

Research Article

Influence of transplanting dates and population densities on the growth and yield of onion

Muhammad Ali^{1,2*}, Abdur Rab², Jawad Ali², Husain Ahmad^{1,2}, Sikandar Hayat^{1,2}, Kashif Wali², Anwar Rashid², Waqas Ahmad^{1,3} and Haji Muhammad²

1. College of Horticulture, Northwest A & F University, Yangling, Shaanxi, China 712100.

2. Department of Horticulture, The University of Agriculture Peshawar, Pakistan.

3. College of Agronomy and Biotechnology, China Agricultural University, Beijing, P. R. China

*Corresponding author's email: maliaup4@gmail.com

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Abstract

A field experiment was carried out to study the “Influence of transplanting dates and population densities on the growth and yield of onion” was carried out at Dargai with collaboration of Agriculture Extension Department, Dargai Malakand Division, Pakistan. The experiment was designed as Randomized Complete Block Design (RCBD) as Split plot arrangement having two factors, transplanting dates and row spacing. Transplanting dates (15th December, 31st December and 15th January) were in the main plots while row spacing (15, 20, 25 and 30 cm) were in sub plots replicated three times. Recommended dose of NPK (120: 90: 60) kg ha⁻¹ were applied. Swat-I variety of onion was grown. The data on number of leaves plant⁻¹, plant height (cm), leaf width (cm), bulb diameter (cm), average bulb weight (g), number of bulbs kg⁻¹ and total yield t ha⁻¹ were recorded. Significant variations were recorded for transplanting dates and different row spacing for all the parameters studied. The mean data showed that plants with transplanting date of 15th December resulted best in all the parameters, i.e. maximum number of leaves plant⁻¹ (9.94), plant height (47.58 cm), leaf width (1.42 cm), bulb diameter (6.06 cm), average bulb weight (79.70 g) and yield (28.64 t ha⁻¹). Among row spacing, the maximum row spacing (30 cm) produced the maximum number of leaves plant⁻¹ (10.18), plant height (47.00 cm), leaf width (1.41 cm), bulb diameter (6.58 cm) and average bulb weight (91.59 g). Maximum number of bulbs (18.22 kg⁻¹) was recorded at plants with row spacing of (15 cm). However, plants with row spacing (20 cm) produced a maximum yield (29.29 t ha⁻¹). It is concluded from the experimental study that best yield was observed at row spacing 20 cm with a transplanting date of 15th December, therefore recommended for onion production under the agriculture climatic condition of Malakand.

Key words: Onion (*Allium cepa* L.); Transplanting dates; Row spacing; Number of leaves plant⁻¹; Plant height

Introduction

Onion botanically called as *Allium cepa* (Latin), is a bulbous crop belongs to *Amaryllidaceae* family. It is commercially grown in different countries including Pakistan. It is used in green as well as in bulb stages [1]. Genus *Allium* has about 300 species and many of them have onion flavor and smell [2].

Onion is a monocotyledonous, cross-pollinated, biennial, cool-season, and comparatively shallow rooted [3]. Its bulb has a sulphur-bearing compound, which is volatile oil (allyl propyl disulphide) and pungent. Onion stores food as starches, sugar or oils. In the first year, an onion plant stores sugars in the bulb; this is actually swollen leaf base. In the second years, this sugar is used up as the plant grows and flowers. When the sugar of onion is strongly heated it turns the onion brown [4].

Agronomic practices greatly influence onion production among which, planting time is one of the important factor that greatly affect the growth and yield of onion [5]. Early planting gives the longest growth cycle and thus the highest yield (16th November) [6, 7]. On the other hand, high temperature faced by late planting results in early maturity and thus lower yield. Optimum time of planting gives favourable conditions for maximum vegetative growth and it is not obtained with the delayed planting [8, 9].

