Research Article

Effect of Steckling Sizes and Phosphorus Levels on Seed Production of Radish (*Raphanus sativus* L.)

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Abstract | Effect of steckling sizes and phosphorus levels on seed production of radish *(Raphanus sativus* L.) cv. 'Green Neck' was conducted at the Horticulture Research Farm, The University of Agriculture, Peshawar; Pakistan during the session (2020-2021). The experiment was designed in Randomized Complete Block in split plot arrangement with three times replication. The main plot consists of phosphorus levels i.e. (0, 25, 50, 75, 100 kg ha^{-1}), whereas steckling sizes i.e. (10, 20, 30 cm) were assigned to subplots. The statistical analysis of the experiment showed that various phosphorus levels enhanced all the quantitative parameters of the radish crop. Maximum, plant height (65 cm), number of pods plant^{-1} (187), pod length (7.9 cm), pod diameter (3.70 mm), seed pod^{-1} (8), 1000 seed weight (22.6 g), seed yield plot^{-1} (25.8 g), seed yield (170.5 kg ha^{-1}) and seed germination viability (97.8) with less number of days to 50% flowering (32) were noted in the plants supplied with phosphorus at the rate of 100 kg ha^{-1}, while the minimum were observed in the control plots. Steckling size also affected the growth and yield parameters of radish crop. Maximum plant height (68 cm), number of pods plant^{-1} (183), pod length (7.4 cm), pod diameter (3.54 mm), seed pod^{-1} (7), 1000 seed weight (21.9 g), seed yield plot^{-1} (23.2 g), seed yield (153.4 kg ha^{-1}) and seed germination viability (90.0) with less days to 50% flowering (39) were noted at 30 cm of steckling size, while the minimum were examined at 10 cm of steckling size. However, plots treated with steckling size and phosphorus level (30cm and 100 kg ha^{-1}), respectively performed better than the rest of the plots and hence recommended for climate change and growers of district Peshawar.

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Introduction

Radish (*Raphanus sativus* L.) is an essential crop from the family Brassicaceae. It is cultivated for its edible root (Anonymous, 2015). It is a winter season vegetable and split widely into 2 categories, i.e., temperate or European and tropical or Asiatic. The root is produced by European types in a tropical and

sub-tropical climate, whereas, Asiatic type produced roots and seed under tropical climate (Tripathi *et al.*, 2017). Radish is a rapidly maturing, easy-growing root vegetable in both tropical and temperate areas. In case of radish cultivars, the large-rooted oriental style radish took 45-100 days to maturity (Alam *et al.*, 2010). The tuberous root is the most common eating part of radish, the radish upper is used as a veggie salad whereas, the entire plant of radish is edible. It is oldest vegetable which has been cultivated all around the year throughout Pakistan.

Radish has many medicinal properties, increase appetite; prevents constipation, liver disorders urinary as well as gall bladder disorders (Khadem *et al.*, 2010). In ancient time, radish was mostly grown for its medicinal values, because it has many medicinal properties, radish rich in antioxidants, protects against cancer and in homeopathy it is used to cure headache, sleeplessness and chronic diarrhea (Khadem *et al.*, 2010). Radish provides vitamin A, vitamin C, and minerals e.g., calcium, potassium, phosphorus, magnesium etc. The edible part mainly contains pectin and proto-pectin. Around 100 grams of radish which is fit to eat consists of 94 milligram water, 1.0 milligram of protein, 4.0 milligram of carbohydrates, 0.7 milligram of fiber, 1 milligram of fat, 1 milligram of iron and 42 milligrams of calcium. According to USDA (2016), radish root has an excessive amount of protein and carbohydrate. Pakistani vegetable growers grow very poor quality and yield radishes.

Phosphorus is the vital macro element that is required for growth and maturity of radish crop (Sadia *et al.*, 2013). Phosphorus is effective in different activities like photosynthesis, cell extension and formation of protein (Manzoor *et al.*, 2021). Root development, flower formation, seed production and stem strength are stimulated by phosphorus. Improvement of crop, uniformity, early maturity and disease resistance is also stimulated by phosphorus (Griffith, 2010). Phosphorus deficiency limits the growth of plants and they remain immature (Sadia *et al.*, 2013). For radish, tuberous root formation higher amount of phosphorus is required (Brintha and Seran, 2009). Early root formation and plant maturity were mostly due to phosphorus (Afsher *et al.*, 2012).

