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Effect of Planting Geometry and Nitrogen on Seed Yield of Onion (*Allium cepa* L.)

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Abstract This study was conducted to investigate the effect of various levels of nitrogen and planting geometry on seed yield of onion. For this study 12 treatment combinations were laid in factorial arrangement in randomized block design with four replications. Healthy bulbs with fairly uniform size of about 40—60 g in weight were selected for planting. Four nitrogen levels (N_1–100 kg N/ ha, N_2–120 kg N/ ha, N_3–140 kg N/ha and N_4– kg N/ha) and three planting spacing (closest S_1 – 60 ×10 cm, wider S_2–60×15 cm and widest S_3 – 60 × 20 cm) was considered in this experiment. The different nitrogen levels and planting distance had significant effect on growth parameters viz ; plant height, number of days required for first flower opening, diameter of umbel, seed yield per hectare and weight of thousands seeds. The results revealed that the highest plant height (66.77 cm) and highest seed yield (17.153 q) per hectare was obtained from the higher dose of nitrogen (160 kg/ha, N_4) with the closest spacing of 60×10 cm (S_1), while the minimum number of days required for first flower opening, diameter of umbel and weight of thousands seeds were found to be non-significant. Hence, higher dose of nitrogen with closest plant spacing is suggested for onion seed production in Rewa district of Madhya Pradesh.

Keywords Onion seed, Planting geometry, Bulb, Seed yield, Umbel.

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Introduction

Onion is one of the most important vegetable crops grown in India either for local consumption or for export in fresh or dried condition it has good return and income for farmers, also it provide hard currency for local income. Onion (*Allium cepa* L.) belongs to the family Amaryllidaceae (amaryllis) or liliaceae and is one of the most important monocotyledonous, cross-pollinated and cool season vegetable crops. It is grown as a rabi season crop in northern plains. It is valued for its distinct pungent flavor and antioxidental components like, allicin, allinthiosulfates and sulfites present in onion helps fighting against free radicals which causes cancer, high blood cholesterol, sugar, liver problems and intestinal problems. The area and production of onion in India are about 10.51 lakh hectares and 168.13 lakh tonnes of bulb, respectively, with an average productivity of 16.0 t/ha [1]. The productivity is very low as compared to the world average productivity of 19.4 t/ha [1]. In MP it is grown in an area of 58.30 thousand hectare, with the production of 1021.50 thousand tones with 17.50 Mt/ha productivity [1]. Onion seeds are poor in keeping quality and lose viability within a year. Therefore, it is essential to produce seeds afresh and use the same for bulb production. Onion seeds are poor in keeping quality and lose viability within a year. Therefore, it is essential to produce seeds afresh and use the same for bulb production. There are two basic methods of seed production, bulb- to -seed production and seed-to-seed production. Bulb-to-seed production has the advantage that it is possible to select the bulb to maintain the quality of the seed stalk and to discard the off types, like double bulbs misshapen bulbs or premature bolting. Difference in onion seed yield is caused by different planting distance. Mosleh [2] indicated that planting distance had significant influence on growth and yield of onion seed production and closest planting were favorable for getting higher bulb and seed yield of onion. Among the fertilizers, N containing ones is the most important, since it is being a component of amino acids and chlorophyll, promotes rapid vegetative growth, protein content and yield of the crop [3]. The optimum dose of nitrogen fertilizer is of utmost importance for obtaining sustained high seed yield. Planting geometry plays an important role as optimum-planting geometry provides favorable environmental conditions for growth and seed yield. The present investigation has been undertaken with the objectives to determine the effect of planting geometry and nitrogen levels on seed yield of onion.

Materials and Methods

The experiment was conducted during *rabi* season of 2013-2014 at the Research Farm of College of Agriculture, Rewa (MP) on onion cultivar Agrifound light red. Plant and row spacing with 3 levels (S_1–60 × 10 cm, (S_2–60 × 15 cm, S_3–60 × 20 cm) and Nitrogen with four levels (N_1–100 kg N/ha, N_2–120 kg N/ha, N_3–140 kg N/ha and N_4–160 kg N/ha) and all the twelve treatment combinations (S_1N_1, S_1N_2, S_1N_3, S_1N_4, S_2N_1, S_2N_2, S_2N_3, S_2N_4, S_3N_1, S_3N_2, S_3N_3 and S_3N_4) were used as randomly allotted to different plots in factorial arrangement under randomized block design with four replications. The mean weekly maximum temperature varied from 18.21 to 39.66°C while minimum temperature range between 7.41°C to 19°C. The physico-chemical analysis of soil showed that the soil of experimental site was mixed red and black silty clay loam in texture, medium in organic carbon (0.565%) and normal in reaction (pH 7.25). The bulbs of almost the same size (45—50 g in weight) were planted on south side of the ridges of 60 cm ridges at 10, 15 and 20 cm within row spacing, in November 18th, 2013. They were irrigated at 7 days interval and the other cultural practices (fertilizer application, weeding and pest control) were done as recommended.

