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Effect of Potash Levels and Row Spacings on Onion Yield

Shah Saud[1], Chun Yajun[1], Muhammad Razaq[2], Muhammad Luqman[2] ,Shah fahad [3],Muhammad Abdullah[4],and Arooj Sadiq[5]

1.Department of Horticulture, Northeast agriculture University harbin, china.
2.Department of Horticulture, Northeast Forestry University harbin, china.
3.Department of Agronomy Huazhong Agriculture University Wuhan, china.
4.College of Economics and Management ,Northeast Agriculture University Harbin,China..
5.Department of Agriculture Resource and environmental sciences Northeast agriculture University Harbin, China.

Corresponding Author: chenyajun622@163.com/ saudhort@gmail.com
Author: chen yajun

Abstract

The research study the effect of potassium and row spacing on yield of onion was conducted at Dargai Malakand during summer 2012. The experiment was conducted in Randomized Complete Block Design with split plot arrangement having three replications. Potassium levels (0, 40, 80 and 120 kg ha^{-1}) were applied to main plot while row spacing (15, 20 and 25 cm) were kept in sub plot. Recommended doses of nitrogen were applied at two split doses and phosphorus and potassium were applied at time of planting. The studied perimeters were plant height, number of leaves $plant^{-1}$, bulb diameter, average bulb weight, numbers of bulb kg^{-1} and yield (t ha^{-1}). The maximum plant height (51.6 cm), number of leaves $plant^{-1}$ (9.89), bulb diameter (5.93), average bulb weight (64.89 g), leaf width (1.33 cm) and yield (22.91 t ha^{-1}) were observed with the application of 120 kg K_2O ha^{-1}. The maximum number of bulb kg^{-1} (15.78) was observed in control. On the other hand the maximum plant height (47.1 cm), number of leaves $plant^{-1}$ (8.67), bulb diameter (5.64 cm) and average blub weight (54.92 g) were recorded at 25 cm row spacing. And maximum leaf width (1.26 cm) and yield (22.45 t ha^{-1}) was observed at 20 cm row spacing. The maximum bulb kg^{-1} (16.92) was observed at 15 cm row spacing. The highest yield were observed with the application of 120 kg ha^{-1}potash application and at 20 cm row spacing. Based on the above result it is recommended that 20 cm row spacing with 120 kg K_2O ha^{-1} should be used for best growth and maximum yield of onion under the agro climatic condition of Dargai at Malakand.

I. INTRODUCTION

Onion (*Allium cepa* L.), belonging to family amaryllidaceae. It is an important monocotyledonous, cross pollinated and cool season vegetable crops. Its origin is reported to be Afghanistan, Tajikistan and Uzbekistan, Western Tien Shan and India. Western Asia and the areas around the Mediterranean Sea are secondary countries of development.

A pound of onion crop contain protein 6 g, Fats 0.9 g, Carbohydrate 44 g, Calcium 137 mg, Phosphorous 188 mg, Iron 2.1 mg, Thiamine 0.15 mg, Riboflavin 0.1mg, Niacin 0.6 mg and Ascorbic acid 38 mg. Onion is one of the important vegetable crop and occupies an important place in the vegetable cultural of this area. As it demands worldwide so it is grown around the globe. (Thomson and Kelly 1982)

Onion contains all essential elements and is widely used in chutney, curry and pickles etc. Pakyurek *et al.* (1994) and Rizk (1997) observed that the highest sowing rate (planting density) produced a noticeably higher yield of good quality bulbs than the lower sowing rate. Verma *et al.* (1994) found that average branch length increased between the low and medium spacing. Weerasinghe *et al.* (1994) investigated that increasing plant competition significantly reduced seedling leaf number. Farrag (1995) emphasized that high planting density significantly increased single-bulb, double-bulb and total yields, as well as reducing bulb weight diameter. Coleo *et al.* (1996) reported that highest commercial bulb yield was recorded at higher planting density, while the highest proportion of large bulbs and average bulb weight were examined at lower planting density. Stoffella (1996) apprehended that percentage of small and medium-sized bulbs increased and percentage of large bulbs decreased as in-row spacing decreased. Viegas (1996) found that close of larger bulbs decreased on contrast to the yield of small bulbs, which was highest at the highest density. Pakyurek *et al.* (1994) tested various varieties for yield and quality and concluded that not all the varieties gave the similar response.

Similarly, Rumpel and Felezynski, (1997) reported that greater yield was produced by Mercato and lower yield was obtained in Summit Fl. Gendi (1998) studied the susceptibility of onion varieties to disease and observed that Giza 20 was more susceptible to thrips infestation than Giza 6 and Behiri was the least susceptible. Singh and Sachan (1999) compared two varieties Kalyanpur Round Red and Nasik Red for seed yield and observed that Kalyanpur Round Red was superior to Nasik Red; comparing onion varieties, (Vanparys, 1999) Rumpel *et al.* (2000) reported that in both varieties, the highest yield being obtained with the smallest spacing.

The greater commercial yield, onion production is still very low in Pakistan as compared to the other countries of the World. It could be attributed to the lack of adaptation of proper planting density and cultivation of unsuitable varieties for the specific locality. Plating density greatly influenced quality, texture, taste and yield of onion even within a particular variety. The varieties of the same species grown in the same environment often respond differently. Keeping in view the above facts, therefore, the present research work was initiated to determine the optimum planting density and best performing onion varieties which give higher yield with qualitative characters.