In implant procedure, steckling devising (formulation) and time of implanting two considerable constituent of the production of radish seed. It is an ordinary operation, to transplant steckling in the mid of November, when the vegetative growth is completed. In the month of March, bolting takes place, in winter plants after transplantation, In May-June, the silique is ripe and in the middle period of July, harvesting process takes place (Kumar *et al.*, 2007). In the large size of steckling, the seed production was high as well as yields from smaller size steckling (Singh and Dhillion, 2016; Paradisi and Montanari, 1985). Expansion in length of steckling has affected the seed production. Plant with more pods, seed weight and seeds was produced in superior steckling size and eventually the average seed production was increased (Ahmed, 2000; Duczmal, 1989).

Materials and Methods

Effect of steckling sizes and phosphorus levels on seed production of radish *(Raphanus sativus* L.)" was undertaken at Horticulture Research Farm, The University of Agriculture Peshawar during (2020-21), with the aim to determine the best steckling size and phosphorus level for better seed production of radish. For this experiment, steckling of the radish cultivar "Green neck" was produced and the roots were harvested in the first week of January and transplanted to another field immediately. Before transplanting, different levels of phosphorus (0, 25, 50, 75 and 100 kg ha^{-1}, respectively) were applied. Radish, which were selected for transplanting were cut in 3 sizes i.e. 10, 20 and 30 cm portion from the root tip and got steckling 10, 20 and 30 cm respectively (shown in Figure 1). There were fifteen treatments combination, which were replicated three times. Phosphorus level was kept in main plot, while steckling sizes was kept in sub plots. The distance between plants was 12 cm, while the distance between rows was 60 cm. First seeding was done on ridges, which were 30 cm high and basil dose of NPK (75:50:60 kg ha^{-1}) was given for steckling production. All culture practices like hoeing, weeding etc. were carried-out equally at proper time.

Parameters were studied

The research data were observed on the following parameters.

Days to 50% flowering

Data were taken by counting the number of days from sprouting to stage when 50% flowers were open in the treatment and then days to 50% flowering were recorded.

Figure 1: *Steckling preparation and transplanting in the experimental field.*

Plant height (cm)
Data regarding plant height were taken at the time of harvesting by measuring the height of randomly selected five plants of each treatment and then their mean was recorded.

Number of pods plant^{-1}
Data regarded the number of pods plant^{-1} was counted from 5 selected plants and then their average was noted.

Pod length (cm)
This data were recorded by measuring the length of a pod from different branches of five randomly selected plants and then calculating their mean.

Pod diameter (mm)
This data was collected by measuring the diameter of five randomly selected plants pods and was measured by using (vernier caliper) and its mean was noted.

Seed pod^{-1}
Data of number of seeds pod^{-1} was determined by calculating the seeds obtained from each pod of five randomly selected plants and then by calculating their mean.

1000 seed weight (g)
For this purpose, data was collected by counting the 1000 seeds, which were collected from the seed lot of each treatment and weighting the seed with digital weight machine and its weight were recorded.

Seed yield plot^{-1} (g)
After the maturity of the plant, the crop was harvested. Then their seeds were collected individually and seed yield plot^{-1} (g) was noted by using digital weight machine.

Seed yield (kg ha^{-1})
Seeds obtained from each plot after pneumatic separation and were weighing with digital weight machine and then converted into seed yield kg ha^{-1} by the following formula.

$$\text{Seed yield (kg ha}^{-1}) = \frac{\text{Seed yield plot}^{-1}(g)}{\text{Plot area (m}^2)} \times 10000m^2$$

Seed germination viability
For checking the viability and quality of seeds, randomly 10 seed were taken from each treatment and poured on the tissue paper in petri dish, sprinkled water on seed for humidity purpose which helps in germination and then counting the days of germination, until the seed germinated.

Statistical analysis
The data collected was analyzed at 1% level of significance; the least significant difference was utilized to compute mean difference. Statistical software STATISTIX (8.1) was used for analysis (Jan *et al.*, 2009).

