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Research Article

Effect of priming on okra cultivars with different single super phosphate (SSP) concentrations

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Citation

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Abstract

The experiment was conducted at New Horticulture Research Farm Malakandher, The University of Agriculture, Peshawar, Pakistan during the year 2016. The experiment was laid out according to Randomized Complete Block Design (RCBD) with 2 factor factorial, having 24 treatments each replicated three times. Factor (A) consisted of okra cultivars (Punjab Selection, Sabz Pari, Supper Green and Swat Green). Factor (B) consisted of different single super phosphate concentrations {0.5%, 1%, 1.5% and 2%}.Seeds were primed for 24 hours. Unprimed seed and priming with water were taken as control treatments. Results showed that seed primed with 0.5 % of single super phosphate concentration had maximum germination percentage (93.17 %), minimum number of days to emergence (5.12 days) and number of days to first flowering (29.77 days), maximum plant height (140.84 cm), number of leaves plant^{-1} (32.62), number of pods plant^{-1} (25.09), pod length (9.76 cm), number of seeds pod^{-1} (42.22), pod yield (8.94 tons ha^{-1}), seed yield (769.98 kg ha^{-1}), and 100 seed weight (6.34 g), whereas maximum survival percentage (95.55 %) was recorded in the seeds primed with 2% SSP. In case of cultivars maximum germination percentage (88.32 %), minimum number of days to emergence (5.39 days) number of days to first flowering (30.67 days) maximum plant height (140.11 cm), number of leaves plant^{-1} (31.59), number of pod plant^{-1} (24.22), pod length (9.37 cm), number of seeds pod^{-1} (41.39), and pod yield (8.84 tons ha^{-1}) were recorded in Sabz Pari whereas maximum survival percentage (92.72%), seed yield (768.06 kg ha^{-1}), 100 seed weight (6.32 g) were recorded in Swat Green. It is concluded that seed priming with 0.5 % phosphorus gave better result in almost all parameters. Okra cultivar, Sabz Pari showed best result in majority attributes under the agro-climatic condition of Peshawar, Khyber Pakhtunkhwa-Pakistan.

Keywords: Okra cultivars; Priming; Single super phosphate

Introduction

Okra *(Abelmoschus esculentus* L.) a member of family *Malvaceae* originated from Ethiopia commonly called lady's finger and locally it is called bhindi [1]. It is a vegetable crop of summer, mostly grown in subtropical and tropical regions of the world. The flowers of okra are cream in color, and its fresh pods are used in soups and cooked in curries [2]. The tender green fruits containing green round seeds are used as a vegetable and marketed in fresh form, but sometimes also available in canned or dehydrated form. Okra play vital role in human diet [3] due to the presence of proteins, vitamin C and carbohydrates [4]. Okra is a good source of protein, mineral, iodine and some important vitamins. Okra stem is used as a fiber for making paper and rope [5]. CH_2O are mostly present in the form of mucilage [6]. The total area under okra cultivation during (2014-15) n Pakistan was 14855 ha with the overall production of 112983 tons, in which KPK contributed an area of 1957 ha with total production of 15630 tons, Contribution of Punjab was 5603 hectares with the total production 62593 tons, share of Baluchistan was 2690 ha with the total production of 16541 tons and that of Sindh was 4605 ha with the total production of 18219 tons [7]. The requirement of nutrients for the crops depends on the types of soil moisture, previous cropping intensity, texture of soil and vegetation cover [8]. Phosphorus, potassium and nitrogen are the key nutrients, necessary for development and growth of all species of plants. Phosphorus is a fundamental nutrient in the development of high energy compounds, such as Adenosine monophosphate (AMP), Adenosine diphosphate (ADP) and Adenosine triphosphate (ATP) that helps in respiration and photosynthesis. It is an important element of phospholipids and nucleic acids [9]. Phosphorus helps in early stage of development, harmonizes the germination activity and increase the final yield, especially in those soil where phosphorous is deficient. [10, 11]. It also enhances disease resistance in crop. The family Malvaceae grows best in summer with average temperature of 18^{o}C and 35^{o}C respectively. In plain areas seeds are sown in March or early April and at the hilly areas, it is sown in April. The main problem of okra seed is the slow and irregular germination in the beginning of spring sowing [12]. The germination percentage of okra seed is relatively low, due to presence of hard seed coat [13]. In agriculture fast and uniform germination is very important, for this reason different treatments are used for priming [14]. Priming of seed is the hydration of seed which increases seedling emergence and uniformity. It also enables the seed to tolerate unfavorable environmental conditions [15]. Priming of seed is a technique used before sowing of seed to enhance the seedling uniformity in germination [16]. It is effective, low cost and simple method for early seedlings, growth and yield. Priming triggers the activation or synthesis of some enzymes that catalyze the utilization of storage reserves in seed, where endosperm weakens by hydrolase activities. Priming may enhance resistance to abiotic stresses [17]. Priming can improve anti-oxidative activity, resulting reduction in lipid peroxidation rate, contributing to seed invigoration and allows some of the metabolic processes for germination to occur. Priming induces the production of antioxidant enzymes like dismutase peroxidase, catalase and superoxide etc. which help in cell protection against membrane damage during lipid peroxidation [18].