For the production of onion spacing is very important factor. It directly influences the quality and production of onion. Proper spacing of onion crop may be a significant factor for economic and high bulb yield. Khan *et al.* [10] who stated that, the wider spacing (20 x 10 cm) gave maximum number of leaves, leaf length, plant height, bulb length, diameter and weight of onion. As plant population increases, onion bulb

yield also increases because the leaf canopy intercepts a higher percentage of light [11]. Plant population needs to be optimized. The optimum use of spacing or plant population has dual advantages [12]. It avoids strong competition between plants for growth factors such as nutrient, water and light. In addition, optimum plant population enables efficient use of available cropland without wastage. So it is a great time to respond these problems.

Materials and methods

An experiment entitled “The influence of transplanting dates and population densities on the growth and yield of onion” was carried out at Dargai with collaboration of Agriculture Extension Department, Dargai Malakand Division. The experiment was designed as Randomized Complete Block Design (RCBD) having a split plot arrangement. Two factors viz, transplanting dates and row spacing. Swat-I variety of onion was grown.

Soil was ploughed thoroughly and leveled. Well-decomposed farmyard manure was mixed with the soil. Swat-I variety of onion was used. Different row spacing was given in the field. All other practices were done usually. Recommended dose of NPK (120: 90: 60) kg ha⁻¹ were applied. In this experiment, Urea was source of nitrogen having 46% of nitrogen which was applied in two split doses. Half dose was applied at the time of transplantation and half after one month of transplantation. Sulphate of potash was source of potash, having 50% of potash while single super phosphate was source of phosphorous, having 18% of phosphorous. From experimental field, soil samples were taken randomly from different places at 15 to 30 cm depth before other fertilizer applications were analyzed. Below the given figures 1 and 2 showed the average rainfall and temperature of that experimental year (2011-2012) of dargai area.

Apparently equal height and vigor seedling was transplanted on December 15th, December 31st and January 15th in the field with the row spacing of 15, 20, 25 and 30 cm. The seedling was immediately irrigated. Cultural practices i.e. hoeing, weeding, etc. was performed on a regular basis throughout the experiment.

Statistical analysis

The data of different parameters were Analysis for Variance (ANOVA) technique

to see the differences between different treatments and their interactions. In cases where differences were found significant, the means were further assessed for differences using Least Significant Difference (LSD) test. Statistical computer software, MSTATC (Michigan state university, USA), was applied for computing both ANOVA and LSD. (Steel and Torrie, 1980).

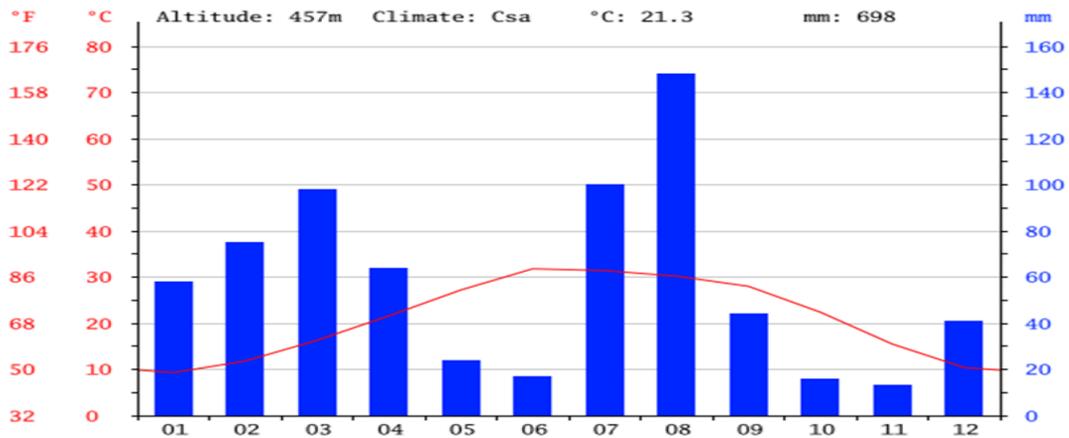


Figure 1. Rainfall graph. The least amount of rainfall occurs in November. The average in this month is 13 mm. The greatest amount of precipitation occurs in August, with an average of 148 mm