The onion is a cool-season crop affected by the length of the day and day length requirement of different varieties may differ. Therefore only acclimatized verities should be grown. A relatively high temperature and a long photoperiod are essential for bulb formation in most of the commercial varieties grown in Pakistan. However, for seed stalk development, temperature as more important than day length.

Onion is grown on nearly all types of soils, but they grow more successfully on fertile soil which is rich in humus and well drained. Onion are sensitive to high acidity and produce there maximum yield over a fairly narrow range of soil reaction; optimum PH ranges from 5.8-6.5. Tisdal *et al* (1985)

Potassium is a major plant nutrient, which is needed by the plants in large amount and is supplied by the fertilizer.it is available to the plants in the form of cation (k^+). Actually potassium is essential for a variety of process i.e. photosynthesis, fruit formation, winter hardiness and disease resistance. It stiffens straw and thus reduces lodging, and plays an important role in protein formation especially in grain filling. Moreover, all the root crops frequently respond to the potassium application. The commercial yield of onion is still very low in Pakistan as compared to the other countries of the World. It could be attributed to the lack of adaptation of proper planting density that greatly affects the quality, texture, taste and yield of onion. Tahir saleen *et al* (1986)

The higher yield can be obtained if all the growth factors act optimally. Spacing is an important factor for the production of onion. As the plant spacing influence both the yield and its quality, so in the experiment we grown onion crop at different row spacing to determine the optimum row spacing to get the highest yield. Malik *et al* (1994) The present study is initiated with aim to find out the optimum row spacing and potash levels for the onion production under the following objectives.

Objectives:

1) To determine the effect of potash levels on onion yield.
2) To determine the effect of row spacing on onion yield.
3) To determine the combined effect of potash and row spacing on onion yield.

III. MATERIALS AND METHODS

This study under the topic Effect of potassium levels and row spacing on onion yield was conducted at Dargai, Malakand in the year of 2012. The experiment was carried out in Randomized Complete Block Design with split plot arrangement, and then replicated 3 times. There were four levels of Sulphate of potash e.g. 0, 40, 80,120 kg ha^{-1} and three row spacing e.g. 15cm, 20cm and 25 cm. The sub plot size was 2.4 m^2. Swat-1 variety was used in the experiment. Half dose of nitrogen and full dose of phosphorous and sulphate of potash was applied during field preparation and half dose of nitrogen was applied after one month. All the standard culture practices were carried out to raise a good crop.

Soil Preparation and Analysis

Soil Samples were randomly taken from six locations in field for chemical analysis. Their soil sample was analyzed for potash, bulk density, PH, EC and texture.

Table. A. soil analysis shows the status of soil.

Determination	Potash mg/kg	Bulk density gm./cm cubic	pH	EC dms^{-1}	Texture
Quantity	0.25	1.440	8.3	2.31	Sandy clay loam

The experiment was consisting of following factors.

Factor A: Main plot

A. (Potassium levels)

K_1 = control

K_2 = 40 kg ha^{-1}

K_3 = 80 kg ha^{-1}

K_4 = 120 kg ha^{-1}

Factor B: Sub-plot

B. (Row spacing)

RS_1 = 15 cm

RS_2 = 20 cm

RS_3 = 25 cm

Data were recorded on the following growth and yield parameters.

Plant height (cm) Plant height data were recorded on five randomly selected plants in each treatment for each replication and calculated their average.

Number of leaves plant^{-1} Number of leaves plant^{-1}were recorded on five randomly selected plants in each treatment for each replicate and calculated their average.

Leaf width (cm) Leaf width was measure with help of measuring tape at three different places of leaves and their average was calculated.

Bulb diameter (cm) the bulb diameter was recorded with help of vernier caliper of 10 randomly selected bulbs in each treatment for each replication and calculated their average.

Number of bulbs kg^{-1} Number of blubs kg^{-1} were recorded with help of electrical balance and counted number of blubs in 1 kg.

Average weight of bulb (g) Average weight of blub was recorded by weighting the bulbs of for each treatment and calculated their average.

Yield (t ha^{-1}) Bulb harvested from each treatment was weighted with help of electrical balance then their yield was converted to tons ha^{-1}.

STATISTICAL ANALYSIS The whole data was recorded over various parameters of plant yield, plant analysis and soil analysis that were subjected to statistical analysis for comparison as suggested by Steel and Torric (1980). The use of LSD was for mean comparison while the use of orthogonal contrast for the comparison of effect of different groups.

IV. RESULTS AND DISCUSSION

Plant height (cm) Table No.01 contains on the data about the plant height whereas the Table No. 01A is on their analysis of variance.. The results of the statistical data showed that plant height was affected significantly by the levels of potassium and the row spacing and their interaction as well.

Mean data for potassium revealed that tallest plant height (51.6 cm) was recorded with the application of 120 kg K_2O ha^{-1} followed by (47.1 cm) with the application of 80 kg K_2O ha^{-1} while in control treatment the lowest plant height (40.1 cm) was observed. The plant height was recorded significantly tallest in plot treated with 120 kg K_2O ha^{-1}. The highest plant height was recorded with 120 kg ha^{-1}potash level and lowest plant height was recorded in control treatment. It shows that the plant height increased with the increase in potash levels. and it shows a positive relation with plant height. It lines with the finding of A.Salam *et al.(* 2004) who stated that potassium application increase the efficiency of plant for utilization of nitrogen that enhance the plant growth.