Phosphorus in inorganic form orthophosphate (H_2PO_4) ion is taken up by the plant. Among macronutrients, Phosphorus (P) is a crucial element for growth of the plants and if not sufficiently provided by the soil and other external sources, results in limited plant growth. For obtaining optimum crop yield, phosphorous must be applied either organically or inorganically in phosphorus deficient soils. However, excessive application of phosphorus could result in eutrophication in water bodies due to surface runoff in form of sediments carrying P or leaching of P in sandy soils [19]. Phosphorus application could also influence green pod yield of okra, enhances root growth and hastens seed maturity [20]. The present research was therefore conducted to investigate seed priming effects using different levels of single super phosphate (SSP) on different Okra cultivars with the objective to find out the optimum level of SSP for seed priming of okra, the response of different okra cultivars to priming and to sought out the interaction between priming concentrations and okra cultivars.

Materials and methods

The experiment was conducted at New Developmental Horticulture Research Farm Malakandher, The University of Agriculture, Peshawar, Pakistan during the year 2016.

Soil Analysis

Random soil samples from various parts of the field before sowing, up to depth of 25 cm was taken with the help of gauge auger (30 mm diameter) and then analysis was carried out in the Soil and Environmental Science (SES) Laboratory at The University of Agriculture, Peshawar (Table 1).

Table 1. Soil analysis of the experimental field

Electrical conductivity	80.4ds Ml^{-1}
pH	7.8
Organic matter	1.2 %
P_2O_5	0.02mg L^{-1}
Nitrogen	0.82 mg L^{-1}
Textural class	Silt loam

Experimental design

The experiment was comprised of two factors (Table 2) and carried out in (RCBD) two factor factorial having twenty four treatments and each was replicated three times. Total experimental area was 150 m^2 in which 130 m^2 was crop area and the remaining was used for pathways and water channels.

Preparation of the field and sowing method

The field was thoroughly prepared with application of FYM pre-sowing @ 20-22 tones ha^{-1} then ploughed soil for equal distribution of irrigation water. Ten seeds for each treatment were sown on sides of each ridge (60cm width), keeping 30cm P-P and 60cm R-R distance. After sowing the field was irrigated. Second irrigation was given after a week and more irrigation was followed according to the demand and field condition. All cultural practices were uniformly performed at proper time.

Table 2. Shows factors detail

Factor A		**Factor B**	
Phosphorous Levels		**Okra cultivars**	
P_1	Un-primed seed	CV_1	Punjab Selection
P_2	Water (W)	CV_2	Sabz Pari
P_3	.5 % solution of SSP	CV_3	Super Green
P_4	1% P solution of SSP	CV_4	Swat Green
P_5	1.5% P solution of SSP		
P_6	2% P solution of SSP		

Preparation of solution

The experiment consisted of two types of priming, nutrient priming and hydro priming. Calculated quantities were prepared separately and dissolved in one liter of water.

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Hydro priming

Seeds of different cultivars were soaked separately for 24 hours in 250 ml of H_2O in beaker.

