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Effect of Potash Levels and Plant Density on Potato Yield

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Abstract
The research study effect of potash levels and plant density on potato yield was carried out during 2012 at New Developmental Farm Horticulture Section, University of Agriculture, Peshawar. Experiment was layout in split plot arrangement of the Randomized Complete Block Design while each treatment was repeated thrice. Four levels of Sulphate of potash (SOP) i.e. 0.00, 50.00, 100.00 and 150.00 kg $ha^{-1}$and three plant spacing i.e. 15 cm, 25 cm and 35 cm were studied for different growth and yield parameters. Result showed that the tallest plant height (97.07 cm), highest number of tubers $plant^{-1}$ (8), the number of large size tuber $plot^{-1}$ (37) and yield of large size tubers $plot^{-1}$ (6.5 t ha^{-1}) was recorded at 35 cm plant spacing. The highest number of tubers $plot^{-1}$ (82.25), number of medium size tuber (36.50), yield of medium size tuber (8.13 t ha^{-1}) and total yield (15.91 t ha^{-1}) were recorded at 25 cm plant spacing. The highest number of small size tuber $plot^{-1}$ (33.16) and yield of small size tubers (4.52 t ha^{-1}) was recorded at 15 cm plant spacing , while the tallest plant height (98.87 cm), maximum number of tubers $plant^{-1}$(6.85), number of tubers $plot^{-1}$(88.66), highest number of small size $tubersplot^{-1}$ (28.77), medium size $tubersplot^{-1}$ (39.44), large size tubers $plot^{-1}$ (28), highest yield of small size tubers (3.55), medium size tubers (7.55), large size tubers (5.16 t ha^{-1}) and total tuber yield (16.27 t ha^{-1}) was recorded by using potash @ of 150 kg ha^{-1}. Result lead to the conclusion that the best performance of potato crop were recorded in most of growth and yield parameter at 25 cm plant spacing with 150 kg potash ha^{-1}. Therefore, this production technology is recommended for the highest potato crop under the agro climatic condition of Peshawar.

I. INTRODUCTION

Potato *(Solanum tuberosum* L.) is herbaceous plant and belongs to family Solanaceae. Potato plant produced white, pink, red, blue, or purple flowers having yellow stamens. Generally, potato with white flowers produce white skins tubers, while of those varieties produce colored flowers are pinkish skins tuber (Winch, 2006). Potato is cross-pollinated crop which is mostly pollinated by the insects, including bumble bees even then a substantial amount of self-fertilizing may also occurs. Potato plant produce green small fruits that are resembles to green cherry tomatoes, each of which contains true seeds of potatoup to 300. Potato fruit contains considerable amounts of toxic alkaloid (solanine) which is not suitable for utilization. Potatoes are mainly propagated by true potato seed (TPS) or seed potato (tubers) (Amador *et al*., 2003).

Potato is ranged the fourth most important crop in the world in terms of its production and occupy sixth position in yield averaging 15.3 tons ha^{-1}. On the basis of fresh matter, it is the third highest yielding crop after Sugar cane and Sugar beet. It is a cheap source of energy because it contains a large amount of carbohydrate content. Potato crop also contains significant amount of vitamin B, C and salts. For the production of starch and alcohol it is also used in many industries. (Abdel *et al*., 1977).

In Pakistan the area under potato cultivation is 145 thousand hectares with a production of 2941.3 thousand tones and our national yield is 18.10 tons ha^{-1}. In Khyber Pakhtunkhwa it is grown on 9.1 thousand hectares with a total production of 121.0 thousand tones and KPK average yield is 13.2 tones ha^{-1} (MINFAL 2009).

The use of potassium fertilizer is almost negligible in our country which has resulted not only in stagnation of crop yield but also the quality of the crop. Soil quality is continuously degraded because of continued removal of potassium along with the other nutrients from the soil by cropping. Potato crop yield can be increased significantly with the use of balanced potash fertilizer application. Potato plants require adequate supply of potassium than any other vegetable crop. Potassium plays a vital role in maintaining the plant vigor and guard cell in stomata. Potassium improves the size and quality of potato crop. Potato crop sometimes considered as an indicator crop for potassium availability due to its high potassium requirement and considered vital in photosynthesis (Ulrich and Ohki, 1996). Potassium is important for the synthesis of simple sugars and starch and also play important role in the translocation of carbohydrates (Smith and Smith, 1977). The quality of crop produce can also be improved with potassium use up to great extent (Winch, 2006).

