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

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ABSTRACT: A field experiment was carried out to study the effect of plant spacing on the growth and yield of two cultivars of onion, under the agro-climatic conditions of Dera Ismail Khan. The experiment was laid out in split plot design with two cultivars in main plots and plant spacing in sub-plots. The aim of this study was to evaluate the performance of Naurang local and Phulkara cultivars with respect to different plant spacing (10, 15, 20 and 25 cm). The data on number of leaves/ plant, plant height, leaf length, bulb weight, bulb diameter, bulb yield/ plot and total yield t/ha were recorded. Significant variations were recorded for two onion cultivars and different plant spacing for all the parameters studied. Phulkara excelled in all the parameters against Naurang Local as it produced maximum leaves per plant (9.63), plant height (52.98 cm), leaf length (46.32 cm), bulb weight (56.40 g), bulb diameter (5.25 cm), bulb yield per plot (2.89 kg) and total yield (10.78 t/ha). Among plant spacing, although, the widest plant spacing (25 cm) produced the maximum leaves per plant, plant height, bulb weight and bulb diameter but it reduced the yield per plot and total yield. However, closest plant spacing (10 cm) produced significantly maximum yield per plot and total yield. For better yield of onion, Phulkara cultivar with closet plant spacing of 10 cm is highly recommended for D.I.Khan conditions.

Key words: Onion, *Allium cepa*. L, plant spacing, plant height, yield.

INTRODUCTION

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

It is adapted to a wide range of temperatures and is frost tolerant. Best production is obtained when cool temperature prevails over an extended period of time, permitting considerable foliage and root development before bulb formation starts. After bulb formation begins, high temperature and low relative humidity extending into the harvest and curing period are desirable. Some important cultivars grown in Pakistan includes Swat-1, Phulkara, Sariab Red, Chiltan-89, Desi red, Shah Alam etc.

The onion has its own distinctive flavor and used in soups, dishes, salad and sandwiches and is cooked alone as a vegetable. It is consumed at its young green stage or after its full development and maturity when it is harvested in the form of a dry bulb. Its pungency is due to the presence of volatile oil (allylpropyl disulphide). The mature bulbs contain some starch, appreciable quantities of sugar, some protein, and vitamins A, B and C. Keeping in view the consumption rate and continuous market demand, it can be easily assumed that there is always shortage of onion in Pakistan. This could be attributed to lower yields per unit area coupled with increase in population. Since the population is expected to be doubled with in next few years, therefore, productivity per unit area will have to be increased substantially to meet expected food requirements. The high and the valuable yield can be obtained only if all growth factors act together optimally. Spacing is an important factor for the production of onion. Onions are grown in different spacing to find the best spacing for the achievement of higher yield and optimum production. Bulb size and weight is increased with increasing with inter and intra row spacing but total bulb yield becomes higher with closer spacing (Rashid and Rashid, 1978). Stoffela (1996) found that as number of rows per bed increased or in-row spacing decreased, marketable onion yield linearly increased and mean bulb size (g/bulb) decreased. According to Balraj et al., (1998) with increase in spacing, the bulb weight and size increased, but the yield/ ha decreased. Spacing is very responsive regarding plant height, length and the diameter of longest leaf, diameter of the thickest stem, number of leaves/ plant, plant spread, bulb diameter and highest bulb yield, in case of onion. The spacing has a direct effect on the quality and production of onion. Spacing of 10-15 cm is found to be the best one as

compared to others (Kumar *et al.,* 1998). Resende *et al.,* (1999) reported that higher yield was obtained with 10 cm plant spacing and with further increase in spacing, the yield decreased. Mohanty and Prusti (2001) advocated onion cv. Arka Niketan and Pusa Madhavi for medium sized bulbs, better storage quality and high yielding characters. Khan *et al.,* (2002) reported that various plant spacing resulted in the increased plant height, onion bulb size, weight of the bulbs, bulbs per plot and yield of the bulbs. Ghafoor *et al.,* (2003) concluded in their study that onion cultivar Phulkara gave the best results for plant height and leaf length. Khan *et al.,* (2003) reported that wider spacing (20 X 10 cm) produced higher size of plant height, leaf length and number of leaves, bulb length, diameter and weight of onion. On the contrary, highest yield was observed at the closest spacing (7.5x7.5 cm) and the lowest yield at widest spacing (20x10 cm). Khan et al., (2003) further added that BARI Piaz-1 performed better in respect of yield and other parameters. Khan *et al.,* (2005) reported that Swat-1 performed better for bulb yield and plant growth parameters as compared to Phulkara under the climatic conditions of Rawalpindi. Ijoyah *et al.,* (2008) observed that onion variety 'CAL 606' recorded the highest number of leaves, bulb size, biological bulb weight, economic bulb weight, dry bulb weight and best yield amongst the other cultivars. Keeping in view, the importance of these problems the present study was under taken to find out the optimum plant spacing to get maximum growth and yield of two onion cultivars under the agro-climatic conditions of D.I.Khan