Nutrient priming

Nutrient priming treatments were prepared from SSP at 0.5%, 1%, 1.5% and 2% Phosphorus concentrations. Calculated amount of SSP i.e. 63.2 g, 126.4 g, 189.8 g and 253.0 g were dissolved in one liter of water to make 0.5%, 1%, 1.5% and 2% Phosphorus concentrations. The seeds were soaked in supernatant solutions for 24 hours in beakers. The seeds were then taken out from these solutions and air dried for 30 minutes at room temperature. The treated seeds were sown manually on the ridges on 17th April 2016.

Statistical analysis

Statistical analysis was carried using MSTAT-C as described by [21] and mean separation among the treatments was done by using LSD at 0.05 level of probability.

Studied parameters

Following parameters were studied during experiment.

Germination percentage
Survival percentage
Days to emergence
Number of days to first flowering
Plant height (cm)
Number of leaves plant^{-1}
Number of pod plant^{-1}
Pod length (cm)
Pod yield (tons ha^{-1})
Number of seeds pod^{-}
Seed yield (kg ha^{-1})
100 seed weight (g)

Results and discussions

Germination percentage

The data pertaining to germination percentage is given in the (Table 3). Mean values revealed that seed priming of different single super phosphate concentrations had significant effect on germination percentage while the interaction was non-significant. Mean table showed maximum value for germination percentage (93.17 %) of the seed primed with 0.5% Phosphorous soloution of single superphosphate, while minimum germination (73.95%) was recorded in unprimed seeds. Comparison of okra cultivars indicated that maximum germination % (88.32%) was noted in Sabz pari, followed by Swat Green (87.98%), while minimum germination (84.20%) was recorded in Punjab Selection. The increase in germination percentage with priming is correlated with soaking which may involve in activation of several biological and physiological processes vital for seed germination. Phosphorous priming at optimum concentration may have provide sufficient amount of energy activation (ATP) during germination by DNA replication and repair, increased RNA and protein synthesis [22, 18]. The above results are in conformity with those of [23] who concluded that priming of okra with phosphorus solution increased germination

Survival percentage

The data regarding survival percentage is presented in the (Table 3). Mean values revealed that priming with different single super phosphate concentrations had significant effect on survival percentage, while the interaction between okra cultivars and single super phosphate concentration were found non-significant. Analysis of the mean table showed that highest survival % (92.72 %) was recorded in Swat Green, while minimum (87.11 %) was recorded in Punjab selection. While in case of single super phosphate concentrations maximum survival % (95.55 %) was noticed by the seed primed in 2 % phosphorus solution, while minimum (81.48 %) was recorded in the seed unprimed. Priming with phosphorus may decrease seed infection inoculums that provide better chances for survival and germination. [24] Stated that pearl millet downy mildew (PDM) disease was decreased by certain phosphorus sources. Under laboratory conditions, phosphorus act as a growth stimulant by improving seed germination and vigor, hence leading to better survival of the seedling. The probable reason for the slight decrease in survival percentage may be that, some pathogen are endo-phytes (embryo, cotyledons), while some are exo-pyhtes present in the testa as contaminants. As the seeds were sown, pathogens got position in young seedlings to feed on them or cause them ill, hence reduced survival percentage or lead them to death. Cultivars are different from one another due to their genetic makeup and the environmental conditions in which they grow. Variations in the survival percentage between okra cultivars may be due to their genes expression that some genotypes respond well to that environment and some genotypes may not that affect the growth of the plant and may not survive. This result is supported by **[11]** who found significant variation in cereal crop.