Many experiments have been conducted to make obvious the effect of plant density on potato yield and tuber size. Little information's are available that how plant population affects growth and that how the plants

give back when grown wide apart or closer together (Sieczka *et al*., 1986).

It has been observed that the potato growers not only give proper attention to potassium fertilizer application but also proper spacing. Although high yield of potato crop mainly depends on the proper sowing time, balanced fertilizer and optimum plant population in the field. The recent study is therefore initiated to determine the influence of plant spacing and potash doses on the growth and yield of potato and generate a successful production for potato crop in the area of Peshawar.

II.MATERIALS AND METHODS

Field study was conducted at the New Developmental Farm, Horticulture section, University of Agriculture, Peshawar during year 2012. Four levels of Sulphate of Potash (SOP) i.e. 0, 50, 100 and 150 kg $ha^{-1}$and three plant spacing i.e. 15 cm, 25 cm and 35 cm were studied for different growth and yield parameters. Experiment was laid out in Randomized Complete Block Design with split plot arrangement and each treatment was replicated thrice in the experiment. There were 12 treatments in each replication and total 36 treatments. For each treatment net plot size was 2.4 m^2 and total size of the whole experimental plot was 86.4 m^2. Medium size healthy tubers were selected and cut into small seed pieces having at least two eyes in each seed piece. The seed pieces were treated with a fungicide (Alliete) at the rate of 2.5-3 gm L^{-1} of water and dried for few minutes before sowing. Field was fertilized by using N 100 kilogram and 80 P kg ha^{-1} during the field preparation and half of the nitrogen dose was applied after one month of potato germination. Raja variety and Sulphate of potash fertilizer were used in the experiment. The crop was uprooted at gaining the full maturity when the lower leaves become yellow. All the standard cultural practices were carried out according to the crop requirement.

Soil analysis

For soil chemical analysis, soil samples were taken from five different locations in the field at a depth of 13 to 20 cm. soil sample were analyzed for N, phosphorus, K_2O, pH, electric conductivity and organic matter. In table A the result of soil analysis is revealed.

Table A: Soil Characteristics of Horticulture Farm.

Depth (cm)	O.M %	Nitrogen	Phosphorus	Potash	pH	EC
13-20 cm	0.42 %	0.81 %	0.4358 mg kg^{-1}	64.6 mg kg^{-1}	7.64	0.90dsm^{-1}

The following growth and yield parameters were studied.

Plant height (cm) the data were recorded for plant height (cm) from base to the plant tip in randomly five selected plants by a measuring tape and their average was calculated.

Number of stem plant $^{-1}$ the data were recorded by counting the number of stems $plant^{-1}$ in randomly five selected plants in each treatment for each replication and their average were calculated.

Number of tubers $plant^{-1}$ the data were recorded by counting the number of tubers $plant^{-1}$ in randomly five selected plants in each treatment for each replication and their average were calculated.

Number of tubers $plot^{-1}$ the data were recorded by counting the number of tubers $plot^{-1}$ in each treatment for each replication and their average were calculated.

Number of Small Size tubers $plot^{-1}$ (<25 gm) the data were recorded by counting of small size tubers in each treatment for each replication and their average were calculated.

Number of Medium size tubers $plot^{-1}$ (26-75 gm) the data were recorded by counting medium size tubers in each treatment for each replication and their average were calculated.

Number of Large size tubersplot^{-1} (>75 gm) the data were recorded by counting the large size tubers in each treatment for each replication and their average were calculated.

Yield of small size tubers (t ha^{-1}) the data were recorded by weighing the small size tuber from each treatment in each replication and their average were calculated.

Yield of medium size tubers (t ha^{-1}) Yield of medium size tubers were recorded by weighing the medium size tuber of each treatment in each replication and their average were calculated.

Yield of large size tubers (t ha^{-1}) the data were recorded by weighing the large size tuber of each treatment in each replication and their average were calculated.

