118.66	125.24	126.17	122.70	123.20 EF
8	119.97	127.07	135.15	125.90	127.02 DE
12	121.73	134.30	136.47	135.77	132.07 D
16	134.43	141.87	149.98	142.60	142.22 C
20	136.57	160.03	163.77	151.07	152.86 B
24	140.13	172.27	168.10	163.80	161.08 A
28	141.73	134.10	159.87	130.97	141.67 C
32	120.26	130.57	144.10	128.73	130.92 D
36	118.26	127.33	133.20	127.63	126.60 E
40	116.66	125.24	127.17	122.97	123.01 EF
44	113.12	120.37	124.40	119.50	119.35 FG
48	116.68	122.03	117.90	112.70	117.33 FG
Mean	123.58 C	133.53 AB	138.97 A	130.40 B	

LSD value for different sources = 6.675, LSD value for various soaking durations = 6.871, Means followed by the same letter are not significantly different using LSD test at 5% level of probability.

first flowering were recorded in un-primed seed plot followed by (45.41) days to first flowering were recorded in un-primed seed plot, while minimum (27.73) days to first flowering were taken by plot in which were soaked for 24 h in SSP solution. Days to flowering are generally used as a measure of maturity period. Days to flowering character is highly correlated with physiological maturity. It is considered as the termination of vegetative cycle and start of reproductive cycle. Chemicals break the dormancy of the seeds. Growth harmones are released and the growth rate may become much faster than normal. Similar results are also reported by Harris et al. (2001) who reported that primed crop emerges fast, flower earlier and give higher yield. Mauromicale et al. (2000) evaluated seed osmopriming as a mean to improve early flowering, maturity time and yield of summer squash (*Cucurbita pepo* L.) He also reported that plants from primed seed exhibited advances of 2.5 to 7.5 days in anthesis of first female flower.

Plant height (cm)

The data pertaining to plant height are presented in Table 5. According to statistical analysis of variance data showed that soaking of seeds with different sources of phosphate solutions and various soaking durations had a significant effect on plant height and their interaction had no significant effect on plant height. According to the mean values of experimental results maximum plant height (138.97 cm) was recorded in plot in which the seeds were soaked in SSP solution followed by (133.53 cm) plant height in plot in which the seeds were soaked in DAP solution while minimum plant height (123.58 cm) was recorded in distilled water plot, while results of various soaking durations revealed that maximum plant height (161.08 cm) was recorded in plot in which the seeds were soaked for 24 h followed by (152.86 cm) plant height in plot in which the seeds were soaked for 20 h while minimum plant height (113.81 cm) was recorded in control plot. While the interaction result show that maximum plant height (172.27 cm) was recorded in plot in which seeds were soaked for 24 h in DAP solution followed by (168.10 cm) plant height in plot in which seeds were soaked for 24 h in SSP solution and minimum plant height (108.46 cm) was recorded in un-primed seed plot. Plant height is a function of the genetic as well as the enviormental condition. It is considered as expression of its full vegetative potential and reproductive cycle. The enhanced plant height in primed seed plots may be due to improved and faster emergence in primed seed plots which created cooperative competition among the plants for light, water and nutrients and resulted in taller plants. Probable reason could be that priming might have increased seedling vigour which had enhanced the competitiveness for light, water and nutrients. The results are in agreement with the work of Rashid et al. (2002) who reported that seed priming has been shown to improve plant stands. Asgedom and Beaker (2001) also reported that Zn primed seeds showed higher vigour than unprimed seed as reflected in maximum plant height.

Number of pod plant^{-1}

The data pertaining to number of pods per plant are presented in Table 6. According to statistical analysis of variance data showed that soaking of seeds with different

Table 6. Number of pods per plant as affected by priming of okra with different sources at various soaking durations.

Soaking durations (h)	Sources				
	Distilled water	DAP	SSP	SSP+Na_2CO_3	Mean
0	19.97^{xyz}	19.18^{yz}	20.11^{xyz}	20.77^{xyz}	20.01^{I}
4	21.39^{v-y}	31.14^{ijk}	31.56^{ijk}	27.78^{l-p}	27.97^{E}
8	22.33^{u-x}	32.01^{hij}	$32.53g^{hi}$	29.78^{j-m}	29.16^{E}
12	28.45^{lmn}	34.01^{e-n}	$35.18d^{ef}$	32.87^{f-i}	32.63^{D}
16	29.85^{jkl}	36.19^{cde}	37.04^{cd}	32.87^{f-i}	33.99^{C}
20	31.94^{hij}	38.44^{c}	42.46^{b}	34.53^{efg}	36.84^{B}
24	33.17^{f-i}	43.06^{ab}	45.26^{a}	36.08^{cde}	39.39^{A}
28	27.37^{m-q}	29.24^{klm}	$31.56i^{jk}$	27.54^{l-q}	28.93^{E}
32	26.02^{o-s}	26.03^{n-s}	28.02^{l-o}	25.20^{q-t}	26.32^{F}
36	23.50^{t-w}	26.01^{o-s}	28.02^{l-o}	25.18^{q-t}	25.68^{F}
40	20.47^{xyz}	25.42^{p-t}	26.34^{n-r}	23.94r-u	24.04^{G}
44	20.20^{xyz}	21.21^{w-z}	23.53^{t-w}	23.80^{s-v}	22.18^{H}
48	18.83^{z}	17.45^{z}	21.47^{v-y}	19.37^{yz}	19.28^{I}
Mean	24.88^{C}	29.18^{AB}	31.01^{A}	27.67^{BC}	