Number of days to emergence

The data related to number of days to emergence is given in the (Table 3). Analysis revealed that priming with different single super phosphate concentrations had significantly influenced number of days to emergence, while the interaction between okra cultivars and single super phosphate concentrations was non-significant. The data showed that among concentrations, minimum (5.12) number of days to emergence were recorded by the seeds primed with 0.5% of phosphorus solution, followed by the seeds primed with 1.0 % of phosphorus solution (5.25 days), and maximum (6.95) number of days to emergence were recorded by the unprimed seeds. While in case of okra cultivars, minimum number of days to emergence (5.39) was recorded in Sabz Pari, followed by Swat Green (5.54 days), whereas maximum numbers of days to emergence (5.92) were noted in Punjab Selection. Seed emergence plays a significant role in overcoming the future destiny of the plant. Earlier emergence is because of the priming as it synchronizes the metabolism of all the seeds in the seed lot. **[25]** Concluded in his experiment that seed priming increased emergence in mung bean as compared to unsoaked seeds. These findings are agreement by **[17]** who reported that seed priming decreased the germination time. **[10]** Also stated that in maize seed priming with Phosphorus, lower concentration (0.5% P) solution, took minimum (6.154) days to emergence, while unprimed seed took maximum (10) days to emergence and the seed primed in (1.5% P) concentration solution took maximum (7.179) days to emergence. **[23]** Stated that increased concentrations of phosphorus were shown to delay emergence in okra. This result shows that optimum concentration of P solution can minimize the number of days to emergence due to fast bio-chemical activities in the seed. The reasons of variation among okra cultivars for days to emergence are probably the different seed sources, storage condition of seeds, age of seeds which affected number of days to emergence. These results are also supported by **[1]** who reported significant variation in comparing okra cultivars for emergence duration.

Number of days to first flowering

The data related to number of days to first flowering is given in (Table 3). Data analysis revealed that priming with different single super phosphate concentrations had significantly influenced number of days to first flowering, while non-significant interactions were found among the two factors. The mean table of the experiment showed that among concentrations, minimum (29.77) numbers of days to first flowering were observed by the seeds primed with 0.5% of phosphorus solution, followed by the seeds primed with 1.0 % of P solution (30.29 days) and maximum (34.88) numbers of days to first flowering were recorded by the unprimed seeds. While in case of okra cultivars, minimum (30.67) number of days to first flowering was recorded in Sabz Pari, whereas maximum (32.76) days to flowering were taken by Punjab Selection, followed by Super Green (32.28 days).The days to flowering is greatly related with physiological maturity of all crops and is generally noted in order to find the maturity period of crops.The attribute of flowering is considered as the end of vegetative phase and the onset of reproductive phase. Priming promotes the metabolism process in seeds which resultantly break the dormancy. The release of growth hormones leads to faster growth rate. These results are agreement with [26] who concluded that wheat seed priming in various levels of phosphate had profound influence on days to flowering. [27] stated that early emergence and maturity in seed priming could be due to increase in metabolic state. Our results are also supported by [28-30] who stated that seed priming induced fast emergence, early flowering and gave high yield in rice and wheat. [31] Concluded from their experiment that seed priming led to enhanced development and growth, earlier flowering, increase seed tolerance to adverse environment and greater yield in maize. The probable reason for differences between okra cultivars in days to first flowering might be genotypic variation and their acclimatization to an area. Similarly, [5] also noted significant differences in first flowering among different cultivars of okra.

Number of seeds pod^{-1}

The data regarding number of seed per pod is presented in the (Table 3). Mean table revealed that priming of okra cultivars with different single super phosphate concentrations had significantly influenced number of seeds per pod. While the interaction between okra cultivars and single super phosphate concentrations had non-significant effect. Results showed that maximum number of seeds per pod (42.22) was recorded by the seed primed in 0.5% P solution of single super phosphate, followed by 41.68 seeds per pod by the seeds primed with 1.0 % of P solution of single super phosphate, while the minimum number of seeds per pod (36.37) was noted in the unprimed seed. In case of different okra cultivars maximum number of seeds per pod (41.39) was recorded in Sabz Pari, followed by Swat Green (40.53), while minimum number of seeds per pod (39.05) was recorded in Punjab Selection. The probable reason of these results might be that nutrients seed priming enhanced okra performance. It not only affected the vegetative cycle but also affected reproductive cycle. It induced early flowering, increased leaves and pods having many seeds as compared with unprimed seeds. These findings are agreement by the works of [32-34] who found that in many crops priming increased seeds per pod. The variation in the seeds per pod among okra cultivars is due to the differences in genetic makeup. The result of many researchers like [35-37] showed significant variation in seeds per pod among okra cultivars. Variation in number of seeds per pod was also determined by [38, 39].