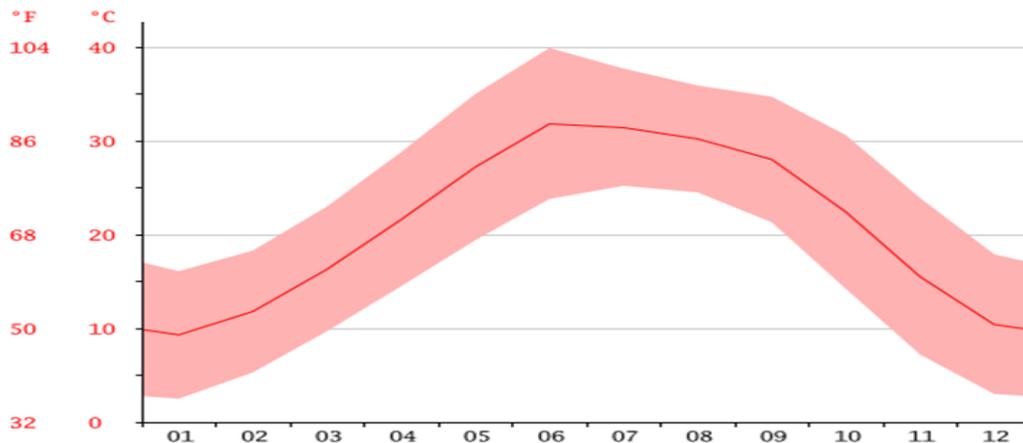


Figure 2. Temperature graph. June is the warmest month of the year. The temperature in June averages 32.1 °C. In January, the average temperature is 9.5 °C. It is the lowest average temperature of the whole year

Results and discussion

The aim of this study was to find out the influence of transplanting dates and different row spacing on the growth and yield of Onion. Onion was sown on (28th Oct, 11th Nov, and 25th Nov) and transplanted on 15th Dec, 31st Dec and 15th Jan respectively, with different row spacing of 15, 20, 25 and 30 cm. The results of the recorded data are discussed as under.

Number of leaves plant⁻¹

The results relating to the number of leaves of onion showed significant variations for the transplanting dates, row spacing and their interactions (Table 1). In case of transplanting dates, significantly maximum number of leaves (9.94) were recorded in 15th December transplantation, which was at par with 31st December transplantation (9.16) while the lowest number of leaves (6.80) was obtained from the seedlings transplanted on 15th January. Seedlings that were transplanted on 15th December resulted in maximum number of leaves. This may be due to the favorable environmental conditions for the specific period of time which positively affected growth of the plant and hence maximum number of leaves was observed. Our results are in agreement with the previous findings of [13], they showed that early sowing favored bulb, leaf and root growth and gave maximum yield. In the same way, the lower number of leaves at later planting dates greatly compared with the results of Attar [9], who reported that later planting resulted in a reduction in the number of leaves, gross yield and net yield.

Different row spacing also showed significant influence on the number of leaves of onion. Highest numbers of leaves (10.18) were obtained in plants with 30 cm row spacing which was statistically different from the rest of treatments, followed by plants having 25 and 20 cm spacing with 9.00 and 8.07 leaves,

respectively. While the plants row spaced at 15 cm gave the least number of leaves (7.29). It might be because of the competition among the plants to get the required food for their growth due to the closer spacing. Weerasinghe [14] also showed the result that rising plant competition significantly reduced seedling leaf number. Mari [15] Rizk [16] also reported that lowering population densities resulted in a higher number of leaves plant⁻¹. Likewise, Singh and Schan [17] stated that with maximum spacing higher number of leaves can be obtained.

The interaction between the transplanting dates and row spacing was also found significant. Highest numbers of leaves (12.00) were noted in 15th December, row spaced at 30 cm followed by 31st December with 30 cm row spacing and 15th December with 25 cm row spacing having 10.67 and 10.18 leaves, respectively. The least response was reported in row spacing of 15 cm transplanted at 15th January (6.00).