Total tuber yield (t ha^{-1}) the data were recorded by weighing the whole tubers in each plot for each replication and then converted into yield per hectare.

$$\text{Total tuber yield (t ha}^{-1}) = \frac{\text{Yield plot}^{-1}\text{ (kg)}}{\text{Area of plot (m}^2)} \times 10000\ \text{m}^2$$

Statistical analysis Subjected to statistical analysis for evaluation as recommended by Steel and Torrie (1980). To evaluate the effect of different groups (LSD) were used for mean evaluation and orthogonal difference.

III. RESULTS AND DISCUSSIONS

Plant Height (cm) the plant density and potash levels had significant effect on plant height (cm) (table 1). The tallest plant height (97.07 cm) was obtained at 35 cm plant spacing closely followed by (82.67 cm) at 25 cm plant spacing. Lowest plant height (62.85 cm) was found at 15 cm plant spacing. This might be due to more light and nutrient availability to the plants at wider space. In case of Potash levels, the tallest plant height (98.87 cm) was obtained at 150 Kg ha^{-1} followed by (91.20 cm) at 100 kg ha^{-1} potash level and the lowest plant height(60.23 cm) was recorded in control treatment. The highest plant height was obtained with the increase in potash levels. It shows a close relation between potash levels and plant height. The significant increases were noted in plant height because the chlorophyll concentration increases with the increases of potash (Moshileh *et al.,* 2005).

Table1: Plant height (cm) of potato as affected by plant density and potash levels.

	Plant spacing (cm)			
Potash levels kg ha^{-1}	**15**	**25**	**35**	**Mean**
0	54.33	54.80	71.57	60.23b
50	62.40	82.03	75.10	73.17b
100	63.53	89.72	120.37	91.20a
150	71.17	104.17	121.27	98.87a
Mean	62.85b	82.64a	97.07a	

LSD Value for (Plant Spacing) = 15.77
LSD Value for potash = 16.82

Number of Stem $Plant^{-1}$ the plant density and potash levels had no significant effect on number of stem $plant^{-1}$(Table 2). The maximum number of stems $plant^{-1}$ (4.81) were obtained at 25 cm plant spacing followed by (4.47) at 35 cm plant spacing while the minimum number of stems $plant^{-1}$ (4.20) was recorded at 15 cm plant spacing. Plant spacing has no effect on number of stems per plant (Gulluoglu *et al.,* 2009). Potash levels showed that the maximum numbers of stems $plant^{-1}$ (4.75) were found by using potash 100 kg ha^{-1}followed by (4.53) with 50 kg ha^{-1}. While minimum number of stems $plant^{-1}$ (3.96) was obtained at control treatment. Highest numbers of stems $plant^{-1}$ were recorded at 100 kg potash ha^{-1} which shows that potash dose influenced the number of stems $plant^{-1}$. The result of our finding is similar to Moshileh *et al.,* (2005) who stated that the potash levels positively increase the number of stems per plant.

Table 2: Number of stems $plant^{-1}$as affected by plant density and potash levels.

	Plant Spacing (cm)			
Potash levels kg ha^{-1}	**15**	**25**	**35**	**Mean**
0	3.84	4.21	3.83	3.96
50	4.26	4.52	4.82	4.53
100	4.40	5.34	4.48	4.75
150	4.26	5.20	4.76	4.74
Mean	4.20	4.81	4.47	

Number of tubers $plant^{-1}$ the plant density and potash levels had significant effect on numbers of tuber $plant^{-1}$ (Table. 3). The highest number of tubers $plant^{-1}$ (8.00) and (6.06) was recorded at 35 cm and 25 cm spacing, while the lowest number of tubers $plant^{-1}$ (3.00) was recorded at 15 cm plant spacing. The highest numbers of tubers per plant were found at wider spacing which shows that the number of tubers $plant^{-1}$ increased with the increase in plant spacing. It lines with the finding of Bielinski *et al.* (2008) found that the number of tuber $plant^{-1}$ increase with increase in plant spacing. The greatest number of tuber $plant^{-1}$ (6.85) and (6.25) were recorded at 150 and 100 kg ha^{-1} potash levels. Although the lowest number of tubers $plant^{-1}$ (4.05) were obtained at control treatment. The number of tubers $plant^{-1}$ has closed relation with potash fertilizer as the number of tubers $plant^{-1}$ increase with the increase in potash levels. The results are line with the Hojmark *et al.,* (1977) reported that the number of tubers $plant^{-1}$ increased with the increase of amount of potash. In case of interaction, the highest number of tubers $plant^{-1}$ (9.78) was recorded with 150 kg ha^{-1} potash dose at 35 cm plant spacing, while lowest number of tubers $plant^{-1}$ (2.28) was recorded at 15 cm plant spacing with control treatment.