Seed yield (kg ha^{-1})

The data pertaining seed yield (kg ha^{-1}) are given in the (Table 3). Data analysis revealed that priming of okra cultivars with different single super phosphate concentrations had significant effect on seed yield, however non-significant interaction was observed among SSP and cultivars. The experimental results revealed that maximum seed yield (769.98 kg ha^{-1}) was noted by the seed primed in 0.5% P solution of single super phosphate, while minimum seed yield (710.83 kg ha^{-1}) was noted in unprimed seeds. In case of different okra cultivars maximum seed yield (768.06 kg ha^{-1}) was recorded in Swat Green, while minimum seed yield (718.37 kg ha^{-1}) was recorded in Punjab Selection. Seed yield is the important objective for crop production.

Priming induced early flowering, increased leaves and pods having many seeds as compared with unprimed seeds. These results are supported with the work done by **[32-34]** who revealed that priming increased grain in many crops. **[40]**Testified that priming treatment significantly increased plant weight and total biomass of a plant as compared with unprimed seeds.The variation in the seed yield in various cultivars depends upon the size of the seed, number of pods per plant and mean seed weight. These findings are agreement with many researchers **[41, 42]** who reported significant differences in seed yield in different okra cultivars.

100 Seed weight (gram)

The data pertaining to the 100 seed weight (g) is showed in the (Table 3). Mean table revealed that priming of okra cultivars with different single super phosphate concentrations had significant effect on 100 seed weight, while non-significant interaction was observed among SSP and cultivars. Results indicated that maximum100 seed weight (6.34 grams) was recorded by the seed primed in 0.5% P solution of single super phosphate, while minimum 100 seed weight (5.86 grams) was noted in unprimed seeds, while in case of different okra cultivars, maximum100 seed weight (6.32 grams) was recorded in Swat Green, followed by Sabz Pari (6.15 grams), while minimum 100 seed weight (5.92 grams) was recorded in Punjab Selection. These findings are supported by the investigation of **[43]** who revealed that primed seeds produced larger grains. These findings are also supported by the result of **[40]** who investigated that priming treatments significantly enhanced total biomass, weight and seed yield as compared with unprimed seeds. **[44]** Described that in different wheat varieties, seed priming significantly increased fresh weight and dry weight. Priming of rice seed before planting significantly increased its 1000 grains weight at harvesting time and these findings are in line with the work of **[45]** among okra cultivars, variation in 100-seed weight can be endorsed to the genetic potential and the size of the seed of okra. These findings are also in line with **[42, 42]** who reported variation in 1000 seed weight in different okra cultivars.

Plant height (cm)

The data regarding plant height (cm)is showed in the (Table 4). Mean table revealed that priming of okra cultivars with different single super phosphate concentrations significantly influenced plant height, while non-significant interactions were found among the two factors. The experimental results revealed that maximum plant height (140.84 cm) resulted from the seed primed in 0.5% P solution followed by plant height (139.91 cm) by the seeds primed with 1.0 % P solution while minimum plant height (133.89 cm) was noted in the unprimed seed, while in case of different okra cultivars, Sabz Pari showed maximum plant height (140.11 cm) followed by Swat Green (138.63 cm), however the minimum plant height (134.24 cm) was noted in Punjab Selection. The full potential of vegetative growth of the crop is expressed by Plant height. The improved vigor in the height of plants resulted from seeds priming might be due to faster emergence. The enhanced vigor of seedling could be due to the induced capability of plants to compete for nutrients, light and water. These findings are supported by **[46]** who observed increased plant height as a result of priming. Likewise, **[47]** also found that priming increase shoot length in Soybean. **[11, 28]** also found from their experiment that priming seeds showed higher vigor than unprimed seeds. In okra cultivars the variation in the plant height might be due to genetic variation as well as adoptability of the plant in a particular environment. This result is also in agreement with **[48]** who identified that among other morphological traits of okra, plant height is a variable attribute which is required for improving desirable characters in a selection program. These findings are supported by [49] who concluded that in okra cultivars significant fluctuations in plant height may occur.