Results and Discussion

The data regarding days to 50% flowering and plant height (cm) are presented in Table 1. The statistical analysis of the data showed that days to flowering were significantly influenced by various levels of phosphorous. Maximum days to 50% flowering (50 days) was calculated in plants supplied with no phosphorus, followed by the days to 50% flowering (47 days) noted in plants supplied with phosphorus levels @ 25 kg ha^{-1}, while minimum days to 50% flowering (32 days) was examined in plant supplied with phosphorus at the rate of 100 kg ha^{-1}. Data on steckling size showed that steckling size had significantly influenced days to 50% flowering. The mean table showed, that the more days to 50% flowering (43 days) were observed in 10 cm steckling size, while less days to 50% flowering (39 days) reported at 30 cm of steckling size. High application of phosphorus, cause early flowering and large steckling promotes high root growth. In large steckling more water and nutrients will be presented, resulting early plant maturity, blooming and fruit set,

Table 1: *Days to 50% flowering and plant height (cm) of radish as influenced by steckling sizes and phosphorus levels.*

Phosphorus levels (kg ha^{-1})	Days to 50% flowering	Plant height (cm)
0	50 a	52 c
25	47 b	54 bc
50	39 c	57 b
75	36 d	62 a
100	32 e	65 a
LSD (0.01)/Significance	1.9	4.1
Steckling sizes (cm)		
10	43 a	48 c
20	40 b	59 b
30	39 c	68 a
LSD (0.01)/Significance	0.8	2.4
Interactions	NS	NS

thus days to flowering were reduced of that plant, which taken a high level of phosphorus. The results are in accordance of Sharma (2000), who revealed that a high level of phosphorus caused early flowering in radish cv. Japanese. In addition, Manzoor *et al.* (2021) reported that large steckling gives a minimum number of days to flowering. The results of Ilyas *et al.* (2013) also described that more number and early flowering was caused by a high level of phosphorus and also by the size of the root. The statistical analysis of the data showed that plant height of radish was significantly affected both in case of phosphorus levels and steckling size while the interaction between them was not significant. Maximum plant height (65 cm) was recorded in plant supplied with P @ 100 kg ha^{-1} followed by plant height (62 cm) also observed in plant supplied with P @ 75 kg ha^{-1}, while minimum plant height (52 cm) was recorded in untreated plots. Data on steckling size showed that steckling size had significantly affected the plant height of the radish crop. Maximum plant height (68 cm) was observed at 30 cm of steckling, while minimum plant height (48 cm) observed at 10 cm of steckling size. Expansion in plant height at high level of phosphorus and large steckling might be due to enhanced cell division and more formation of tissues, which increased growth of stalk and thus increased plant height (Chhetri *et al.*, 2019). The results of (Wood *et al.*, 1994) are identical to the statement, that phosphorus is a necessity for cell division, promotes stalk growth and strength which causes an expansion in plant height. Further, Bekele (2018) got maximum plant height by the application of 120 kg ha^{-1} phosphorus, as compared with the control in radish cv. Pusa Rashmi. Root which had larger size and larger space resulted in increased the height of plant in carrot as a contrast to small size root and small space as shown by Anjum and Amjad (2002).

Table 2: *Number of pods plant^{-1} and pod length (cm) of radish as influenced by steckling sizes and phosphorus levels.*

Phosphorus levels (kg ha^{-1})	Number of pods plant^{-1}	Pod length (cm)
0	152 e	5.6 c
25	160 d	6.3 bc
50	167 c	6.5 b
75	176 b	6.9 b
100	187 a	7.9 a
LSD (0.01)/Significance	4.8	0.8
Steckling sizes (cm)		
10	152 c	5.6 b
20	171 b	6.9 a
30	183 a	7.4 a
LSD (0.01)/Significance	4.3	0.9
Interactions	NS	NS

The experimental findings regarding the number of pods plant^{-1} and pod length (cm) are presented in Table 2. Data about number of pods plant^{-1} was significantly influenced by various phosphorus levels. The maximum number of pods plant^{-1} (187) was noted in plants supplied with phosphorus at the rate of 100 kg ha^{-1} followed by number of pods plant^{-1} (176) were observed in plants supplied with phosphorus @ 75 kg ha^{-1}, whereas the less number of pods plant^{-1} (152) were examined in control treatment. Data on steckling size showed that steckling size had significantly affected the number of pods plant^{-1} of radish. Maximum number of pods plant^{-1} (183) was observed at 30 cm of steckling, while minimum number of pods plant^{-1} (152) was observed at 10 cm of steckling size. Due to the larger steckling size or root size, number of pods increased. Sizeable steckling carried increased stored food, which may be used for the plant growth. High phosphorus level increased flower formation and gave more number of pods. Hussain *et al.* (197) resulted that, the highest number of pods plant^{-1} was recorded in larger steckling size, while the least no of pods plant^{-1} was noticed in the smallest steckling size. Singh *et al.* (1960) stated that, a maximum dose of phosphorus, with the basal dose of nitrogen, resulted