Mean data for row spacing indicated that the taller plant (47.1 cm) was observed at 25 cm row spacing followed by (45.4 cm) row spacing at 20 cm while the lowest plant height (43.6 cm) were recorded at 15 cm row spacing. The plant height significantly increased at wider row spacing the highest plant height was recorded at wider spacing from the rest of row spacing. It may be due to less competition among the plant for light, H_2o and nutrient. It lines with the finding of Khan *et al* (2003) who stated that wider plant spacing produce the tallest plant.

The mean data for interaction revealed that the tallest plant height (60.30) was recorded with the application of 120 kg K_2O ha^{-1} and 25 cm row spacing. While the lowest plant height (36.0) was recorded in control treatment with 15 cm row spacing.

Table 1. Plant height (cm) of onion as affected by potassium levels and row spacing.

Row spacing (cm)	Potassium (kg ha^{-1})				Mean
	0	40	80	120	
15	36.0	47.0	47.3	44.3	43.6 c
20	40.0	38.3	53.0	50.3	45.4 b
25	44.3	43.0	41.0	60.3	47.1 a
Mean	**40.1 d**	**42.7 c**	**47.1 b**	**51.6 a**	

LSD value for K at 5 % level 2.09
LSD value for RS at 5 % level 1.67
LSD value for K x RS 3.35

Number of leaves plant^{-1}The Table No. 02 is contains about the number of leaves plant^{-1} and Table No. 02A is on their analysis of variance. The statistical analysis of the data highlighted the significant effect of potassium levels on the number of leaves plant^{-1}, their row spacing and interaction.

The data containing the mean value indicated the results that with the application 120 kg potassium ha-1 maximum number of leaves plant-1 (9.89) followed by (8.67) with the application of 80 kg potassium ha-1 whereas in control treatment minimum number of leaves plant-1 (6.67) was observed. The numbers of leaves plant^{-1} increases with increase potash levels. Our result are inconformity with the finding of Baniony (2006) who reported that plant height and number of leaves plant^{-1} increased with increase in potash level up to some extent.

The mean data for row spacing indicated that the maximum number of leaves plant^{-1} (8.67) was observed at 25 cm row spacing followed by (8.42) at 20 cm row spacing while the minimum number of leaves plant^{-1} (7.67) was recorded at 15 cm row spacing. The maximum number of leaves plant^{-1} was found at wider spacing that shows a positive relation with row spacing. It lines with the finding of singh and singh (2000) who stated that the maximum number of leaves were noted at wider spacing.

The mean data for interaction revealed that the maximum number of leaves plant^{-1} (11.67) were observed with the application of 120 kg K_2O ha^{-1} and 25 cm row spacing and the lowest number of leaves plant^{-1} (6.33) was observed in control treatment with 15 cm row spacing.

Table 2. Number of leaves plant $^{-1}$of onion as affected by potassium levels and row spacing.

Row spacing (cm)	Potassium (kg ha^{-1})				Mean
	0	40	80	120	
15	6.33	6.33	9.33	8.67	7.67 b
20	6.33	9.67	8.33	9.33	8.42 a
25	7.33	7.33	8.33	11.67	8.67 a
Mean	**6.67 d**	**7.78 c**	**8.67 b**	**9.89 a**	
LSD for K		0.36			
LSD for RS		0.62			
LSD for K x RS		1.24			

Leaf width (cm) The data regarding to the leaf width is given in Table.3 and their analysis of variance in Table.3a,. Statistical analysis of the data showed that leaf width was non significantly affected by potash levels row spacing and their interaction.

The mean data for potash revealed that the maximum leaf width (1.33) was observed with application of 120 kg K_2O ha^{-1} followed by (1.22) with application of 80 kg K_2O ha^{-1}. While the minimum leaf width (1.20) was observed in control treatment.

The mean data for row spacing indicated that the maximum leaf width (1.26) was observed at 20 cm row spacing followed by (1.23) at 25 cm row spacing. While minimum leaf width (1.21) was recorded at 15 cm row spacing. The maximum leaf width was recorded in wider plant spacing it might be due to the more light availability to the plants and water. It line with the finding of Khan *et al,* (2002) who stated that as row spacing increases the leaf width per plant^{-1} increases.

The mean data for interaction revealed that the maximum leaf width (1.41) was observed with application of 120 kg K_2O ha^{-1} and 25 cm row spacing and the lowest number of leaves plant^{-1} (1.10) was observed in control treatment with 15 cm row spacing.

Table 3. Leaf width (cm) of onion as affected by potassium levels and row spacing.

Row spacing (cm)	Potassium (kg ha^{-1})				Mean
	0	40	80	120	
15	1.10	1.24	1.23	1.25	1.21
20	1.31	1.12	1.28	1.32	1.26
25	1.19	1.18	1.14	1.41	1.23
Mean	**1.20**	**1.18**	**1.22**	**1.33**	
LSD for K		Ns			
LSD for RS		Ns			
LSD for K x RS		Ns			

Bulb diameter (cm) Table No. 04 contains about the bulb diameter and Table No. 04A on their analysis of variance. The statistical analysis of the data illustrated that potassium levels affected the bulb diameter significantly, their row spacing and interaction as well.