MATERIALS AND METHODS

The present research project was conducted at the Horticultural Research Area, Faculty of Agriculture, Gomal University, Dera Ismail Khan. The experiment was laid out in split-plot arrangements using Randomised Complete Block Design (RCBD). There were three replications in the trial and each sub-plot size was kept as 1.5 x 1.5 m^2.

To find out optimum plant spacing on the growth and yield of onion, two onion cultivars (Naurang Local and Phulkara) were allotted as main plots and four different plants spacing (10, 15, 20 and 25 cm apart) were assigned as sub-plots.

The experimental area was thoroughly prepared by ploughing the soil three times. All the required cultural practices were kept constant such as irrigation, weeding, pest and disease control etc. and given uniformly in all the experimental plots. Seedlings of the same size were transplanted with row to row distance of 30 cm and the plant to plant spacing was kept according to treatments. All the four hoeings were practiced manually to check the growth of different weeds during the growth period of the crop.

The crop was harvested manually, when most of the leaves turned yellow and after attaining of full size of bulbs. The parameters under study were number of leaves per bulb, plant height (cm), leaf length (cm), bulb weight (g), bulb diameter (cm), bulb yield per plot (kg) and total yield (t/ha). The results were analyzed by using the Analysis of Variance Techniques (Steel *et al.,* 1997) and Duncan's Multiple Range Test (Duncan, 1955) was used to check the differences among the various treatment means.

RESULTS AND DISCUSSION

Number of leaves per bulb: The results concerning with the number of leaves per bulb of onion demonstrated significant variations for the different plant spacing, cultivars and their interaction (Table 1).

In case of onion cultivars, significantly maximum leaves per bulb (9.63) were recorded in cv. Phulkara, while Naurang Local produced 9.15 leaves per bulb. Our results get support from the previous work done by Ghafoor *et al.,* (2003) and Ijoyah *et al.,* (2008) who also reported significant results for number of leaves per bulb, for different onion cultivars.

Various plant spacing also showed a significant effect on the number of leaves per bulb of onion. Maximum leaves per bulb (9.94) were obtained in plants with 25 cm spacing, followed by plants with 20 cm and 15 cm plant spacing with 9.58 and 9.22 leaves per bulb, respectively and both these spacing showed non-significant behavior against each other. Whereas the closest (10 cm) spaced plants gave the minimum number of leaves per bulb (8.45). It might be due to the competition among the plants to achieve the required food for their growth due to the closer spacing. Khan *et al.,* (2002) also reported that closed plant spacing produced minimum plant height in onion, due to higher competition between the plants.

On the other hand, the interaction between the two factors was significant. Maximum leaves per bulb (10.21) were recorded in phulkara with 25 cm plant spacing, followed by Phulkara with 20 cm plant spacing and Naurang Local with 25 cm plant spacing having 9.83 and 9.67 leaves, respectively and all these treatments were statistically alike. The least response was reported in both Naurang local and Phulkara with 10 cm plant spacing with 8.66 and 9.03 leaves per bulb, respectively.

Plant height (cm): The data regarding the height of the onion plants showed significant results for onion cultivars and different plant spacing, as shown in the Table-1. Significantly maximum plant height (52.98 cm) was recorded in Phulkara, whereas Naurang Local produced 50.18 cm long plants. Similar results were quoted by Ghafoor *et al.,* (2003) who also described that Phulkara

cultivar produced maximum plant height as compared to other onion cultivars.

Various plant spacing significantly affected the plant height in onion production. Maximum height (55.48 cm) was recorded in the plants spaced 25 cm, followed by the plants spaced by 20 and 15 cm apart with 52.45 and 51.24 cm long plants, respectively, whereas the least plant height (49.14 cm) was reported in the plants with closet plant spacing i.e. 10 cm. Similarly, Khan *et al.,* (2002) also reported that due to higher competition amongst the lowest plant spacing, it produced least response for plant height in onion. Our results are in agreement with the previous findings of Khan et al., (2003) who also reported that wider plant spacing (20X10 cm) produced higher plant size, in onion. Interaction between both the factors was non-significant.