Table 1. Effect of planting geometry and nitrogen levels on average plant height of onion (cm).

Spacing levels	Nitrogen levels N_1	N_2	N_3	N_4	Average
S_1	61.33	58.40	62.34	66.77	62.21
S_2	54.10	57.52	57.27	60.30	57.29
S_3	50.60	56.30	58.70	59.54	56.29
Average	55.34	57.41	59.44	62.20	
		SEm		CD (p = 0.05)	
Spacing (S)		0.234		0.673	
Nitrogen (N)		0.270		0.777	
Interaction (S×N)		0.467		1.344	

Results and Discussion

Plant height (cm)

The significant difference in plant height at all the crop growth stages was observed due to various treatments (Table 1). The tallest plant of 62.20 cm was recorded with 160 kg N/ha (N_4) followed by 140 kg N/

Table 2. Effect of planting geometry and nitrogen levels on number of days required for first flower opening of onion.

Spacing levels	Nitrogen levels N_1	N_2	N_3	N_4	Average
S_1	83.65	82.34	81.28	79.46	81.68
S_2	83.59	82.60	81.50	79.32	81.75
S_3	83.70	82.41	81.32	79.13	81.64
Average	83.65	82.45	81.37	79.30	
		SEm		CD (p = 0.05)	
Spacing (S)		0.043		NS	
Nitrogen (N)		0.050		0.144	
Interaction (S×N)		0.086		NS	

Table 3. Effect of planting geometry and nitrogen levels on diameter of the umbel (tertiary) of onion (cm).

Spacing levels	Nitrogen levels N_1	N_2	N_3	N_4	Average
S_1	4.22	4.52	4.87	5.14	4.69
S_2	4.53	4.98	5.21	5.55	5.07
S_3	4.60	5.23	5.42	5.79	5.26
Average	4.45	4.91	5.17	5.49	

	SEm	CD (p = 0.05)
Spacing (S)	0.043	0.124
Nitrogen (N)	0.050	0.143
Interaction (S×N)	0.086	NS

Table 4. Effect of planting geometry and nitrogen levels on average seed yield per hectare of onion (q).

Spacing levels	Nitrogen levels N_1	N_2	N_3	N_4	Average
S_1	11.990	13.049	14.482	17.153	14.169
S_2	10.382	11.323	11.709	13.212	11.657
S_3	10.146	11.146	11.222	12.656	11.293
Average	10.839	11.839	12.471	14.340	

	SEm	CD (p = 0.05)
Spacing (S)	0.025	0.071
Nitrogen (N)	0.028	0.083
Interaction (S×N)	0.05	0.143

ha and superior to all other treatments, where as the minimum height (55.34 cm) was recorded with 100 kg N/ha (N_1). Maximum plant height (62.21 cm) was found under 60 × 10 cm (S_1) spacing followed by 60 × 15 cm (57.29 cm). The effect of interaction was found to be significant variation in plant height. The treatment combination consisting of $S_1 \times N_4$ (60 × 10 cm + 160 kg N/ha) produced significantly tallest plant (66.77 cm) followed by 60 × 10 cm + 140 kg N/ha (62.34 cm) as compared to all other treatment combinations. The minimum plant height (50.60 cm) was noticed under $S_3 \times N_1$ (60 × 20 cm + 100 kg N/ha) treatment combination. The increase in plant height with increase in nitrogen levels might be due to the increase in cell size and enhancement of cell division, which ultimately resulted in increased plant height [4, 5]. The spacing's are also responsible for changing the plant height. More plant height due to closer spacing may the results of less space for lateral growth and more competition among the plant for light and air. Similar findings were also reported earlier [6—12]. Aliyu et al. [13] reported that various plant spacing and nitrogen levels resulted in varied plant heights, with the densest planting leading to growth of shorter plants due to high competition among plants for growth factors.

Number of days required for first flower opening

Table 2 revealed that only different levels of nitrogen statistically influenced the number of days required for first flower opening. Minimum number of days (79.30 days) were required for first flower opening with 160 kg N/ha per hectare followed by 140 kg N/ha (81.37 days) and were superior to all other treatments. The first flower opening was delayed with the application of nitrogen as 100 kg/ha. The higher dose of nitrogen helped in more rapid growth of the plants leading to breaking of the scape of umbels. Similar kinds of finding were also reported earlier [7, 14]. The plant spacing and the interaction effects between the different nitrogen levels and spacing were found to be non-significant.