LSD value for different sources = 2.987, LSD value for various soaking durations = 1.213, LSD value for interaction = 2.247, Means followed by the same letter are not significantly different using LSD test at 5% level of probability.

sources of phosphate solutions, various soaking durations and their interaction had a significant effect on number of pods per plant. According to the mean values of the experimental results maximum (31.01) pods per plant was recorded in plot in which seeds were soaked in SSP solution followed by (29.18) number of pods per plant in plot in which seeds were soaked in DAP solution while minimum (24.88) pods per plant was recorded in distilled water, while results of various soaking durations showed that maximum number of pods per plant (39.39) was recorded in plot in which seeds were soaked for 24 h followed by (36.84) number of pods per plant in plot in which seeds were soaked for 20 h while minimum number of pods per plant (19.28) was recorded in plot in which seeds were soaked for 48 h. While in their interaction maximum (45.26) pods per plant was recorded in plot in which seeds were soaked for 24 h in SSP solution followed by (43.06) number of pods per plant in plot in which seeds were soaked for 24 h in DAP solution and minimum number of pods per plant (17.45) was recorded in plot in which seeds were soaked for 48 h in DAP solution. Numbers of pods per plant is a major component which determines the final yield. Numbers of pod has direct relationship with number of leaves. When the number of leaves increases there will be incresase in number of pods also.The Ullah et al. (2002b) reported same kind of results that priming increases yield parameters such as number of primary branches per plant, no. of pods per plant. The probable reason for increase in pods might be due to improved emergence and better seedling growth as endorsed by several researchers (Harris et al., 1999, 2001).

Pod yield (kg ha^{-1})

The data pertaining to pod yield per hectare are presented in Table 7. According to statistical analysis of variance data showed that soaking of seeds with different sources of phosphate solutions, various soaking durations and their interaction had a significant effect on pod yield per hectare. According to the mean values of the experimental results maximum pod yield per hectare (2702.69 kg) was recorded in plot in which seeds were soaked in SSP solution followed by (2688.35 kg) yield per hectare in plot in which seeds were soaked in DAP solution while minimum pod yield per hectare (2293.69 kg) was recorded in plot in which seeds were soaked in distilled water. While results of various soaking durations showed that maximum pod yield per hectare (4511.52 kg) was recorded in plot in which seeds were soaked for 24 h followed by (3761.33 kg) pod yield per hectare in plot in which seeds were soaked for 20 h while minimum pod yield per hectare (1411.50 kg) was recorded in plot in which seeds were soaked for 48 h. And in their interaction maximum pod yield per hectare (5063.53 kg) was recorded in plot in which seeds were soaked for 24 h in SSP solution followed by (4840.63 kg) pod yield per hectare in seed soaked for 24 h in DAP solution and minimum pod yield per hectare (1274.39 kg) was recorded in plot in which seeds were soaked for 48 h in SSP+Na_2CO_3 solution. 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 as

Table 7. Pod yield (kg ha^{-1}) as affected by Priming of Okra with different sources at various soaking durations.

Soaking durations (h)	Sources				
	Distilled water	DAP	SSP	$SSP+Na_2CO_3$	Mean
0	1507.58^{r-w}	1620.41^{q-u}	1756.51^{p-s}	1349.12^{vw}	1558.40^{H}
4	2248.03^{klm}	1647.46^{q-t}	1930.77^{nop}	2492.23^{jkl}	2079.62^{F}
8	2631.19^{j}	2593.65^{j}	2956.70^{i}	2558.48^{j}	2685.01^{D}
12	3026.28^{i}	3306.70^{gh}	3479.08^{efg}	3513.20^{efg}	3331.32^{C}
16	3089.22^{hi}	3472.62^{efg}	3437.39^{efg}	3650.37^{de}	3412.40^{C}
20	3373.74^{fg}	3865.95^{cd}	3883.13^{cd}	3922.49^{c}	3761.33^{B}
24	3615.69^{def}	4840.63^{a}	5063.53^{a}	4526.23^{b}	4511.52^{A}
28	2236.66^{lm}	3005.15^{i}	3010.55^{i}	2561.3^{j}	2703.42^{D}
32	1837.83^{opq}	3068.55^{hi}	2668.99^{j}	2514.17^{jk}	2522.39^{E}
36	1765.86^{pqr}	2531.93^{j}	2085.08^{mno}	2146.15^{mn}	2132.26^{F}
40	1627.87^{q-u}	2466.23^{jkl}	1753.08^{p-s}	1873.22^{opq}	1930.10^{G}
44	1491.56^{s-w}	1481.53^{t-w}	1652.78^{q-t}	1640.11^{q-t}	1566.50^{H}
48	1366.45^{uvw}	1547.76^{r-v}	1457.42^{t-w}	1274.39^{w}	1411.50^{I}
Mean	2293.69^{B}	2688.35^{A}	2702.69^{A}	2617.04^{A}	

