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Effect of Various Plant Spacing and Different Nitrogen Levels on the Growth and Yield of Onion *(Allium cepa* L.)

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Abstract: Various plant spacing resulted in the increased plant height, onion bulb size, weight of the bulbs, number of the bulbs per plot and yield of the bulbs. In case of different nitrogen levels, all the parameters under the study were significantly affected. However, 12 cm plant spacing with 100 kg N ha^{-1} gave the best results. Maximum yield of onion bulbs (22.90 and 22.82 t ha^{-1}) was obtained from 12 cm plant spacing with 100 kg N ha^{-1}, respectively.

Key words: Onion, *Allium cepa*, spacings, nitrogen, leaves growth, yield

Introduction

Onion (*Allium cepa* L.), belonging to the family Liliaceae, is of great importance due to its medicinal and dietic values. Onion is a bulb crop and also has great significance among the different vegetable crops. There is too much low yield of onion is observed in the Dera Ismail Khan region. Onion production is greatly influenced by the environmental factors, cultivars and agronomic practices. Among the agronomic practices, set size, spacing and nitrogen fertilization play an important role to reach the optimum yield potential. Nitrogen is essential to increase the bulb size and yield but excessively high doses of nitrogen cause delay in bulb maturity. Shaikh *et al.* (1987) found that application of 90 kg N ha^{-1} increased the yield of bulbs. Baloch *et al.* (1991) conducted fertilizer experiments on onion and found that application of 125 kg N with 75kg K_2O gave the highest yield. Bhardwaj *et al.* (1991) found that seed production in onion was enhanced by the application of 80 kg N ha^{-1} and 60 kg P_2O_5 ha^{-1}, which increased the number of scapes, size of the umbel, seeds per umbel and seed yield per plant. Mishra (1994) reported that the application of 120 kg N ha^{-1} significantly increased the number of flowering scapes. Umbel size, seed yield and seed germination. Pandey *et al.* (1994) reported that application of nitrogen @ of 80 and 120 kg ha^{-1} gave significantly higher yield than the lower fertilizer rates. Patel and Vachhani (1994) reported that yield increased with the rate for Nitrogen. Kumar *et al.* (1998) stated that application of nitrogen at 150 kg ha^{-1} gave the best results with regard to plant height, leaf length and the diameter of the longest leaf, diameter of the thickest stem, number of leaves per plant, plant spread, time to bulb maturity, bulb diameter, bulb fresh weight and dried weight, length of the longest root and bulb yield. Kashi and Frodi (1998) observed that the effect of nitrogen fertilizer on the yield and bulb mean weight was significant at 1% level and the highest yield mean and bulb weight was obtained at 120 kg N ha^{-1}. Keeping in view the importance of onion production efficacy, the present study was, therefore, carried out to find the best planting space dozes of Nitrogen, their effects on the bulb yield and related parameters in onion crop under the existing agro-climatic conditions of the Dera Ismail Khan region.

Materials and Methods

This experiment was conducted at the Horticultural Research Area, Faculty of Agriculture, Gomal University, Dera Ismail Khan, in Rabi season, 2000.

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 2 m^2.

To find out optimum plant spacing and as efficient dose of nitrogen fertilizer on the yield of onion, three different plants spacing (main plots) and three levels of nitrogen fertilizers with one control (sub plots) were included in the project. Row to row distance was kept constant i.e. 20 cm and the plants were transplanted on the respective plant spacing in each plot. The plant spacings in main plots were: S1 = 9 cm, S2 = 12 cm and S3 = 15 cm and the nitrogen levels (kg ha^{-1}) in sub plots were: N1 = control, N2 = 50, N3 = 100 and N4 = 150 kg ha^{-1}.

The experimental area was thoroughly prepared by ploughing the soil three times. A red nasik India cultivar of onion was selected for the experiment. The potassic (SOP) and phosphatic (SSP) fertilizers were applied at the seedbed preparation @ 60 + 60 kg ha^{-1} both. The different doses of nitrogen fertilizer (urea) mentioned in the study were applied in two splits doses. The crop was harvested when most of the leaves turned yellow and after attaining of full size of bulbs. The parameters under study were; plant height (cm), number of leaves per plant, size of bulbs (cm), weight of bulbs (g), number of bulbs per plot and bulb yield (t ha^{-1}).

The results were analyzed by using the analysis of variance techniques (Steel and Torrie, 1984) and Duncan's multiple range test (Duncan, 1955) was used to check the differences among the various treatment means.