Diameter of the umbel

Table 3 shows that the diameter of the tertiary umbel significantly increased with the increase in nitrogen dose. The plants produced maximum diameter of umbel 5.49 cm, with 160 kg N/ha (N_4) which was significantly superior to all other treatments. The least diameter of umbels (4.45 cm) were produced with 100 kg N/ha. This clearly showed that nitrogen was mainly concerned with the vegetative growth of the plants. Plant produced significantly highest diameter of tertiary umbel (5.26 cm) with 60 × 20 cm spacing. The minimum diameter of tertiary umbel (4.69 cm) was associated with 60×20 cm spacing. This could be due to happy consumption of nitrogen combined with good spacing of onion. Closer spacing resulted in competi-

Table 5. Effect of planting geometry and nitrogen levels on weight of thousand seed of onion (g).

Spacing levels	Nitrogen levels N_1	N_2	N_3	N_4	Average
S_1	3.513	3.632	3.712	3.770	3.656
S_2	3.550	3.668	3.731	3.802	3.687
S_3	3.568	3.685	3.758	3.810	3.705
Average	3.541	3.661	3.733	3.794	

	SEm	CD (p = 0.05)
Spacing (S)	0.0033	0.0095
Nitrogen (N)	0.0038	0.0109
Interaction (S×N)	0.0065	NS

tion for nutrient and light thus resulting in plants that were thin while the wider spaced plants had adequate space for stem growth and development. This result showed that nitrogen is mainly play great role in vegetative and reproductive parts of the plants. Intra-row spacing with 20 cm had very significance difference. Nitrogen significantly increased umbel diameter without affecting the length. This result in line with the work of Nasreen et al. [15] reported as significant increase in the diameter of umbel due to the application of N 150 kg ha. There was no significant effect of interaction between nitrogen and intra-row spacing on the umbel diameter of onion.

Seed yield per hectare (q)

Table 4 indicated that there were significant differences in seed yield per hectare for the nitrogen levels and maximum seed yield per hectare was recorded under 160 kg N/ha (14.340 q) followed by 140 kg N/ha (12.471 q). The minimum seed yield per hectare (10.839 q) was found with 100 kg N/ha. With regard to different spacing, the maximum seed yield per hectare (14.169 q) was found under 60 × 10 cm spacing followed by 60 × 15 cm (11.657 q). These two spacing (S_1 and S_2) were significantly superior to the S_3, (60 × 20 cm) level of spacing which gave the lowest seed yield per hectare of 11.293 q. The effect of interaction was found to be significant for variation in yield and highest seed yield per hectare (17.153 q) was noticed under treatment combination 60 × 10 cm + 160 kg N/ha, which was significantly superior to all other interactions. The lowest seed yield per hectare of 10.146 q, was noticed in spacing level of 60 × 20 cm with 100 kg N/ha. The treatment combination exhibited significant effect on the seed yield per hectare. The highest seed yield per hectare was associated in 60 × 10 cm spacing with 160 kg N/ha followed by 60 × 10 cm spacing with 140 kg N/ha and the lowest seed yield was recorded in 60 × 20 cm spacing with 100 kg N/ha. The higher seed yield on account of high nitrogen dose may be due to maximum vegetative growth, it may synthesize more food material as per source of sink theory might have translocated food material towards the production of seed and therefore application of 160 kg N/ha resulted in production of more seed yield. The seed yield per hectare was more on account of maximum number of plants per unit area. Even though, per plant yield was more at wider spacing but per hectare seed yield was significantly more at closer spacing due to more plant population per unit area and the seed yield was maximum at the closer spacing of 60 × 10 cm than other spacing. A number of previous workers[9–11, 16–19] have also reported the identical finding, who reported that closer planting spacing and higher dose of nitrogen produced maximum seed yield of onion.

Weight of thousand seed (g)

Data in respect of 1,000-seed weight indicated the boldness of seed presented in Table 5. Data indicated that there was significant variation in weight of 1,000-seed for nitrogen doses. The highest weight was recorded under 160 kg N/ha (3.794 g) this was superior to 140 kg N/ha (3.733 g). With regard to different level of spacing the highest weight of 1,000-seed (3.705 g) was found under 60 × 20 cm spacing, which was significantly superior to all other spacing, lowest weight of 3.656 g was noticed in 60 × 10 cm spacing. The interaction effects between the different levels of nitrogen and spacing were found to be non-significant. The trend of 1,000-seed weight decreased as the plant spacing decreased. This might be due to the fact that wider spacing supplied more food materials to the growing seeds compared to the closest spacing. Authors [17—19] also found that 1,000-seed weight was significantly higher at wider spacing.

Conclusion

This result indicate that the interaction effect of nitrogen and spacing had no significance differences between the treatments except plant height and seed yield per hectare showed the highest performances in all parameters. This could be due to different factors related to increased growth in height of onion. In conclusion therefore, the easiest method of obtaining high growth performance of plant which leads to increased yield could be using 160 kg/ha nitrogen and spacing of 60 × 10 cm. These could be suggested to farmers ; however the conclusive recommendation should be based on the results of repeated experiments. Moreover, emphasis should be given to optimum level of nitrogen and spacing under Rewa condition with further finding.

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