The mean data for potash revealed that the maximum bulb diameter (5.93) were recorded with application of 120 kg K_2O ha^{-1} followed by (5.65) with the application of 80 kg K_2O ha^{-1} while the minimum bulb diameter (5.01cm) were recorded in control treatment. The bulb diameter was significantly high with 120 kg ha^{-1} potash from the rest of potash levels. The maximum bulb diameter were recorded at highest potash dose which shows a relation of potash level with bulb diameter and lowest bulb diameter were recorded in control treatment. It lines with the finding of Ali *et al.* (2007) who reported that bulb diameter of onion crop is positively affected by potassium the bulb diameter increases with increases potash levels.

The mean data for row spacing revealed that the larger bulbs diameter (5.64) was observed at 25 cm row spacing followed by (5.46) at 20 cm row spacing while the small bulb diameter (5.39) was observed at 15 cm row spacing. The bulb diameter of onion was significantly affected by row spacing. The maximum bulb diameter were recorded at wider row spacing it might be due to more light availability to plants and less competition among the plants. Its lines with the finding of Mohanty and Prusti (2001) who stated that as row spacing increases the bulb diameter increases.

The mean data for interaction revealed that the large bulbs diameter (6.46) was observed with application of 120 kg K_2O ha^{-1} and 25 cm row spacing and the lowest bulbs diameter (4.68) was observed in control treatment with 15 cm row spacing.

Table 4. Bulb diameter (cm) of onion as affected by potassium levels and row spacing.

Row spacing (cm)	**Potassium (kg ha^{-1})**				**Mean**
	0	40	80	120	
15	4.68	5.89	5.54	5.43	5.39 b
20	5.42	5.31	4.97	6.13	5.46 ab
25	4.93	4.94	6.46	6.22	5.64 a
Mean	**5.01 d**	**5.38 c**	**5.65 b**	**5.93 a**	
LSD for K		0.19			
LSD for RS		0.19			
LSD for K x RS		0.38			

Number of bulb kg^{-1} The Table No. 05 contains the data about the number of bulb kg-1 and Table No. 06A on their analysis of variance. the statistical analysis of the data demonstrated the number of bulb kg-1 was significantly affected by potash levels row spacing and their interaction.

Mean data for potash revealed that the highest number of bulbs kg^{-1} (15.78) were observed in control treatment followed by (13.00) kg^{-1} with 40 kg K_2O ha^{-1} while the lowest bulbs kg^{-1} (8.67) was recorded with the application of 120 kg K_2O ha^{-1}. The number of bulbs kg^{-1} was highly affected by potash doses. The number of bulbs kg^{-1} increased with the decrease of potash levels. The result of our finding was similar to Pervez *et al.* (2004) who stated that as potash levels increases the number of bulbs kg^{-1} decreases.

Mean data for row spacing indicated that maximum number of bulbs kg^{-1} (16.92) was recorded at 15 cm row spacing followed by (11.33) at 20 cm row spacing. While the minimum number of bulbs kg^{-1} (8.42) was recorded at 25 cm row spacing. The number of bulbs kg^{-1} increases with decreases the row spacing it might be due to less availability of nutrients and water competition of the plant. The result of our finding was similar to Kumar *et al.* (1998) who stated that as plant density increases the number of bulb kg^{-1} increases.

The mean data for interaction revealed that the maximum number of bulbs kg^{-1} (20) was recorded in control treatment with 15 cm row spacing and the minimum bulbs kg^{-1} (5) was recorded in 120 kg K_2O ha^{-1} with 15 cm row spacing.

Table 5. Bulb kg^{-1} (g) of onion as affected by potassium levels and row spacing.

Spacing	**Potash (kg ha^{-1})**				**Mean**
	0 k	40 k	80 k	120 k	
15	20.00	18.67	15.33	13.67	16.92
20	15.67	11.67	10.67	7.33	11.33
25	11.67	8.67	8.33	5.00	8.42
Mean	**15.78**	**13.00**	**11.44**	**8.67**	
LSD for Potash		0.618			
LSD for RS		0.594			
LSD for Potash X RS		1.189			

Average bulb weight (g) The data regarding to the number of average bulb weight is given in Table 6. And their analysis of variance was given in Table No. 06A. The statistical analysis of the data illustrated the significant affect by potassium level on average bulb weight, the row spacing and their interaction.

Mean data for potash revealed that maximum bulb weight (64.89 g) were observed with the application of 120 kg K_2O ha^{-1} followed by (50.69 g) with the application of 80 kg K_2O ha^{-1} while minimum average bulb weight (31.89 g) were observed in control treatment. Bulb weight increases with increases the potash levels. Similar result were quoted by Ghafoor *et al*. (2003) who reported that as average bulb weight increases with increases in potash levels.

Mean data for row spacing indicated that maximum bulb weight (54.92 g) was observed at 25 cm row spacing followed by (48.57 g) at 20 cm row spacing while minimum average bulb weight (41.17 g) was recorded at 15 cm row spacing. The average bulb weight significantly increased with wider spacing. The maximum average weights were recorded at 25cm row spacing from the rest of row spacing. It might be due to more space available to bulb for expression and less competition for nutrient and light. Its line with the finding of Balraj *et al* (1998) reported that bulb diameter and average bulb weight increased with increasing the row spacing.

The mean data for interaction revealed that the maximum bulbs weight (78 g) was recorded in 120 kg k_2o ha^{-1} at 15 cm row spacing and the minimum bulbs (26.67) was recorded in control treatment with 15 cm row spacing.

Table 6. Average bulb weight (g) of onion as affected by potassium levels and row spacing.