Results and Discussion

Plant height (cm): The data regarding the height of the onion plants shows the significant results for plant spacing and nitrogen levels (Table 1). Various plant spacing significantly affected the plant height in onion production. Maximum height was recorded as 29.75 cm when the plants were spaced at 12 cm distance amongst each other. While the lowest height was produced by the plants 9 cm apart with 27.50 cm height, which remained non-significant with 15 cm, spaced plants.

On the other hand, different N levels also affected significantly the plant height. As N is mainly concerned with the vegetative growth of the plants, so nitrogen application increased the height of the plants. That is why 100 kg N ha^{-1} gave the highest plant height of 30.36 cm against the minimum height of 25.83 cm, which was observed in the control plots. Further increase in the N rates decreased the height. The results of 50 and 150 kg N ha^{-1} remained non significant between each other. Whereas, Kumar *et al.* (1998) observed the maximum plant height in onion, when the nitrogen was applied @ 150 kg ha^{-1}. As far as the interaction is concerned, no significant variations were observed in both the factors.

Number of leaves per bulb: The results concerning with the number of leaves per bulbs of onion demonstrated significant variations for the different N doses and the interaction between

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Table 1: Different parameters of onion as affected by various plant spacing and different nitrogen levels

Nitrogen levels (kg ha^{-1})	Plant spacing (cm) 9	12	15	Means
Plant height (cm)				
N1= control	25.13NS	26.97	25.40	25.83c
N2= 50	26.97	30.03	28.57	28.52b
N3= 100	29.23	32.17	29.67	30.36a
N4= 150	28.67	29.83	27.43	28.64b
Means	27.50b	29.75a	27.77b	
Number of leaves per bulb				
N1= control	9.33d	10.33c	10.67c	10.11c
N2= 50	10.33c	11.67b	11.67b	11.22b
N3= 100	12.67a	13.00a	12.67a	12.78a
N4= 150	12.67a	12.67a	12.33ab	12.56a
Means	11.25NS	11.92	11.83	
Size of the bulb (cm)				
N1= control	3.80NS	4.40	4.73	4.31c
N2= 50	4.13	5.07	5.10	4.77b
N3= 100	4.50	5.13	4.87	4.83b
N4= 150	5.50	5.90	5.67	5.69a
Means	4.48b	5.13a	5.09a	
Weight of bulbs (gm)				
N1= control	37.17NS	50.93	52.50	46.87d
N2= 50	42.00	56.13	56.53	51.56c
N3= 100	45.83	62.50	62.27	56.87a
N4= 150	45.00	61.00	60.71	55.74b
Means	42.63b	57.64a	58.00a	
Number of bulbs				
N1= control	140.0d	118.7e	99.00f	119.2d
N2= 50	144.0c	119.0e	99.00f	120.7c
N3= 100	149.0a	120.0e	100.00f	123.0a
N4= 150	145.3b	119.3e	99.67f	121.4b
Means	144.6a	119.3b	99.42c	
Bulbs yield (t ha^{-1})				
N1= control	17.33e	20.13c	17.31e	18.25d
N2= 50	20.13c	22.24b	18.63d	20.34c
N3= 100	22.74b	24.98a	20.74c	22.82a
N4= 150	22.02b	24.24a	20.09c	22.12b
Means	20.56b	22.90a	19.19c	

Any two means in their respective column not sharing a common letter(s) are significant at 5 % level of probability.

two factors (Table 1).

Various plant spacing did not significantly affect the number of leaves per bulb of onion. However, maximum leaves per bulb (5.92) were obtained from 12 cm spaced plants whereas the 9 cm spaced plant gave the minimum number of leaves per bulb i.e. 5.25. It might be due to the competition among the plants to achieve the required food for their growth due to the closer spacing.

In case of different N doses, the results were significant. Nitrogen is mainly concerned with the vegetative growth of the plants. Maximum leaves per bulb (6.78) was recorded in the treatment (100 kg N ha^{-1}) which is very closely followed by 150 kg N ha^{-1} with 6.56 leaves per bulb. The number of leaves per bulb was increased up to 100 kg N ha^{-1}. Further increase in the N dose resulted in the decline of leaves but the difference was minute. Both of these levels remained at par and also non-significant with each other. The control plots, where no N was applied produced the minimum leaves per bulb (4.11). These results coincide with the findings of Kumar *et al.* (1998) who also reported that number of leaves per plant were increased in onion while applying the nitrogen @ 150 kg ha^{-1}.

On the other hand, the interaction between the two factors was significant. The plants 12 cm apart and getting the nitrogen doze of 100 kg ha^{-1} gave the highest leaves per bulb (13.00). Different treatments S1N3, S1N4, S2N3 and S3N3 produced the same number of leaves per bulb i.e. 12.67 leaves each. All these means were remained non-significant among each other.