Leaf Length (cm): The data revealed that onion cultivars, different plant spacing and their interaction had showed a significant behavior for leaf length, as shown in Table 1. Maximum leaf length (46.32 cm) was recorded in Phulkara, whereas, Naurang local had produced 42.31 cm long leaves. Similar results were quoted by Ghafoor *et al.,* (2003) who also reported that onion cv. Phulkara produced significantly longer leaves (46.55 cm) as compared to other onion cultivars.

Maximum leaf length (43.68 cm) was recorded in plants spaced 20 cm apart, closely followed by the plants spaced at a wider spacing of 25 cm, producing 43.14 cm long leaves and both these spacing were at par with each other. Whereas, shortest leaves (40.53 cm) were observed in plants, with the closet plant spacing of 10 cm.

As far as, interaction is concerned, statistically similar results were recorded for the plants at wider spacing (20 and 25 cm) for both the cultivars. Whereas the least response was noticed by both the cultivars with the closet spacing of 10 cm. The results showed that wider spacing produced much longer leaves as compared to closer spacing. Similar results were quoted by Khan *et al.,* (2003) who also reported that wider spacing produced higher leaf length in various onion cultivars.

Bulb Weight (g): The results showed that onion bulb weight was statistically affected by onion cultivars and spacing, whereas their interactions were non-significant. Amongst the cultivars, Phulkara produced much heavier bulbs (56.40 g) as compared to Naurang Local, producing bulbs of 53.96 g.

For spacing, the result once again showed the supremacy of widest spacing as it produced much heavier bulbs as compared to the other spacing. Significantly maximum bulb weight (59.82 g) was recorded in plants spaced at 25 cm apart, followed by 20 cm apart plant spacing with 57.45 g weighed bulbs. Production of heavier bulbs in wider spacing might be attributed to the fact that, plants widely spaced experienced littler or no competition for limited environmental resources compared to closely spaced plants. Similar results were quoted by Balraj *et al.,* (1998), Khan *et al.,* (2002) and Khan *et al.,* (2003) who stated that wider plant spacing in onion, resulted in heavier bulb production.

Bulb Diameter (cm): The data regarding bulb diameter showed that onion cultivars, plant spacing and their interaction showed significant behavior.

Significantly maximum bulb diameter (5.25 cm) was recorded in Phulkara, whereas, Naurang Local produced bulbs of 4.32 cm diameter (Table 2). Our results get support from the previous findings of Mohanty and Prusti (2001) and Ishwori *et al.,* (2006) who also reported significant variations for bulb diameter amongst different onion cultivars.

Significant variations were also observed for different plant spacing, as the widest spacing once again showed its superiority over all the other spacing. Significantly maximum bulb diameter (5.69 cm) was recorded in the widest plant spacing, followed by 20 cm spaced plants, producing 5.00 cm bulb diameter and closest spacing (10 cm) with 3.99 cm bulb diameter. Khan *et al.,* (2003) also reported similar results by stating that wider plant spacing increased the bulb diameter in onion.

The interaction also showed that wider spacing produced maximum bulb diameter. Maximum onion bulb diameter of 5.93 and 5.38 cm were recorded in Phulkara and Naurang Local with 25 cm plant spacing, respectively. As the plant spacing was reduced the bulb diameter also reduced. The reason may be due to the higher number of bulbs competiting for the nutrients, shade and water under low plant spacing and vice versa. Our results are in agreement with the previous findings of Balraj *et al.,* (1998) who also stated that increasing the plant spacing will result in an increase in onion bulb diameter.

Bulb yield per plot (Kg): Data showed that bulb yield per plot was significantly affected by onion cultivars, different plant spacing and their interaction, as shown in Table 2. The results showed that onion cultivar Phulkara produced comparatively higher bulb yield per plot (2.89 kg) than Naurang Local (2.40 kg). Similar results were quoted by Ghafoor *et al.,* (2003) who also reported significant variation among different onion cultivars for bulb yield per plot.

Different plant spacing also affected the bulb yield per plot. The data showed that maximum onion bulb yield per plot (3.29 kg) was recorded in the plants with the closet plant spacing of 10 cm. It was followed by the plant spacing of 15 and 20 cm producing an average yield of 2.45 and 2.28 kg per plot, respectively and both these spacing showed statistically alike results for each other. The minimum bulb yield per plot (1.64 kg) was reported with the widest plant spacing (25 cm). The reason, for

such a result might is obvious as with wider plant spacing the number of seedling bulbs were reduced, thus causing a reduction in yield and vice versa. Kumar *et al.,* (1998) also reported similar results by stating that closet plant spacing produces higher onion bulb yield.