Spacing	Potash (kg ha^{-1}) 0 k	40 k	80 k	120 k	Mean
15	26.67	41.00	46.33	50.67	41.17
20	31.67	45.19	51.41	66.00	48.57
25	37.33	50.00	54.33	78.00	54.92
Mean	**31.89**	**45.40**	**50.69**	**64.89**	

LSD for Potash 18
LSD for RS 6.5
LSD for Potash X RS 13

Yield (t ha^{-1}) the data regarding to the number of Yield tons ha^{-1}is given in Table No. 07 and their analysis of variance in Table No. 07A. The Statistical analysis of the data showed the significant effect of Yield tons ha^{-1} by potassium levels, row spacing and their interaction.
The mean data for potash revealed that maximum yield (22.91 t ha^{-1}) were observed with the application of 120 kg K_2O ha^{-1} followed by (19.47 t ha^{-1}) with application of 80 kg K_2O ha^{-1} while the minimum yield (16.21 t ha^{-1}) was recorded in control treatment. The maximum yield was recorded at 120 K_2O ha^{-1} from the rest of potash levels it might be due the optimum potash availability to the plants as potash level increases the yield increases. The same result was also concluded by Khan *et al.* (2003) who stated that as potash level increases up to optimum levels the yield (t ha^{-1}) increases.
The mean data for row spacing indicated that highest yield (21.47t ha^{-1}) was observed at 20 cm row spacing followed by (20.50 t ha^{-1}) at 25 cm row spacing while lowest yield (15.00 t ha^{-1}) was recorded at 15 cm row spacing. The maximum yield was recorded in 20 cm row spacing from the rest of the row spacing. Its line with the finding of Balraj *et al.* (1998) who stated that increasing the plant spacing will result in an increase in onion yield.
Mean data for interaction revealed that the maximum yield (25.89 t ha^{-1}) were observed with application of 120 kg K_2O ha^{-1} and 20 cm row spacing while the minimum yield (11.28 t ha^{-1}) was recorded in control treatment and 15 cm row spacing.

Table 7. Yield tons ha^{-1} of onion as affected by potassium levels and row spacing.

Spacing	Potash (kg ha^{-1}) 0 k	40 k	80 k	120 k	Mean
15	11.28	14.04	15.31	19.36	15.00
20	19.29	22.19	22.45	25.89	22.45
25	18.07	19.75	20.67	23.49	20.50
Mean	**16.21**	**18.66**	**19.47**	**22.91**	

LSD for Potash 0.299612
LSD for RS 0.262923
LSD for Potash X RS 0.525846

V. SUMMARY, CONCLUSION AND RECOMMENDATIONS

The research study the under the topic Effect of potassium and row spacing on yield of onion was carried out in the District Malakand, Village Dargai in the year of 2012 summer season. The experimentally was conducted in Randomized Complete Block Design with split plot arrangement having three replications. Potassium levels (0, 40, 80 and 120 kg ha^{-1}) were applied to main plot while row spacing (15, 20 and 25 cm) were kept in sub plot. Recommended doses of nitrogen were applied at two split doses and phosphorus and potassium were applied at time of planting.
The parameter study were plant height, number of leaves plant^{-1}, bulb diameter, bulb kg^{-1}, average bulb weight, leaf width and yield ton ha^{-1}.
Maximum plant height (51.6 cm), number of leaves plant^{-1} (9.89), bulb diameter (5.93), average bulb weight (64.89 g), leaf width (1.33 cm) and yield ton (22.91 ha^{-1}) were observed with the application of 120 kg K_2O ha^{-1}. The maximum bulb kg^{-1} (15.78) was observed in control. The minimums plant height (40.1 cm) number of leaves plant^{-1} (6.67), bulb diameter (5.01), average bulb weight (31.89 g) and yield (16.21t ha^{-1}) were recorded in control condition. The minimum leaf width (1.18) was recorded in 40 kg K_2O ha^{-1} and minimum bulb kg^{-1} (8.67) was recorded in 120 kg K_2O ha^{-1}.
On the other hand the maximum plant height (47.1 cm), number of leaves (8.67), bulb diameter (5.64 cm) and average blub weight (54.92) were recorded at 25 cm row spacing and the maximum leaf width (1.26 cm) and yield (22.45 t ha^{-1}) was observed 20 cm row spacing. The maximum bulb kg^{-1} (16.92) was observed at 15 cm

row spacing. Whereas the minimum plant height (43.6 cm), leaf width (1.21 cm), number of leaves (7.76), bulb diameter (5.39 cm), average blub weight (41.17) and yield (15.00 t ha^{-1})were recorded in 15 cm row spacing. The minimum blub kg (8.42) was recorded in 25 cm row spacing.

Conclusion and Recommendation

From the result discus in pervious chapter it is concluded that:

- Maximum yield of onion were produce by application of 120 kg K_2O ha^1.
- Maximum yield of onion were observed in 20 cm row spacing

The following recommendation can be formulated from the present research work for the guidance of farmer and for general cultivation of onion.

- The application of 120 kg K_2O ha^{-1} at 20 cm row spacing is recommended for the highest production of onion at Dargai Malakand area.

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References.