Leaf width (cm)

The statistical analysis of data showed that transplanting dates and row spacing, significantly influenced leaf width of onion, whereas the interaction between transplanting dates and row spacing was found non-significant (Table 1). The data showed that 15th December transplantation produced higher leaf width (1.42 cm) than that of 31st December and 15th January having 1.37 and 1.15 cm leaf width, respectively. The reason for such a result might be due to the favorable environmental conditions for the specific period of time which positively affected growth of the plant and hence maximum leaf width was recorded. The same results were shown by Hussain and Islam [18] who reported that early planting produced larger number of leaves plant⁻¹ and leaf width which decreased gradually with delayed planting.

Different row spacing also showed significant influence on leaf width of onion. Higher leaf width (1.41 cm) was obtained in plants with 30 cm row spacing which was statistically different from the rest of treatments, followed by plants having 25 and 20 cm spacing with 1.35 and 1.28 cm widths, respectively. While the plants row spaced at 15 cm gave the least leaf width (1.21 cm). Availability of more sunlight due to wider spacing might have enhanced the number of leaves plant⁻¹ and leaf width. Similar results were shown by Singh and Sachan [17], Naruka and Singh [19] in garlic and Shanti and Balakrishnan [20] in aggregatum onion. Generally high planting density results in less availability of soil nutrients, light and water etc, might be due to this the leaf did not attain their respective size.

Plant height (cm)

The data about the height of plants gave significant results for transplanting dates and different row spacing (Table 1). Plants transplanted at 15th December gave the tallest plants (47.58 cm), which significantly varies from the rest of treatments, followed by 31st December transplantation (42.58 cm). While the minimum plant height (35.42 cm) was recorded in seedlings transplanted on 15th January. The reason for such a result might be due to the favorable environmental conditions for the specific period of time which positively affected growth of the plant and hence maximum plant height was recorded. The same results were shown by Rahman [21] that onion transplanted in December had highest number of leaves (8.6), taller plant up to (50cm) and highest yield 9.6 t ha⁻¹ while in case of January transplant lowest yield of 1.3 t ha⁻¹ was recorded. Plant height has strong positive relation with leaf number plant⁻¹; bulb yield and bulb diameter plant⁻¹. Onion yield

showed significant positive relation with plant height and bulb yield plant⁻¹ [22].

Different row spacing significantly affected the plant height in onion production. Maximum plant height (47.00 cm) was recorded in the plants spaced 30 cm, followed by the plants spaced by 25 and 20 cm with 43.67 and 39.78 cm heights, respectively, while the minimum height (37.00 cm) was reported in the plants with 15 cm row spacing. Likewise, Khan [23] also stated that due to more increased competition amongst the lowest plant spacing, it gave least response for plant height in onion. Our results are in agreement with the previous findings of Khan [10] who also reported that wider plant spacing produced higher plant size, this may due to wider spaces and effective utilization of sun light during photosynthesis.

Interaction between transplanting dates and row spacing was significant. Maximum plant height (53.00 cm) was recorded in onion seedling transplanted on 15th December with 30 cm plant spacing. While lower plant height (33.00 cm) was obtained in seedling transplanted on 15th January row spaced at 15 cm.

Bulb diameter (cm)

The mean data table clearly showed that transplanting dates, row spacing significantly affected bulb diameter where as a non-significant variation was observed in interaction between transplanting dates and row spacing (Table 1). More bulb diameter (6.06 cm) was recorded in seedling transplanted on 15th December, whereas, 31st December produced smaller bulbs (5.56 cm). Seedlings that were transplanted on 15th December resulted in maximum bulb diameter. This may be due to the favorable environmental conditions for the specific period of time which positively affected growth of the plant and hence maximum bulb diameter was

observed. Our results are in agreement with findings of Lisboa [24] and Nes [25] who found that delay in sowing lead to small bulb size.

Different row spacing showed significant variations and the maximum spacing (30 cm) was superior to all the other spacing, where higher bulb diameter (6.58 cm) was obtained, followed by 25 cm spaced plants, giving (6.04 cm) bulb diameter. While seedling row spaced at 15 cm give the lowest bulb diameter (4.01 cm). Khan [10]

also stated that wider plant spacing increases the bulb diameter in onion. As the plant spacing was reduced the bulb diameter also reduced. The reason might be due to the high competition of bulbs for the nutrients, water and shade with low plant spacing and vice versa. Our results get support from the previous work done by Balraj [26] who also stated that increasing the plant spacing resulted in an increased bulb diameter of onion.