Table 3: Number of tubers plant^{-1} of potato plant as affected by plant density and potash levels.

	Plant Spacing (cm)			
Potash levels kg ha^{-1}	**15**	**25**	**35**	**Mean**
0	2.28	4.88	4.99	4.05d
50	2.63	5.77	8.40	5.60c
100	3.49	6.45	8.83	6.25b
150	3.63	7.14	9.78	6.85a
Mean	3.00c	6.06b	8.00a	

LSD Value for plant Spacing = 0.0878
LSD Value for potash = 0.0585
LSD Value for interaction 0.05% level of probability = 0.1013

Number of tubers plot^{-1} Plant density and potash levels had significant effect on the numbers of tuber plant^{-1} (Table 4). The highest number of tubers plot^{-1} (82.25) was recorded at 25 cm followed by (72) at 15 cm plant spacing while the lowest number of tubers plot^{-1} (66.83) was recorded at 35 cm plant spacing. Maximum number of tubers plot^{-1} was recorded at 25 cm optimum plant spacing than wider spacing 35 cm. The number of tubers plot^{-1} was extensively high at 25 cm from the rest of plant spacing. The same results line with the finding of Bielinski *et al.,* (2008) that as plant spacing increases from 20 to 25 cm the number of tubers plot^{-1} increase. The highest number of tubers plot^{-1} (88.66) were noted with application of 150 kg ha^{-1} potash, followed by (84) with the application of 100 kg potash ha^{-1}, while the lowest number of tuber plot^{-1} (59.77) was recorded in control treatment. Maximum number of tubers plot^{-1} was recorded in the plot treated with 150 kg ha^{-1} potash level and significantly high number of tubers plot^{-1} from the rest of the applied levels that shows a correlation between potash levels and number of tubers plot^{-1}. The results are in conformity with the finding of Demagante *et al.* (1988) that the number of tuber plot^{-1} increases up to (140.33) as potash applied at 150 kg ha^{-1}. In case of interaction, the highest number of tubers plot^{-1} (99) was recorded with 150 kg ha^{-1} potash level at 25 cm plant spacing while lowest number of tubers plot^{-1} (59.77) were recorded with control treatment at 15 cm plant spacing.

Table 4: Number of tubers plot^{-1} of potato plant as affected by plant density and potash levels.

	Plant Spacing (cm)			
Potash levels kg ha^{-1}	**15**	**25**	**35**	**Mean**
0	59.00	61.00	59.33	59.77d
50	69.00	77.00	65.00	70.33c
100	91.00	92.00	69.01	84.00b
150	93.00	99.00	74.00	88.66a
Mean	78.00a	82.25a	66.83b	

LSD Value for plant Spacing = 4.43
LSD Value for potash = 3.86
LSD Value for interaction 0.05% level of probability = 6.68

Number of small size tuber plot^{-1} (<25gm) Potash levels and plant density had significant effect on the number of small size tubers plot^{-1} (Table. 5). The mean values indicated that the heights number of small size tuber plot^{-1} (33.16) were recorded at 15 cm followed by (27.41) at 25 cm plant spacing. While the lowest number of small size tuber plot^{-1} (8.49) was recorded at 35 cm plant spacing. This might be due to more number of plants in less space having maximum light and growth competition to gain full size of tubers. It lines with the finding of Love and Thompson Johan in (2006), Karafyllidis *et al* (1997) stated that highest number of small tuber were observed at high plant density. In case of potash levels the greatest number of small size tuber plot^{-1} (28.77) were obtained at 150 kg ha^{-1} followed by (28.00) at 100 kg ha^{-1}, while the minimum number of small size tuber plot^{-1} (13.55) were recorded in control. The interaction value shows that the maximum numbers of small size tuber plot^{-1} (40) was recorded with 100 kg ha^{-1} at 15 cm plant spacing, while the lowest number of small size tuber plot^{-1} (5.33) was recorded at 35 cm plant spacing with control treatment.