in more number of umbels plant^{-1}. Similarly, Eid and Sedera (1992) reported that, large roots produced the maximum umbel plant^{-1}. The pod plant^{-1} was more due to larger and wider steckling in radish crop (Manzoor *et al.*, 2021). Phosphorus levels significantly changed the pod length of radish. The highest pod length (7.9 cm) was noticed in plant supplied with P @ of 100 kg ha^{-1} followed by pod length (6.9 cm) was observed in plant supplied with phosphorus @ 75 kg ha^{-1}, while the smallest pod length (5.6 cm) was recorded in untreated plants. Data on steckling size showed that steckling size had significantly affected the pod length of the radish crop. Maximum pod length (7.4 cm) was observed at 30 cm of steckling, while minimum pod length (5.6 cm) was observed at 10 cm of steckling size. An increase in the length of steckling size and increasing the application of phosphorus affected the length of a pod in a radish crop. Phosphorus helps in cell division and stimulated the strength of root which ultimately increased the length of pod. Manzoor *et al.* (2021) described, that improving the size of steckling, improved the length of a pod in radish crop. Also, finding of Hamid *et al.* (2002) was that, the maximum steckling size resulted in lengthy pods in radish crop, as compared with a small steckling size.

Data on pod diameter (mm) and seed pod^{-1} as affected by phosphorus levels and steckling sizes are given in Table 3. Pod diameter was significantly affected by phosphorus levels and steckling sizes while the interaction between them is non-significant. Data pertaining to pod diameter was significantly influenced by various phosphorus levels. The maximum pod diameter (3.70 mm) was reported in plants supplied with phosphorus @ of 100 kg ha^{-1} followed by pod diameter (3.43 mm) was noted in plants supplied with P levels @ of 75 kg ha^{-1}, while minimum pod diameter (3.21 mm) was examined in the control treatment. Data on steckling size showed that steckling size had significantly affected the pod diameter of the radish crop. Maximum pod diameter (3.54 mm) was observed at 30 cm of steckling, while minimum pod diameter (3.28 mm) was observed at 10 cm of steckling size. It is conducted, that maximum pod diameter with high phosphorus level and steckling size, might be due to increased length of the root, which in turn increase area for water and nutrients absorption. Hamid *et al.* (2002) reported that, larger sizes of steckling conducted more stored food, which affected the development of seed in a plant and it also increased the pod formation and size. Pod formation and size of pod associated with primary and secondary branches. The conclusion of Noor *et al.* (2020) informed that, the production of good quality seed in radish, steckling size plays an important role. Data related to seed pod^{-1} was significantly influenced by various levels of phosphorous. The maximum seed pod^{-1} (8) was recorded in plant supplied with phosphorus @ of 100 kg ha^{-1} followed by seed pod^{-1} (8) was monitored in plant supplied with P at the rate of 75 kg ha^{-1}, while less seed pod^{-1} (5) was noticed in control treatment. The recorded data on steckling size showed that steckling size had significantly affected the seed pod^{-1} of the radish crop. Maximum seed pod^{-1} (7) was observed at 30 cm of steckling, while minimum seed pod^{-1} (6) was observed at 10 cm of steckling size. No of seed pod^{-1} is more in larger steckling size and high phosphorus level because larger steckling size carried more nutrients and food supplied will be more as compared to smaller one. Manzoor *et al.* (2021) reported that, longer and wider steckling increased the number of seed pod^{-1}. Similarly, the results of Ilyas *et al.* (2013) reported that, a high quantity of phosphorus increased the no. of seeds. Thomer *et al.* (1998) reported that, high quantity application of NPK ha^{-1} to coriander resulted in more umbellate umbel^{-1}. The findings of Eid and Sadera (1992) reported that, maximum numbers of umbellate umbel^{-1} were produced by increased steckling size. Finding regarding the number of seed pod^{-1} was in a match, with that of Hamid *et al.* (2002) conducted that large root produced maximum number of seed pod^{-1}, as compared with smaller one in radish crop.