Table 1. No. of leaves plant⁻¹, leaf width (cm), plant height (cm), bulb diameter (cm)

	No. of leaves Plant ⁻¹	Leaf width (cm)	Plant height (cm)	Bulb Diameter (cm)
Transplanting Dates				
15th Dec	9.94a	1.42a	47.58a	6.06a
31st Dec	9.16a	1.37a	42.58b	5.56b
15th Jan	6.80b	1.15b	35.42c	4.96c
LSD (0.05)	1.58	0.07	2.64	0.31
Row spacing				
15cm	7.29d	1.21d	37.00d	4.01d
20cm	8.07c	1.28c	39.78c	5.47c
25cm	9.00b	1.35b	43.67b	6.04b
30cm	10.18a	1.41a	47.00a	6.58a
LSD (0.05)	0.529	0.041	1.264	0.233

Means followed by different letter(s) are significantly different at 5% level of significance used LSD test.

Average bulb weight (g)

The data regarding bulb weight (g) of onion is given in (Table 2). The mean data table clearly showed that transplanting dates, row spacing significantly affected bulb weight where as a non-significant variation was observed in the interaction between transplanting dates and row spacing.

The data showed that 15th December transplantation leads to much heavier bulb (79.70 g) as compared to 31st December and 15th January, producing bulbs of 72.62 and 69.14 g, respectively. The reason for such a result might be due to the favorable environmental conditions for the specific period of time which positively affected growth of the plant and hence maximum

average bulb weight was observed. Our results are supported the findings of Singh and Singh [13] and Mingoichi and Mpanda [27] they found that early dates of sowing gave maximum bulb weight which was reduced by late sowing.

The results once again showed that the maximum row spacing (30 cm) was superior to all the other spacing, as it produced much heavier bulb weight as compared to the other row spacing. Significantly maximum average bulb weight (91.59 g) was obtained in the maximum row spacing (30 cm), followed by 25 cm row spacing with (79.76 g) weighed bulbs. While the closest row spacing (15 cm) gave minimum bulb weight (54.50 g). Wider row spacing produced

heavier bulbs and this might be due to effective utilization of environmental resources due to little competition as compared to the closely spaced plants. Similar results were showed by Balraj [26] Khan [10, 23] who stated that wider plant spacing in onion, resulted in heavier bulb production.

Number of bulbs kg⁻¹

The result showed that number of bulbs kg⁻¹ of onion cultivar “Swat 1” was significantly affected by transplanting dates and different row spacing while the interaction between transplanting dates and row spacing was non-significant (Table 2). It was noted that 15th January transplanted seedlings produced a comparatively higher number of bulbs (14.83 kg⁻¹) than 31st December and 15th December having 14.25 and 13.08 numbers of bulbs kg⁻¹, respectively. Seedlings that were transplanted on 15th December resulted in less number of bulbs kg⁻¹. This may be due to the favorable environmental conditions for the specific period of time which positively affected growth of the plant. The results were in conformity with Nes [25] who reported that late sowing reduced bulb size and Khokhar [28] Mingochi and Mpanda [27] also reported that early sowing increase bulbs weight.

Different row spacing also significantly affected the number of bulbs kg⁻¹. The results showed that maximum number of bulbs (18.22 kg⁻¹) was recorded in the plants with the closest row spacing of 15 cm, followed by the row spacing of 20 and 25 cm giving an average number of bulbs 14.44 and 12.56 kg⁻¹, respectively. The minimum number of bulbs (11.00 kg⁻¹) was recorded with the maximum row spacing 30 cm. The reason, for such a result might be that with wider row spacing the number of seedling bulbs were reduced, thus causing a reduction in yield and vice versa. Similar results were quoted by Kumar [29] 1998 Rashid and Rashid [30] who found that onion bulb size

and weight increases with increasing row spacing but reduced total bulb yield. The yield decreased with increasing the row spacing and the number of marketable bulbs reduced.