Table 5: Number of small size tuber plot^{-1} of potato as affected by plant density and potash application

	Plant Spacing (cm)			
Potash level kgha^{-1}	**15**	**25**	**35**	**Mean**
0	24.66	10.66	5.33	13.55c
50	29.66	28.33	7.33	21.77b
100	40.00	34.66	9.33	28.00a
150	38.33	36.00	12.00	28.77a
Mean	33.16a	27.41b	8.49c	

LSD Value for planting Space = 0.6811
LSD Value for fertilizer = 1.1941

LSD Value for interaction = 2.0682

Number of Medium size tuber plot^{-1} (25-75gm) Potash levels and plant density had significant affect on the number of medium size tubers plot^{-1} (Table. 6).

The data pertaining to the number of tuber plot^{-1} indicated that the maximum number of medium size tuber plot^{-1} (36.50) was noted at 25 cm plant spacing followed by (35.58) at 35 cm plant spacing, while the lowest numbers of medium size tuber plot^{-1} (32.33) were recorded at 15 cm plant spacing. It might be due to optimum availability of space to potato crop. The result of our finding is similar to Bielinski et al (2008) who revealed that more number of medium size tuber plot^{-1} were obtain at 25 to 30 cm plant spacing. The data concerning to the number of tuber plot^{-1} shows that the highest number of medium size tuber plot^{-1}(39.44) and (37.77) were obtained by using potash at 150 kg ha^{-1} and 100 kg ha^{-1}. The lowest numbers of medium size tubers plot^{-1} (28.88) were recorded in control. The number of medium size tuber increases with increase of potash. Bansal *et al*., (2010) stated that the minimum numbers of medium size tubers were found in the plot treated with lowest levels of potash. Interaction value shows that the maximum numbers of medium size tubers plot^{-1} (41.66) were recorded with 150 kg ha^{-1} potash at 25 cm plant spacing, while the minimum number of medium size tuber plot^{-1} (26.66) was recorded with control treatment at 15 cm plant spacing.

Table 6: Number of medium size tuber plot^{-1} of potato as affected by plant density and potash application.

Potash level kg ha^{-1}	Plant Spacing (cm)			
	15	**25**	**35**	**Mean**
0	26.66	29.66	30.33	28.88c
50	30.33	34.33	34.66	33.11b
100	34.66	40.33	38.33	37.77a
150	37.66	41.66	39.00	39.44a
Mean	32.33b	36.50a	35.58a	

LSD Value for planting Space = 2.4449
LSD Value for fertilizer = 2.0216
LSD Value for interaction = 3.5015

Number of Large size tuber plot^{-1} (≥75gm) Plant density and potash levels had significant influence on the number of large size tubers per plot (Table.7).

The mean values show that the maximum number of large size tubers per plot (37.58) was recorded at 35 cm followed by (23.08) at 25 cm plant spacing while the lowest number of large size tuber plot^{-1} (9.083) was recorded at 15 cm plant spacing. The highest number of large size tuber was recorded at wider plant spacing it might be due to more nutrients, water and light availability. It line with the result of Bielinski *et al* (2008) who stated that the plant spacing increases from 30 to 40 cm increase the number of large size tuber but the total number of tuber plot^{-1} decreases. The highest number of large size tuber plot^{-1} (28.11) was obtained with 150 kg ha^{-1} folowed by (24.55) with 100 kg ha^{-1}, while the minimum number of large size tuber plot^{-1}(18) was recorded in control treatment. The maximum number of large size tuber plot^{-1} was found in the plot treated with highest dose of potash. These findings coincide to the results of Singh and grewal (1996) reported that as K_2O levels increases from 100 kg ha^{-1} to 160 kg ha^{-1} the number of large size tuber significantly increases upto some levels. The interaction value shows that the maximum numbers of large size tuber plot^{-1} (41.66) were recorded with 150 kg ha^{-1} at 35 cm plant spacing, while the minimum numbers of large size tuber plot^{-1} (4.66) were recorded with control treatment at 15 cm plant spacing.

Table 7: Number of large size tuber plot^{-1} of potato as affected by plant density and potash application.