Size of bulbs (cm): Data on various plant spacing showed significant results on the bulb size of the onion plants. The widest bulbs (5.13 cm) were obtained from 12 cm spaced plants, which is closely followed and at par with 15 cm spacing by producing 5.09 cm wide bulbs (Table 1). The plants being spaced 9 cm apart produced the shortest bulbs of onion. The plants were transplanted on a very limited distance among each other. This closer space between the plants resulted in the weaker bulbs because the bulbs could not expand due to the unavailability of space required by the plants.

In case of different nitrogen levels, the treatment means were significantly affected. Maximum bulb size was recorded as 5.69 cm in the N4 nitrogen level. The minimum bulb size was measured as 4.31 cm from the control plots where no nitrogen was applied to the plants. The results from 50 and 100 kg ha^{-1} were at par and also non-significant with each other. Kumar *et al.* (1998) also reported that the bulb diameter was maximum, when nitrogen was applied @150 kg ha^{-1}.

On the other hand, the interaction between the two factors was remained non-significant.

Weight of bulbs (g): The statistical data concerning the weight of onion bulbs was significant for both the factors (Table 1).

Various plant spacing significantly affected the weight of onion bulbs. Closer spacing among the plants did not allow the plants to expand their bulbs with increased weight. Due to this close spacing, the plants 9 cm spaced gave the lowest average weight for a single onion bulb. While in 15 cm spacing plants, the weight of the bulbs remained maximum because of the larger space for the plants to give more weighed onion bulbs, which was at par and very closely followed by S2 with 57.64 g weighed bulbs. Both the means remained non-significant between each other.

On the other hand, different N levels also affected significantly. Increase in N dose resulted in the increased weight of bulbs. But above 100 kg N ha^{-1}, it started decline in the bulbs weight. However, N3 treatment produced the maximum weighed bulbs (56.87 g) and showed the most economical dose of N for the onion bulb formation. The control plots produced the lowest weight (46.87 g) of the onion bulbs due to the absence of the N, which is the main and important source of the plants food. Kashi and Frodi (1998) also reported that highest bulb weight was obtained at 120 kg N ha^{-1}.

The interaction amongst different treatment means of the two factors was remained non-significant.

Number of bulbs per plot: The data relating to the number of onion bulbs per plot showed the significant variations for both the factors as well as the interaction between two (Table 1).

Plant spacing significantly affected the number of bulbs per plot. It is quite clear from the spacing treatments studied in the project that lower the plant spacing, more will be the number of plants. Plants 9 cm spaced gave the maximum number of the bulbs per plot while the 15 cm spaced plants produced the minimum number of bulbs in their respective plots.

On the other hand, different N levels significantly increased the number of onion bulbs per plot. The plots received N3 gave the highest number of bulbs (123.0) per plot. While the lowest bulbs per plot i.e. 119.2 bulbs were recorded from the control plots where no nitrogen was applied. This might be due to the unavailability of the major plant food nutrient, as a result of which the plants became weaker and lower the number of bulbs.

As far as the interaction of two factors is concerned, significant differences were checked. Maximum bulbs per plot (149.0) were taken from the plots with 9 cm plant spacing receiving N3. Whereas the minimum number of bulbs (99.00) were noted each in 15 cm spacing with control plots and 15 cm spacing with N2 plots.

Bulbs yield (t ha^{-1}): Plant spacing affected significantly the yield of the onion bulbs (Table 1). Lower plant spacing gave the maximum number of bulbs but due to closer spacing, their weight had

become less. Plants 12 cm spaced produced maximum bulb yield of 22.90 t ha^{-1} because of more weighed bulbs though the number of bulbs were lesser as compared to the 9 cm spacing plants. The plants 15 cm spaced showed minimum yield. These results are in contrast to the findings of Vishnu and Parabhakar (1989), who suggested that the closest spacing produced the maximum yield of onion.

On the other hand, N doses revealed the similar trend as earlier and significantly affected the yield. Increase in N dose up to 100 kg ha^{-1} resulted in the increased yield of onion bulbs (22.82 t ha^{-1}). But further increase showed the yield decline. Due to further increase in N above 100 kg ha^{-1}, the vegetative period of the plants become longer and as a result of which the yield had become lowered. Whereas the minimum bulb yield of 18.25 t ha^{-1} was observed from the control plot, where no N was applied. Same results were also reported by Patel and Patel (1990) and Shaikh *et al.* (1987) who stated that application of 90 kg N ha^{-1} increased the yield of onion bulbs.

The interaction between the plant spacing and N levels remained also significant for bulbs yield. The highest yield (24.98 t ha^{-1}) very closely followed by 24.24 t ha^{-1} was noted form the plots of 12 cm plant spacing each with N3 and N2, respectively and were at par with each other.

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