Total yield ha⁻¹ (tons)

The data in Table 2 showed that yield t ha⁻¹ was statistically affected by transplanting dates and row spacing, while their interactions were non-significant. The data showed that 15th December transplantation produced more onion yield (28.64 t ha⁻¹) than 31st December and 15th January with 26.44 and 25.21 yield t ha⁻¹, respectively. Seedlings that were transplanted on 15th December resulted in maximum yield t ha⁻¹. This may be due to the favorable environmental conditions for the specific period of time which positively affected growth of the plant and hence maximum yield t ha⁻¹ was recorded. The results were in conformity with Brewster [31] Lisboa [24] Nes [25] Guerra and Tomer [32] who stated that delayed sowing date shortened the cultural cycle of the onion cultivars but resulted in small bulb size and lowest yield. Different row spacing significantly affected the yield t ha⁻¹. The lowest bulb yield was recorded for the maximum row spacing of 30 cm with a yield (23.03 t ha⁻¹) while the highest yield (29.29 kg ha⁻¹) was recorded in row spacing of 20 cm. Generally high planting density results in less availability of soil nutrients, light and water etc. due to this the bulbs did not attain their respective size. Our results also support the findings of Rashid and Rashid [30] Kumar [29] Resendle [33] they found that onion bulb size and weight increases with increasing inter and intra row spacing while decreasing the plant spacing will ultimately increase the total yield in onion. The present results also agreed with Stoffella [34] who reported that % age (weight) of small bulbs increased as in-row spacing decreased i.e. as plant density increased. Similarly, Cardoso and

Costa [35] found that higher planting density results in smaller bulb's size; and yield of small bulbs was highest at the highest planting density of 140 plants 4m⁻² Rumpel [36] and Rizk [16] observed that the highest sowing rate (planting density) produced a noticeably higher yield of good quality bulbs than the lower sowing rate. May [37] found similar results that bulb size

decreased as plant population increased from 60 to 108 plants m⁻². Generally, higher onion yield is obtained with increasing plant population (plants ha⁻¹) Bleasdale [38] Brewster and Salter [39] Kelbert [40] and McGeary [41]. The results showed that by increasing the spacing the yield also declined.

Table 2. Average bulb weight (g), number of bulbs kg⁻¹, total yield ha⁻¹ (tons)

	Average Bulb weight (g)	Number of bulbs kg ⁻¹	Total Yield ha ⁻¹ (tons)
Transplanting Dates			
15th Dec	79.70a	13.08b	28.64a
31st Dec	72.62b	14.25a	26.44b
15th Jan	69.14b	14.83a	25.21b
LSD (0.05)	6.54	0.94	1.91
Row spacing			
15cm	54.50d	18.22a	27.63b
20cm	69.43c	14.44b	29.29a
25cm	79.76b	12.56c	27.10b
30cm	91.59a	11.00d	23.03c
LSD (0.05)	5.225	0.904	1.570

Means followed by different letter(s) are significantly different at 5% level of significance used LSD test.

Conclusion and recommendations

In case of population densities, the plants with row spacing of 20 cm resulted in maximum yield of onion. Seedling transplanted on 15th December showed best results regarding number of leaves, plant height, leaf width, bulb diameter, average weight of bulb and yield t ha⁻¹. Since best yield was observed at row spacing 20 cm with a transplanting date of 15th December, therefore recommended for onion production under the agro climatic condition of Malakand. It is recommended that this research be further expended using 5, 10, 15 and 20 cm row to row spacing and 15th Nov, 1st Dec and 15th Dec transplanting dates.

Authors' contributions

Conceived and designed the experiments: A Rab & H Muhammad, Performed the experiments: M Ali, Analyzed the data: S Hayat & H Ahmad, Contributed reagents/

materials/ analysis tools: J Ali, K Wali & W Ahmad, Wrote the paper: M Ali & A Rashid.

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