Table 3: *Pod diameter (mm) and seed pod^{-1} of radish as influenced by steckling sizes and phosphorus levels.*

Phosphorus levels (kg ha^{-1})	Pod diameter (mm)	Seed pod^{-1}
0	3.21 c	5 c
25	3.29 bc	6 bc
50	3.36 bc	7 abc
75	3.43 b	8 ab
100	3.70 a	8 a
LSD (0.01)/Significance	0.17	2
Steckling Sizes (cm)		
10	3.28 b	6 b
20	3.37 ab	7 ab
30	3.54 a	7 a
LSD(0.01)/Significance	0.19	1
Interactions	NS	NS

Table 4: *Thousand seed weight (g) and seed yield plot^{-1} (g) of radish as influenced by steckling sizes and phosphorus levels.*

Phosphorus levels (kg ha^{-1})	Thousand seed weight (g)	Seed yield plot^{-1}(g)
0	15.8 c	16.7 d
25	17 bc	18.2 d
50	18.9 bc	20.7 c
75	20.0 ab	23.0 b
100	22.6 a	25.8 a
LSD (0.01)/Significance	3.3	1.8
Steckling sizes (cm)		
10	15.5 c	18.3 c
20	19.2 b	21.1 b
30	21.9 a	23.2 a
LSD(0.01)/Significance	2.5	1.0
Interactions	NS	

Findings of current experiment regarding thousand seed weight (g) and seed yield plot^{-1} (g) are explained in Table 4. Data regarding 1000 seeds weight was significantly influenced by various phosphorus levels. The highest 1000 seed weight (22.6 g) was observed in plants supplied with phosphorus at the rate of 100 kg ha^{-1} followed by 1000 seed weight (20.0 g) was recorded in plants supplied with phosphorus @ of 75 kg ha^{-1}, while the lowest 1000 seed weight (15.8 g) was examined in the untreated plant. Data on steckling size showed that, steckling size had significantly affected the 1000 seeds weight of the radish crop. The maximum 1000 seed weight (21.9 g) was observed at 30 cm of steckling, while the lowest 1000 seeds weight (15.5 g) was observed at 10 cm of steckling size. The increased in seed weight caused by steckling size and phosphorus levels might be attributed to the role of phosphorus in photosynthesis, transfer of energy, and movement of nutrients within the plants. Phosphorus is a major part of the phytin storage formation within the seed, which ultimately increased seed size, seed weight, and seed yield. Research was firmly related to that of Singh and Dhillion (2016) reported that, high application of phosphorus increased 1000 seed weight. Hamid *et al.* (2002) reported that, maximum seed weight (16.7) of 1000 seed, was observed in large steckling size (33.8 cm). Wider space and large size root resulted in maximum seed weight umbel^{-1} in carrot, as compared with small space and small size root by Anjum and Amjad (2002). Results of Kumar *et al.* (2007) were principle in this regard, stated that by the size of steckling, significantly affected the 1000 seed weight, seed germination and gives maximum seed weight as compared to smaller ones. Data pertaining to seed yield plot^{-1} (g) was significantly influenced by various P levels. The maximum seed yield plot^{-1} (25.8 g) was founded in plants provided with phosphorus at the rate of 100 kg ha^{-1} followed by seed yield plot^{-1} (23.0 g) was observed, in plants supplied with phosphorus @ of 75 kg ha^{-1}, whereas, minimum seed yield plot^{-1} (16.7 g) was noted in the control plant. Data on steckling size showed that, steckling size had significantly affected the seed yield plot^{-1} (g) of the radish crop. Maximum seed yield plot^{-1} (23.2 g) was observed at 30 cm of steckling, while minimum seed yield plot^{-1} (18.3 g) was recorded at 10 cm of steckling size. Seed yield plot^{-1} depends on numerous factors, such as the number of pod plant^{-1}, seed pod^{-1}, seed yield plot^{-1} and seed yield plant^{-1} changing in seed yield might be caused by root sizes. More food was contained by large steckling, which might be produced vigor plant body, which enhanced the no of pods and the number of seeds as compared to small steckling, which stored less food. The results were closely related with Paradisi and Montanari (1985) reported that, larger steckling size in carrot gives maximum yield. Findings of Gill and Gill (1996) were conducted that, steckling size affected the seed yield and the whole root gave the highest seed yield. In the finding of Kumar *et al.* (2007) full-size steckling gave the highest yield as compared to smaller one in radish var. Japanese. Arya and Sainni (1978) found that, higher seed yield was given by larger steckling of carrot Var. Early Nantes. The results of Wood *et al.* (1994) were in relation to this report, that for the increase in seed weight and seed production phosphorus is very essential. Ilyas *et al.* (2013) finding resulted, that phosphorus levels affected seed yield, high phosphorus application gives maximum seed yield as compared to low.