- Abd El-Al, F.S., M. R. Shafeek, A.A. Ahmed and A.M. Shaheen, 2005. Response of growth and yield of onion plants to potassium fertilizer and humic acid. Journal of Agriculture Science, Mansoura University 30 (1): 315-326.
- Adam, S. M., E. H. A. El-Salehein and A .M. Abd Alla. 1996. Effect of N and Agri. Stat. pak., 2000-01.Govt. of pak. Minist. Of Food, Agri. And Livestock. Economic Wing Islamabad.
- Al-Abdulsalam, M . A. and A . F. Hamaiel, 2004. Effect of planting dates and compound fertilizers on growth, yield and quality of Hassawi onion under Al-Hassa oasis. Sci. J. of King Faisal Uni. Saudi Arabia. 5 (1): 65-79.
- Ali, M. K., M. F. Alam, M. N. Alam, M. S. Islam and S. M. A. T. Khandaker. 2007. Effect of Nitrogen and Potassium level on yield and quality seed production of onion. J. Appl Sci. Res., 3(12): 1889-1899.
- Balraj, S. R. S. Sharma and Y. Kumar. Effect of bulb spacing and nitrogen levels on growth and seed yield of onion (*Allium cepa* L.). Seed Res.Jaipur, India., 180-182. (1998).
- Bassiony.2006. Effect of Potassium Fertilization on Growth, Yield and Quality of Onion Plants. Journal of Applied Sciences Research, 2(10): 780-785, 2006.
- Coelo, R. F. V. A. B. Souza and M. A. F. Conceicao, 1996. Performance of onion crops under three irrigation regimes and five spacings. Pesquisa Agropecuaria Brasilcira, 31 (8): 585-591.
- Coolong, T. W. and W. M. Randle. 2003. Conditions influences flavor intensity and quality in Granex 33 onion. J. Am. Soc. Horti. Sci., 128: 176-181.
- Darwesh, F. A. M. 1996. Evaluation of some protective techniques for use in tomato productionDuli Zhao , D.M. Oosterhuis and C.W. Bednarz. 2001. 39(1): $103^{-1}09$.
- Duli, Zhao, D. M. Oosterhuis and C. W. Bednarz. 2001. Influence of potassium deficiency on photosynthesis, chlorophyll content and chloroplast ultrastructure of cotton plants. *Photosynthetica*, 39(1): 103-109.
- Ehsan, M. A. K. Bashir, M. Z. Khan and K .M. Khokhar. 2002. Effect of potash application on yield of different varieties of onion (*Allium cepa* L.). Asian J. Plant Sci., 14(1): 324-325.
- F. A. M. Darwesh. 1996. Evaluation of some protective techniques for use in tomato production. J. Agri. Res. 23 (4): 624-641.
- Geetha, A. Sreenivasaraju, P., Chandrasekhar Rao and Suryanarayan Reddy, M., 2000, Effect of individual and combined application of FYM and potash fertilizer on yield and potash nutrition of onion in Alfisol. J. Res. ANGRAU, 28(4) : 34 – 39.
- Gendi, S. M. 1998. Population fluctuation of Thrips tabaci L. on onion plants under Fayoum environmental conditions. Arab Univ. J. Agric. Sci. 6(1): 267- 276.
- Ghaffoor, A. M. S. Jilani, G. Khaliq and K. Waseem. 2003. Effect of different NPK levels on the growth and yield of three onion (Allium cepa L.) varieties. Asian J. Plant Sci., 2(3): 342-346.