Potash level kg ha^{-1}	Plant Spacing (cm)			
	15	**25**	**35**	**Mean**
0	4.66	19.33	30.00	18.00d
50	7.33	22.00	37.66	22.33c
100	10.33	22.33	41.00	24.55b
150	14.00	28.66	41.66	28.11a
Mean	9.08c	23.08b	37a	

LSD Value for planting Space = 1.0347
LSD Value for fertilizer = 1.0908
LSD Value for interaction = 1.8892

Small size tubers yield (t ha^{-1}) Plant density and potash levels had significant affect on small size tubers yield (Table. 8). The mean values shows that the highest small size tuber yield (4.52 t ha^{-1}) were recorded at 15 cm followed by (2.67 ton ha^{-1}) at 25 cm plant spacing, while the lowest small size tubers yield (2.04 ton ha^{-1}) was recorded at 35 cm plant spacing. The small size tubers yield was significantly high at 15 cm from the rest of plant spacing. This might be due to more plant in a small space and less availability of light, nutrients and water. The maximum small size tubers yield (3.55 ton ha^{-1}) were obtained with 150 kg ha^{-1} potash followed by (3.49 ton ha^{-1})

with 100 kg ha^{-1} potash level, while the lowest of small size tubers yield (2.32 ton ha^{-1}) were obtained in control. The small size tubers yield was significantly high at 150 kg potash ha^{-1} from the rest of the potash levels. Nabi *et al*., (2000) reported that the maximum small size tubers yield (6.83 ton ha^{-1}) was obtained with the application of 200 kg ha^{-1}. The interaction mean values shows that the highest small size tubers yield (5.91 ton ha^{-1}) was recorded at 15 cm plant spacing with the application of 100 kg ha^{-1} potash, while the lowest small size tubers yield (1.37 ton ha^{-1}) was recorded at 35 cm plant spacing in control treatment.

Table 8: Small size tubers yield (ton ha^{-1}) of potato as affected by plant density and potash levels.

	Plant Spacing(cm)			
Potash levels kg ha^{-1}	**15**	**25**	**35**	**Mean**
0	3.3	2.3	1.37	2.32d
50	3.48	2.5	2.83	2.93c
100	5.91	2.76	1.79	3.49b
150	5.37	3.11	2.18	3.55a
Mean	4.52a	2.67b	2.04c	

LSD Value for plant Spacing = 0.0134
LSD Value for potash = 0.044
LSD Value for interaction = 0.077

Medium size tubers yield (26-75gm) Plant density and potash levels had significant affect on medium size tubers yield (Table. 9). The mean values show that the highest medium size tubers yield (8.13 ton ha^{-1}) was recorded at 25 cm followed by (6.27 t ha^{-1}) at 35 cm plant spacing while the lowest medium size tubers yield (4.44 ton ha^{-1}) was recorded at 15 cm plant spacing. The medium size tubers yield was highly significant at 25 cm from the rest of plant spacing. Same results were also reported by Camear *et al*., (1999) that the highest yields of medium size tuber were recorded at optimum plant spacing. The maximum medium size tubers yield (7.55 ton ha^{-1}) was recorded in 150 kg ha^{-1}followed by (7.16 ton ha^{-1}) with 100 kg ha^{-1} potash level while the lowest medium size tubers yield (4.64 ton ha^{-1}) was recorded in the control treatment. The significantly high medium size tubers yield was recorded in 150 kg ha^{-1} potash from rest of the potash levels which shows a closer relation of medium size tuber with potash levels. It line with the finding of Bansal *et al.,* (2010) that the highest yield of medium size tubers plot^{-1} were recorded with the application 160 kg ha^{-1} potash level. The interaction values show that the maximum medium size tubers yield (9.73 ton ha^{-1}) was recorded at 25 cm plant spacing with 150 kg ha^{-1} potash, while the minimum medium size tubers yield (3.40 t ha^{-1}) was recorded in control treatment at 15 cm plant spacing.

Table 9. Medium size tubers yield (ton ha^{-1}) as affected by plant density and potash levels.