The maximum bulb yields per plot (3.57 and 3.22 kg) were recorded in plants with the closest plant spacing of 10 cm in both Phulkara and Naurang Local, respectively. With increasing the plant spacing the yield started declining as the number of marketable bulbs reduced. The results in Table 2 also showed that widest plant spacing (25 cm) responded with the least bulb yield per plot for both the cultivars.

Total Yield (t/ha): Similar trend of results were obtained for total yield (t/ha) as were observed in bulb yield per plot (kg). Onion cv Phulkara produced more onion yield (10.78 t/ha) than Naurang Local with 10.17 t/ha. Our results also get support from the previous work done by Ishwori *et al.,* (2006) who also reported that mean highest fresh bulb yield (16.6 t/ha) was observed in onion cv. N-53.

Table 1: Number of leaves per plant, plant height (cm), leaf length (cm) and bulb weight (g) of two onion cultivars as affected by different plant spacing.

Cultivars	Spacing				Means
	10 cm	15 cm	20 cm	25 cm	
Number of leaves per plant					
Naurang	8.66 d	8.99 cd	9.32 bc	9.67 ab	**9.15 b**
Phulkara	9.03 cd	9.45 bc	9.83 ab	10.21 a	**9.63 a**
Means	**8.45 c**	**9.22 b**	**9.58 b**	**9.94a**	
Plant Height (cm)					
Naurang	47.18 N.S.	49.42	51.05	53.07	**50.18 b**
Phulkara	51.10	53.07	53.86	53.88	**52.98 a**
Means	**49.14 d**	**51.24 c**	**52.45 b**	**53.48 a**	
Leaf Length (cm)					
Naurang	40.62 cd	42.00 bc	43.58 a	43.05 ab	**42.31 b**
Phulkara	40.43 d	41.83 bcd	43.78 a	43.23 ab	**46.32 a**
Means	**40.53 c**	**41.92 b**	**43.68 a**	**43.14 a**	
Bulb Weight (g)					
Naurang	50.80 N.S.	51.23	55.97	57.84	**53.96 b**
Phulkara	49.98	54.86	58.94	61.80	**56.40 a**
Means	**50.39 d**	**53.04 c**	**57.45 b**	**59.82 a**	

Any two means (s) not sharing common letter (s) are significant at 5%.
N.S. = Non-significant

Table 2: Bulb diameter (cm), cull bulb weight (kg), bulb yield per plot (kg) and total yield (t/ha) of two onion cultivars as affected by different plant spacing.

Cultivars	Spacing				Means
	10 cm	15 cm	20 cm	25 cm	
Bulb Diameter (cm)					
Naurang	3.50 g	3.96 f	4.44 c	5.38 b	**4.32 b**
Phulkara	4.49 e	5.01 d	5.56 bc	5.93 a	**5.25 a**
Means	**3.99 d**	**4.49 c**	**5.00 b**	**5.65 a**	
Bulb Yield per Plot (kg)					
Naurang	3.22 a	2.50 b	2.31 b	1.59 c	**2.40 b**
Phulkara	3.57 a	3.20 a	2.70 b	2.09 c	**2.89 a**
Means	**3.29 a**	**2.45 b**	**2.28 b**	**1.64 c**	
Total yield (t/ha)					
Naurang	14.28 a	10.25 b	9.20 b	6.95 c	**10.17 b**
Phulkara	14.97 a	10.67 b	9.99 b	7.47 c	**10.78 a**
Means	**14.62 a**	**10.46 b**	**9.50 b**	**7.21 c**	

Any two means (s) not sharing common letter (s) are significant at 5%.

Due to higher number of marketable bulbs, the closet plant spacing produced significantly higher total

yield (14.62 t/ha), followed by 15 and 20 cm plant spacing with an average bulb yield of 10.46 and 9.50 t/ha, respectively. However, the least response for total bulb yield was recorded for the widest plant spacing (25 cm) with a yield of 7.21 t/ha. Similar results were quoted by Kumar *et al.,* (1998) and Resendle *et al.,* (1999) who also reported that decreasing the plant spacing will ultimately increase the total yield in onion.

As far as, interaction was concerned, the plants with closest plant spacing (10 cm) excelled in bulb yield as it produced maximum bulb yields of 14.97 and14.28 t/ ha for Phulkara and Naurang Local, respectively. The results further revealed that by increasing the spacing the yield also showed a declining trend as was obvious due to the presence of low number of marketable onion bulbs.

CONCLUSION: It can be concluded from the present investigation that onion cultivar Phulkara responded well for all the parameter studied. Although, wider plant spacing increased the vegetative growth, bulb weight and diameter, but decreased the yield, under the agro-climatic conditions of Dera Ismail Khan.

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