Table 3. Germination percentage (%), Survival percentage (%), Number of days to first flowering, Number of seeds pod^{-1}, Seed yield (kg ha^{-1}), 100 seed weight (g)

Factors: Level:	Germination percentage (%)	Survival percentage (%)	Number of days to emergence	Number of days to first flowering	Number of seeds pod^{-1}	Seed yield (kg ha^{-1})	100 seed weight (g)
Okra cultivars							
Punjab Selection	84.20c	87.11d	5.92a	32.7 a	39.05d	718.3d	5.92d
Sabz Pari	88.32a	88.56c	5.39c	30.67c	41.39a	747.1B	6.15B
Super Green	85.91b	91.00b	5.74b	32.28ab	39.82c	734.5c	6.05c
Swat Green	87.98a	92.72a	5.54c	31.72b	40.53b	768.0a	6.32a
LSD (P≤0.05)	1.1759	1. 2069	0.1763	0.9397	0.6330	9.9934	0.0842
Phosphorus concentrations (%)							
Unprimed	73.95 e	81.48e	6.95a	34.88a	36.37e	710.8e	5.86e
Water	84.51 d	87.17d	5.52c	32.38b	40.25c	738.6c	6.08c
0.5	93.17 a	90.67c	5.12e	29.77d	42.22a	769.9a	6.34a
1	91.66 b	91.43bc	5.25de	30.29cd	41.68ab	756.4b	6.23b
1.5	90.36 b	92.78b	5.33cd	31.13c	41.25b	750.9b	6.18bc
2	85.97 c	95.55a	5.73b	32.71b	39.43d	725.3d	5.97d
LSD (P≤0.05)	1.4402	1.4782	0.2160	1.1509	0.7752	12.239	0.1031

Number of leaves plant^{-1}

The data regarding number of leaves per plant is showed in the (Table 4). Mean table revealed that priming of okra cultivars with single super phosphate concentrations had significantly influenced number of leaves per plant, however non-significant interaction was observed among SSP and cultivars. The experimental findings showed that maximum number of leaves (32.62) were noted in plants resulted from seed primed in 0.5% single supper phosphate solution followed by (32.05) by the seeds primed in 1% single super phosphate solution, while the minimum (27.75) leaves were noted in the unprimed seeds, while in case of different okra cultivars, maximum number of leaves (31.59) were recorded in Sabz Pari followed by number of leaves (31.38) in Swat Green, while minimum number of leaves (29.78) wereobserved in Punjab Selection. The above findings are supported by the [50] who found that priming enhanced leaf area index and certain other growth parameters compared with unprimed. [51]Concluded from their work that priming treatments improved plant height, leaf area, number of leaves and final yield in rice varieties. The increased number of leaves could be due to better emergence and seedling growth from primed seeds. The current findings are supported by [28,40,17] who revealed that in many crops, seed priming increased leaf area index than unprimed seeds. Such facts could be termed with uniform and faster emergence of seedling with improved growth and vigor of the primed seeds. Cultivars have distinct characteristics because of their distinct genotypes. In different environmental conditions they respond differently. If the environmental condition is favorable for the genotype then it will respond well and develop good vegetative and reproductive growth. The reason for the result may be that some genotypes respond well to that environmental conditions and some genotypes may not that affect the plant growth. Significant differences in number of leaves plant^{-1} was observed in different okra cultivars **[52, 53]**.