	Plant Spacing (cm)			
Potash levels kg ha^{-1}	**15**	**25**	**35**	**Mean**
0	3.40	5.68	5	4.69d
50	3.69	8	5.33	5.67c
100	5.49	9	6.95	7.16b
150	5.19	9.73	7.72	7.55a
Mean	4.44c	8.13a	6.27b	

LSD Value for plant Spacing = 0.34
LSD Value for potash = 0.29
LSD Value for interaction = 0.51

Large size tubers yield (≥ 75gm) Plant density and potash level had significant affect on large size tuber yield (Table. 10). Mean value shows that the highest large size tubers yield (6.59 t ha^{-1}) was recorded at 35 cm followed by (5.11 t ha^{-1}) at 25 cm plant spacing while the lowest large size tubers yield (1.26 t ha^{-1}) was recorded at 15 cm plant spacing. The yields of large size tubers were significantly high at 35 cm from the rest of the plant spacing. This might be due to more light and nutrients were available at wider space. It lines with the finding of Bleasdal *et al.,* (1969) reported that the maximum tubers size and yield were recorded at wider plant spacing. The highest large size tubers yield (5.16 ton ha^{-1}) were recorded with 150 kg ha^{-1} followed by (4.71 ton ha^{-1}) 100 kg ha^{-1} potash while the lowest large size tubers yield (3.23 t ha^{-1}) were obtained in the control treatment. The yield of large size tubers increases with increases in levels of potash. It lines with the finding of Nabi *et al.,* (2000) that size and weight of tubers increases with increases in potash levels. The interaction mean value shows that the highest large size tubers yield (7.68 ton ha^{-1}) was recorded with 150 kg ha^{-1} at 35 cm plant spacing, while the lowest large size tubers yield (0.68 ton ha^{-1}) was recorded in control treatment at 15 cm plant spacing**.**

Table 10. Large size tubers yield (ton ha^{-1}) as affected by plant density and potash levels.

	Plant Spacing (cm)			
Potash level kg ha^{-1}	**15**	**25**	**35**	**Mean**
0	0.68	4	5	3.23d
50	0.77	5.32	6.42	4.17c
100	1.47	5.39	7.29	4.71b
150	2.11	5.71	7.68	5.16a
Mean	1.26c	5.11b	6.59a	

LSD Value for plant Spacing = 0.039
LSD Value for potash = 0.084
LSD Value for interaction = 0.014

Total yield (t ha^{-1}) Plant density and potash levels had significant affect on total yield (ton ha $^{-1}$) (Table. 11). The indicated value shows that the highest total yield (15.91 t ha^{-1}) was recorded at 25 cm plant spacing followed by (14.90 t ha^{-1}) at 35 cm plant spacing while the lowest total yield (10.22 t ha^{-1}) was recorded at 15 cm plant spacing. The total yield was significantly high at 25 cm plant spacing from the rest of the plant spacing. It lines with the finding of Bielinski *et al*., (2008) reported that the highest total yield (t ha^{-1}) were recorded at 20 to 25 cm plant spacing.

The highest total yield (16.27 t ha^{-1}) were recorded with application 150 kg ha^{-1} followed by (15.37 ton ha^{-1}) with 100 kg ha^{-1} potash, while the lowest total yield (10.85 ton ha^{-1}) was obtained in control treatment. The total yield was significantly high at 150 kg ha^{-1} from the rest of the potash levels. It lines with the findings of (lin, 1996; hahlin and Johannason, 1973) stated that potash applied at the rate of 150 kg ha^{-1} produced the highest tubers yield up to 20.06 and 20.03 (t ha^{-1}). The interaction values shows that the highest total yield (18.55 t ha^{-1}) was recorded at 25 cm plant spacing with the application of 150 kg ha^{-1} Potash while the lowest total yield (7.67 t/ha) was recorded at 15 cm plant spacing with control treatment.

Table 11: Total yield (ton ha^{-1}) as affected by plant density and potash levels.

	Plant Spacing (cm)			
Potash level kg ha^{-1}	**15**	**25**	**35**	**Mean**
0	7.67	12.01	12	10.85d
50	7.68	15.90	13	12.24c
100	12.87	17.19	16.04	15.37b
150	12.68	18.55	17.58	16.27a
Mean	10.22c	15.91a	14.90b	

LSD Value for Plant Spacing = 0.32
LSD Value for potash = 0.28
LSD Value for interaction = 0.49

Conclusion and Recommendation

It is concluded that potash levels and plant density had significant affect on the growth and yield of potato. Highest yield could be obtained at 25 cm plant spacing with the application of 150 kg ha^{-1} potash. Therefore, this production technology is recommended for potato crop to get highest yield under the agro climatic condition of Peshawar.

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