LSD value for different sources = 313.0, LSD value for various soaking durations = 134.1, LSD value for interaction = 268.1, Means followed by the same letter are not significantly different using LSD test at 5% level of probability.

reported by Zhang et al. (1998). The improved yield of primed seeds plots may be due to uniform and improved germination, vigorous seedling growth, well developed root system and efficient subsequent growth which ultimately led to higher grain yield reported by Harris et al. (2001). These results endorse the findings of Basra et al. (2003) who reported that priming treatment significantly increased total biomass and plant weight as compared with control.

Conclusions

It has been concluded from the research work that phosphorus seed priming resulted in early germination and produces more yield than un-primed seed. Seed priming using both SSP and DAP solutions perform almost equal and better than other sources. Seed priming using both SSP and DAP solutions for 24 h improved plant weight, plant height, number of pods per plant and increased the yield per hectare.Seed soaking upto 24 h perform better than beyond 24 h as performance get poorer with increasing soaking period after 24 h. On the basis of conclusions, these recommendations were made: (1) Seed priming using SSP and DAP solution may be used as a tool for boost in early germination, rapid seedling height and higher pod yield, (2) Okra seed priming in SSP fertilizer solution can be recommended to farmers because of its easy and cheaper availability as compared to DAP, (3) Seed should be soaked for low time interval upto 24 h, and (4) Further research is considered necessary to study the effect of seed priming on yield and yield component.

REFERENCES

Arif M, Ali S, Shah A, Javeed N, Rashid A (2005). Seed priming maize for improving emergence and seeding growth. Sarhad J. Agric., 21(4): 539-543.

Asgedom H, Becker M (2001). Effects of seed priming with nutrient solutions on germination, seedling growth and weed competitiveness of cereals in Eritrea. In Proc. Deutscher Tropentag, Univ. of Bonn and ATSAF, Margraf Pub. Press, Weickersheim, p. 282.

Basra SM A, Ullah E, Warraich EA, Cheema MA, Afzal I (2003). Effect of storage on growth and yield of primed canola (*Brassica napus* L) seeds. Int. J. Agric. Biol., pp. 117-120.

Bradford KJ (1990). A water relation analysis of seed germination rates. Plant Physiol., 94: 840-849.

Brocklehurst PA, Dearman J, Drew RLK (1987). Recent developments in osmotic treatment of vegetable seeds. Acta Hort., 215: 193-201.

Harris D, Joshi A, Khan PA, Gothkar P, Sodhi PS (1999). On farm seed priming in semi arid agriculture: Development and evaluation in maize, rice and chickpea in India using participatory methods. Exp. Agric., 35: 15-29.

Harris D, Pathan AK, Gothkar P, Joshi A, Chivasa W, Nyamudeza P (2001). On-farm seed priming: Using participatory methods to revive and refine a key technology. Agric. Syst., 69: 151-164.

Kurdikeri MB, Aswathaiah B, Mahadevappa M, Prasanna KPR, Prasad SR (1995). Seed invigoration on yield performance of maize. Mysore J. Agric. Sci., 29(3): 208-212.

Mauromicale G, Cavallaro V, Stoffella PJ, Cantliffe DJ, Damato G (2000). Effects of seed osmopriming on the harvest time and yield of summer squash (*Cucurbita pepo* L.). 8th International Symposium on Timing of Field Production in Vegetable Crops, Bari, Italy, 15-18 October, 1997. Acta Hort., 533: 83-88.

Qayyum S (1990). A varietal trial on okra (*Hibiscus esculentus* L.) cultivars. Pak. Agric. 7(4): 55-78.

Rashid A, Harris A, Hollington PA, Rafiq M (2004). Improving the yield of mung bean (*Vigna radiata* L.) in the North West Frontier Province of Pakistan using on-farm seed priming. Exp. Agric., 40: 233-244.

Rashid A, Harris D, Hollington PA, Khattak RA (2002). On-farm seed priming: a key technology for improving the livelihood of resource poor farmers on saline lands. Centre for Arid Zone Studies, University of Wales, UK., 82: 109-115.

Ullah MA, Sarfraz M, Sadiq M, Mehdi SM, Hassan G (2002a). Effect of pre-sowing seed treatment with micronutrients on growth parameters

of raya. Asian J. Plant Sci., 1(1): 22-23.
Ullah MA, Sarfraz M, Sadiq M, Mehdi SM, Hassan G (2002b). Effect of pre-sowing seed treatment of raya with micronutrients on yield parameters. Asian J. Plant Sci., 1(3): 277-278.
Zhang M, Nyborg M, McGill WB (1998). Phosphorous imbibed by Barley seed: Location within the seeds and assimilation by seedlings. Seed Sci. Technol., 26: 325-332.