Data on seed yield (kg ha^{-1}) and seed germination viability as affected by phosphorus levels and steckling sizes are given in Table 5. Phosphorus levels significantly influenced the seed yield (kg ha^{-1}) of radish. The highest seed yield (170.5 kg ha^{-1}) was observed in plants supplied with phosphorus at the rate of 100 kg ha^{-1} followed by seed yield (152.1 kg ha^{-1}) was observed in plants provided with phosphorus @ of 75 kg ha^{-1}, while the least number of seed yield (110.2 kg ha^{-1}) was examined in untreated plant. Data on steckling size showed that, steckling size had significantly affected the seed yield (kg ha^{-1}) of radish crop.

Table 5: *Seed yield (kg ha^{-1}) and seed germination viability of radish as influenced by steckling sizes and phosphorus levels.*

Phosphorus levels (kg ha^{-1})	Seed yield (kg ha^{-1})	Seed germination viability
0	110.2 d	71.1 c
25	120.3 d	71.8 c
50	136.6 c	87.8 b
75	152.1 b	95.6 a
100	170.5 a	97.8 a
LSD (0.01)/Significance	12.2	7.7
Steckling sizes (cm)		
10	121.3 c	79.3 b
20	139.3 b	88.7 a
30	153.4 a	90.0 a
LSD (0.01)/Significance	6.6	6.7
Interactions	NS	NS

Highest seed yield (153.4 kg ha^{-1}) was observed at 30 cm of steckling, and the least seed yield (121.3 kg ha^{-1}) was observed at 10 cm of steckling size. Many factors cause increased seed yield (kg ha^{-1}) such as number of seed pod^{-1}, pod plant^{-1}, and seed yield plot^{-1} which are mostly highest in high phosphorus application and in sizeable steckling size. The large size of steckling had more accumulated food as compared to small steckling size, in which morphological characteristics of radish were affected. Hamid *et al.* (2002) studied parameter that presented, that largest seed yield kg ha^{-1} was noted in large steckling size. Results were almost related to accordance with of Paradisi and Montanari (1985) and Arya and Saini (1997) who observed that, large size steckling in carrot increased seed yield kg ha^{-1}. The results of Kumar *et al.* (2007) and Ilyas *et al.* (2013) are very important in this regard, reported that, large number of seed yield was obtained with a larger steckling size. The increase in yield of radish by phosphorus application might be due to the role of phosphorus, in improving the fertility of soil and availability of high nutrients which results in high yield and growth parameters. Ilyas *et al.* (2013) reported that maximum, seed yield was noted, in plants provided with high application of phosphorus. Data about seed germination viability was significantly changed by various phosphorus levels. The better viability of seed germination (97.8) was noticed in plants supplied with phosphorus at the rate of 100 kg ha^{-1} followed by seed germination viability (95.6) was noted in plants supplied with P at the rate of 75 kg ha^{-1}, while minimum seed germination viability (71.1) was recorded in control treatments. Data on steckling size showed that steckling size had significantly affected the seed germination viability of the radish crop. Maximum seed germination viability (90.0) was observed at 30 cm of steckling followed by 20 cm of steckling size (88.7) while minimum seed germination viability (79.3) was observed at 10 cm of steckling size. Seed germination depends on many factors, such as healthy vigorous and true to type seeds were the main source for better stand crop. Seed germination was improved by the quality of seed. The result of Singh and Dhillion (2016) reported that, seedling uniformity, genetic purity, and free from seed-borne pathogens will also help in the quality of seed, which also helps in germination. Noor *et al.* (2020) concluded that, seed quality is determined by seed vigor and seed size. The results are well in accordance with those of Kumar *et al.* (2007) stated that, the germination of seed was significantly affected by the size of the root

Conclusions and Recommendations

From the results, it is concluded that radish cultivar "Green neck" showed better growth and seed yield at the rate of 100 kg ha^{-1} of phosphorus and 30 cm of steckling size and hence recommended for climate change and growers of district Peshawar. Furthermore, experiments should be conducted, to study the effect of phosphorus levels and steckling size on other root crops.

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Novelty Statement

Large steckling size (30 cm) of radish cultivar "Green neck" and application of high level of phosphorus (100 kg ha^{-1}) showed highly significant in seed germination viability and production of the radish crop.

Author's Contribution

Alveena Izhar: Conducted research, analysis and wrote the manuscript.
Basit Ullah and Hassam Bin Mujahid: Helped in data collection and proofreading of the manuscript.
Rabia Asghar: Helped in relevant literature.

Aqeel Ahmad: Helped in field experiment and data analysis.

Conflict of interest

The authors have declared no conflict of interest.

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