- Girigowda. J. R., N. C.Narasegowda, and H. C. Krishna, 2005, Effect of fertilizer levels on uptake of primary nutrients and bulb yield of onion hybrids. Mysore J. Agric. Sci. 39(4): 557 – 560.
- Hariyappa. N. 2003. Effect of potassium and sulphur on growth, yield and quality parameters of onion (*Allium cepa* L.). M. Sc. (Agri.) Thesis, Uni. of Agr. Sci, Dharwad.
- Hassan Z. F. F. 2002. Effect of some sources of organic manure and levels of potassium on growth ,yield, quality and chemical composition of pepper (*Capsicum annuum L.*). Ph. D. Fac. Agric. Cairo Univ. Cairo, Egypt.
- Ijoyah, M. O., H. Rakotomavo and M. V. Naiken. Yield performance of four onion (*Allium cepa*L.) cultivars compared with the local variety under open field conditions at Anse Boileau,
- Ishwori, P.G. B. Khatri and G.P. Paudel. (2006). Evaluation of different cultivars of onion and their transplantation times for off-season production in mid hills of Nepal. Nepal Agri. Res. J. 7: 21-26.
- Islam, M .A. A. T. M. Shamsuddoha, M .S .I .Bhuiyan and Miyza Hasanuzzaman 2008. Response of Summer Onion to Potash and its Application Methods. American-Eurasian J. of Agron. 1 (1): 10-15.
- Jilani. M. S. P. Ahmed, K. Waseem and M. Kiran.(2010) Effect of plant spacing on growth and yield of two varities of Onion (*allium cepa* l.) Under the agro- climatic condition of d. I. Khan. *Pakistan journal of science vol. 62 pp 243-249.*
- Khan, H. B. M. iqbal, A. Ghafoor and K. Waseem. (2002). Effect of various plant spacing and different nitrogen levels on the growth and yield of Onion (Allium cepa.L). Online J. Biol. Sci. 2(8): 545- 547.
- Khan, M. A. M. K. Hasan, M. A. J. Miah, M. M. Alam and A. S. M. H. Masum. 2003. Effect of plant spacing on the growth and yield of different cultivars of onion. Pak. J. Biol. Sci. 6 18: 1582^{-1}585.
- Khan, M. A. M. K. Hasan, M. A. J. Miah, M. M. Alam and A. S. M. H. Masum. Effect of plant spacing on the growth and yield of different cultivars of onion. Pakistan J. Biol. Sci. 6 18: 1582-1585.(2003).
- Khan, M. U. H., M. Imran and T. H. Chattha. (2005). Effect of irrigation intervals on growth and yield of onion cultivars Swat–1 and Phulkara. J. Applied Sci.Res. 1 2: 112^{-1}16.
- Koondhar, D. M. 2001. Productivity performance of Phulkara onion under different NPK regimes with stop page of P and K. web site: http://www. parc.gov. pk /NARC/ narc .html.
- Koondhar, D.M. 2001. Productivity performance of Phulkara onion under different NPK regimes with stoppage of P and K. web site: http://www. parc.gov. pk/NARC/ narc.html.
- Kumar, A. R. S. and R. K. Chhillar, 2001. Influence of nitrogen and potassium application on growth, yield and nutrient uptake by onion (Allium cepa). Indian J. Agron. 46(4) : 742 – 746.
- Kumar, A. R. S. and R. K. Chhillar, 2009. Influence of nitrogen and potassium application on growth, yield and nutrient uptake by onion (Allium cepa). Indian J. Agron. 46(4) : 742 – 746.
- Kumar, A., Ranbir Singh and Chhillar, R. K., 2001, Influence of nitrogen and potassium application on growth, yield and nutrient uptake by onion (Allium cepa). Indian J. Agron. 46(4) : 742 – 746.
- Kumar, H., J.V. Singh, K. Ajay, S. Mahak, A. Kumar and M. Singh. .(1998). Studies on the effect of spacing on growth and yield of onion (*Allium cepa*L.) cv Patna Red. Indian J. Agri. Res., 2: 134 $^{-1}$38
- M. Murashkina, M. R. J. Southard and G. S. Pettygrove. 2006. Potassium Fixation in Silt, Sand and Clay Fractions of Soils Derived from Granitic Alluvium of the San Joaquin Valley, California.The 18th World Congress of Soil Science (July 9^{-1}5, 2006) at Philadelphia, Pennsylvania, USA.
- Madan, S. P. S. and J. S. Sandhu. 1985. Influence of nitrogen, phosphorus and potash levels on the growth, bulb yield and dry matter production of white onion variety Punjab-48. Punjab veg. Grower, 20, 17-24. (hort. Absts. 55(3) : 1845).
- Mallangowda, B., Sulikeri, G. S., Hulamani, N. C., Murthy, B.G. and Mudalgeri,B. B., 1995 Effect of NPK and FYM on growth parameters of onion, garlic, and coriander. Cur. Res., 24(11) : 212-213
- Mlik, M. N. 1994. Bulb crops, onion. In Hort. P.P.500-501.National book foundation Islamabad Pakistan i996.
- Mohanty, B.K and A.M. Prusti. (2001). Performance of common onion cultivars in Kharif seasons. J. Tropical Agri. 39: 21-23.
- Murashkina, M., R.J. Southard and G.S. Pettygrove. 2006. Potassium Fixation in Silt, Sand and Clay Fractions of Soils Derived from Granitic Alluvium of the San Joaquin Valley, California.The 18th World Congress of Soil Science (July 9^{-1}5, 2006) at Philadelphia, Pennsylvania,USA. Web site: http://acs.confex.com /crops/wc2006/ techprogram/index.html.
- Nabi, G., N. Rahman, A. Samad, Z. Ali and J. Khan. 2000. The effect of sulphate of potash (SOP) versus muriate of potash (MOP) on the yield of potato (*Solanum tuberosum* L.) crop. *Pak. J. Bio. Sci*., 3(8): p. 1303^{-1}304.
- Nagaich, K. N., Tridevi, S. K. and Fajesh Lekhi, 1998, Effect of sulphur and potassium fertilization on onion (*Allium cepa*L.). South Indian Hort., 46(5 & 6) : 266 – 271.