Number of pods plant^{-1}

The data regarding number of pods per plant is presented in the (Table 4). Mean table showed that priming of okra cultivars with different single super phosphate concentrations had significantly influenced number of pods per plant, while non-significant interactions were found among the two factors.The experimental findings revealed that maximum number of pods plant-1 (25.09) was recorded by the seed primed in 0.5% P solution of single super phosphate, while the minimum pods plant-1 (20.03) was noted in the unprimed seeds. While in case of different okra cultivars maximum number of pods plant-1 (24.22) was noted in Sabz Pari, followed by Swat Green (23.56) whereas minimum number of pods plant-1 (22.19) was noted in Punjab Selection. Number of pod plant-1 is main component which determined the yield. Number of pods has a direct connection with number of leaves. In such case, when the number of leaves increases number of pods will also increase. **[33]** Stated that priming induced yield attributes like number of pods per plant. It might be due to better emergence and well seedling growth **[27, 28]** the main reason of producing different number of pods plant-1 in okra cultivars is the variation in genetic composition and environmental conditions that influenced thegrowth and production of the plant. More adoptable cultivar will have strong root system; they will uptake more nutrients and will produce more photosynthates, which ultimately gives more pods per plant. These findings are supported by **[54]** who described that environment effect genes action and delivers raw constituents for the synthetic process which are regulated by genes.

Pod length (cm)

The data regarding pod length (cm) is given in the (Table 4). Data analysis showed that priming of okra cultivars with different single super phosphate concentrations had significantly influenced pod length, however non-significant interaction was observed among SSP and cultivars. Results indicated that maximum pod length (9.76 cm) was recorded by the seed primed in 0.5% P solution of single super phosphate while the minimum pod length (8.02 cm) was noted in the unprimed seeds, while in case of different okra cultivars, maximum pod length (9.37 cm) was recorded in Sabz Pari, while minimum pod length (8.61 cm) was recorded in Punjab Selection, followed by pod length (8.81 cm) in Super Green. Pod length is a quality character for commercial yield which may depend on the environmental factors and genetic makeup. The reason might be due to earlier germination and enhanced seedling vigor in the primed seeds. Similar results were documented by **[26]** who told that spike length (cm) was significantly affected by the seed primed with phosphorus concentrations in Wheat. **[55]**Reported that slight increase in phosphorus reduced spike length. In okra cultivars, the expression of the genes for a particular trait may vary leading to differences in various okra cultivars. Many researchers like **[1, 56, 57]** documented significant variation in pod length between okra cultivars.

Table 4. Plant height (cm), Number of leaves plant^{-1}, Number of pods plant^{-1}, pod length (cm)

Factors: Level:	Plant height (cm)	Number of leaves plant^{-1}	Number of pods plant^{-1}	Pod length (cm)
Okra cultivars				
Punjab Selection	134.24d	29.78c	22.19d	8.61c
Sabz Pari	140.11a	31.59a	24.22a	9.37a
Super Green	136.21c	30.49b	22.60c	8.81bc
Swat Green	138.63b	31.38a	23.56b	9.05b
LSD (P≤0.05)	1.4501	0.5009	0.4056	0.2840
Phosphorus concentrations (%)				
Unprimed	131.89e	27.75d	20.03f	8.02e
Water	135.19d	30.36c	21.98e	8.87cd
0.5	140.84a	32.62a	25.09a	9.76a
1	139.91ab	32.05ab	24.56b	9.37b
1.5	138.95b	31.73b	24.05c	9.06bc
2	137.01c	30.37c	23.15d	8.69d
LSD (P≤0.05)	1.7760	0.6135	0.4967	0.3478

Conclusions and recommendations

Seed priming with SSP solution gave maximum germination percentage and produced more yield than control seeds. Seed priming with 0.5 % P Solution of single super phosphate significantly affected almost all the parameters. Increase in the concentration levels suppressed the effectiveness of seed priming. In okra cultivars, Sabz Pari and Swat Green showed best result in majority attributes and Punjab Selection showed poor results. Seed priming with 0.5 % Phosphorus concentration of single super phosphate is recommended to obtain maximum germination percentage, growth and yield of okra. The cultivar Sabz Pari and Swat Green are recommended for Peshawar region to obtain high germination percentage, growth and yield compared to other cultivars. Further research is suggested to know the effect of priming using other nutrients on okra cultivars.

Authors' contributions

Conceived and designed the experiments: SQ Shah & N Ara, Performed the experiments: SQ Shah, MN Khan & Dawood, Analyzed the data: SQ Shah, I Irfan& B Said, Contributed materials/ analysis/ tools: M Bakhtiar & TH Khan, Wrote the paper: SQ Shah& MN Khan.

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Field Code Changed