- Naidu A.K., J.P. Tiwari, S.K. Dwivedi and S.K.Saxena, 2000. Effect of various levels of N, P, and K on physiological growthdeterminants of productivity in garlic *(Allium sativum Linn.).* Vegetable Science, 27 (2): 165-167.
- Nandi, A. and Nanda, R. R., 1992, A role on the onion yield as influenced by different levels of nitrogen and potash. Haryana J. Hort. Sci. 21(1-2) : 110 – 111.
- Nandi, R. K., Deb, M., Maity, T. K. and Sounda, G., 2002, Response of onion to different levels of irrigation and fertilizer. Crop Res., 23(2) : 317 – 320.
- Pakyurek, Y. K. Abak, N. Sari, H. Y. Guler, I. Babik and J. Rumpel. 1994. Effects of sowing dates and plant densities on the yield and quality of some onion varieties in Southeast Anatolia. 7th int. Syrnp. On timing Held pro. of vege. Skicrniewice, Poland, 23-27 Aug. 1993.Ada horti .No. 371: 209-214.
- Pakyurek, Y. K. Abak, N. Sari, H. Y. Guler, I. Babik and J. Rumpel. 1994. Effects of sowing dates and plant densities on the yield and quality of some onion varieties in Southeast Anatolia. 7th int. Syrnp. On timing Held pro. of vege. Skicrniewice, Poland, 23-27 Aug. 1993.Ada horti .No. 371: 209-214.
- Patel, K. P., J. C. Patel and S. G. Sadaria. 1992. Yield and nutrient uptake by onion (*Allium cepa L.*) and influenced by irrigation, nitrogen and phosphorus. Indian J. Agri. 37 (2) : 395-396. Hort. Absts. 064-00251).
- Pervez, H. M. Ashraf and M. I. Makhdum. 2004. Influence of potassium rates and sources on seed cotton yield and yield components of some elite cotton cultivars. Journal of Plant Nutrition, 27 .(7): 1295-1317.
- Pramanick, K. K., Narendra Singh and Netrapal, 1999, Physiological effect on growth, yield and storage qualities on onion (*Allium cepa*L.). Indian J. Agric. Sci., 69(2): 126 – 128.
- Rao, H. M. and T. R. Subramanian. 1991. Effect of potassium application on the yield and content of Zn, Ca and Mg in cabbage Okra, tomato and beetroot. J. Pot. Res., 7(3) : 90 – 197.
- Rashid, M. A. and M. M. Rashid. 1978. The effect ofspacing on the yield of onion. Hort. Abstr., 48(6): 481.
- Rumpel. J. and K. Felezynski. 1997. Effect of plant density and cultivar on yield responses in onion (*Allium ccpa* L.) grown from seeds. Acta Agrobotanica.50 (1-2) 22 1 -229.
- Sagadraca, V. B., 1988, Bulb yield and potassium content of multiplies type (native) onions as affected by potassium fertilization and planting method. Munoz, Nurva Ecija, p. 68.
- Salimath, S. S., 1990, Studies on status of potassium and sulphur in soils and their effect on onion (*Allium cepa*L.). M. Sc. (Agri) Thesis, University of Agricultural Sciences, Dharwad.
- Sarode, P. Hadli. J. and Y. D. Charjan. 2001, Nutrient uptake and yield of onion as influenced by fertilizer levels. J. Soils and Crops,. 11(2): 276-277.
- Shrawan, S. P . K. Yadav and S. Balbir. 2004. Effect of nitrogen and potassium on growth and yield of onion (*Allium cepa* L.) cv. Pusa Red. Haryana J. of Hort. Sci,. 33 (3-4): 308-309. (c.a. CAB Abstr.).
- Shrawan, S., P.K. Yadav and S. Balbir, 2004. Effect of nitrogen and potassium on growth and yield of onion (*Allium cepa*L.) cv.Pusa Red. Haryana Journal of Horticultural Sciences 33 (3-4): 308-309. (c.a. CAB Abstr.).
- Singh R.B. and S.B. Singh, 2000. Significance of nitrogen, phosphorus andpotassium on onion *(Allium cepaL.).* raised from onion sets (bulblets). Vegetable Science 27 (1): 88-89.
- Singh, J. P., Singh, M. K. and Singh, R. D., 1993, Growth and yield of onion (*Allium cepa*L.) bulb as influenced by date of transplanting, nitrogen and potash fertilization. Veg. Sci., 20(1): 14 – 17.
- Singh, J., 1998, Effect of stocksorb polymers and potassium levels on potato and onion. J. Pot. Res., 15(1 – 4) : 78 – 82.
- Singh, R. B. and S. B. Singh. 2000. Significance of nitrogen phosphorus and potassium on onion *(Allium cepa L.).* raised from onion sets (bulblets). Veg. Sci,. 27 (1): 88-89.
- Singh, S., Yadav, P. K. and Balbir Singh, 2004, Effect of nitrogen and potassium on growth and yield of onion (*Allium cepa*L.) Cv. Pusa Red. Haryana J. Hort. Sci., 33(3 & 4) : 308 – 309.
- Steel, R .G .D. and J. H. Torrie. 1980. Principals and procedures of statistics. A biometrical approach. McGraw-Hill, New York.
- Stoffella, PJ. 1996. Planting arrangement and density of transplants influence sweet Spanish onion yields and bulb size. Hort. Sci.31 (7): 1 129-1 130.
- Tahir .S., Hadli, J. and Charjan, Y. D., 1986, Nutrient uptake and yield of onion as influenced by row spacing. J. Soils and Crops,. 11(2): 276-277.
- Thomson, H.C. and W.C. Kelly, 1982. Bulb crops vegetable crops. Ta Ta .McGrew- hill publishing company limited New York. Reprinted at Pak Printing works, Lahore. (.P. P. 61).
- Tiwari, R. S. and Agarwal, A., 2003, Influence of N, P, K levels on yield of garlic (Allium sativum L.). J. Pot. Res. 19 : 119 – 123.under low and high temperature conditions. M. Sc. Thesis, Fac. Agric. Cairo Univ.

Cairo, Egypt.
- Verma, T.S., R. Chand, P.C. Thakur, K.D. Lalkhanpal, A. Singh, R. ('hand and A. Singh. 1994. Effect of bulb size and plant spacing on seed yield of onion. Ind. J. Hill Farming. 7(1): 102-104.
- Viegas, A.D.A. 1996. Effect of nitrogen and spacing on bulb splitting in onion cv. Bombay Red. TVIS Newsl. 1 (2): 26 p.
- Weerasinghe, S.S., R. Fordhan, I, Babik and J. Rumpel. 1994. The effect of plant density on onion established from multi-seeded transplants. 7th int'l. Symp. on timing field production of vegetables, Skiemicwice, Poland. Acta Horticulturae. 371: 97-104.
- Yadav, R.L., Sen, N.L., Fageria, M. S. and Dhaka, R. S., 2002, Effect of nitrogen and potassium fertilization on quality bulb production of onion. Haryana J. Hort. Sci. 31(3&4): 297-298.