IJPS INTERNATIONAL JOURNAL OF PLANT SCIENCES
e ISSN-0976-593X Volume **12** | Issue 1 | January, 2017 | 28-35
DOI: 10.15740/HAS/IJPS/12.1/28-35
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RESEARCH ARTICLE

Effect of plant and row spacing on growth and yield of onion under Mokokchung district of Nagaland

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SUMMARY

The experiment was undertaken to determine the effect of different plant and row spacing on growth and yield of onion. 8 different spacings were taken *viz.*, 20x10 cm, 20x15 cm, 20x20 cm, 25x10cm, 25x15 cm, 25x20 cm, 30x10 and 30x15cm. Variety Nasik Red was used for the study. The results demonstrated that plant spacing had significant effects on growth, yield components and yield of onion. Significantly wider spacing produced higher size of plant height, leaf length and number of leaves. Bulb diameter, circumference and weight also have the same trend in wider spacing. The weight of individual onion bulb (53.0 g) was increased with the widest spacing of 30x15 cm. On the contrary, the overall yield/ha was the highest (17.69 t/ha) at the closest spacing (20 x10cm) and the lowest (9.51 t/ha) was at widest spacing (30x15 cm).

Key Words : Onion, Spacing, Growth, Yield

How to cite this article : Ngullie, Renbomo and Biswas, Pijush Kanti (2017). Effect of plant and row spacing on growth and yield of onion under Mokokchung district of Nagaland. *Internat. J. Plant Sci.*, **12** (1): 28-35, **DOI: 10.15740/HAS/IJPS/12.1/28-35**.

Article chronicle : Received : 06.07.2016; **Revised :** 11.11.2016; **Accepted :** 07.12.2016

Onion (*Allium cepa* L.) belongs to the genus *Allium* of the family Alliaceae (Hanelt, 1990). Onion is the most important of the bulb crops cultivated commercially in most parts of the world. The crop is grown for consumption both in the green state as well as in mature bulbs. It is valued for its bulbs having characteristic odour, flavour and pungency, which is due to the presence of a volatile oil – allyl-propyl-disulphide.

Onion is the richest sources of flavonoids in the human diet and flavonoid consumption has been associated with a reduced risk of cancer, heart disease and diabetes. In addition it is known for anti bacterial, antiviral, anti-allergenic and anti-inflammatory potential. One onion quality parameter, the percentage of single-center bulbs, has become important to meet demands of both processing and fresh market buyers (Brewster and Rabinowitch, 1990).

Even though the crop has great contribution both in economic and health issues, its production and productivity is not scaled to the required level. This is because use of appropriate agronomic management practices and improved technology inputs are still not highly used which have an undoubted contribution in increasing crop yield potential. One of the important measures to be taken in increasing the productivity of onion is determining spacing for each agro-ecology since full package of information is required for each growing region of the country to optimize onion productivity (Gupta

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et al., 1994)

Onion production is greatly influenced by cultivars and agronomic practices (Mondal *et al.*,1986 and Mondal, 1991). To increase the per hectare yield of onion, emphasis must be given on adopting improved varieties, plant spacing, depth of planting and other cultural measures. The control of plant spacing is one of the cultural practices to control bulb size, shape and yield (Geremew *et al*., 2010). The higher yield and better control of over or under bulb size could be obtained if plants are grown at optimum density. Total bulb yield can be increased as population density increases (Kantona *et al*., 2003). Several researchers in many countries have shown that varieties and plant spacing had profound effects on the growth and yield of onion (Pandey *et al.*, 1991; Bhonden *et al.*, 1995 and Kumar *et al.*, 1998). Successful bulb production depends on the plant spacing. Spacing affects the plant growth, size of bulb, yield as well as the quality of the produce (Purewal and Dargan, 1962; Badaruddin and Haque, 1977 and Rahim *et al*., 1983). Planting at proper spacing increases the quality and size of bulb (Nichols and Heydecker, 1964). Many workers reported that wider spacing caused higher yield per plant, although the closer spacing gave higher yield per unit area due to increased plant density up to a certain limit (Decampose *et al.*, 1968; Singh and Rathore, 1977 and Nehra *et al.* 1988). Planting of onion at optimum density also gives the best economic return (Rashid and Rashid, 1976). Considering the above stated situations, the present study was undertaken to determine the effects of different plant and row spacing on growth and yield of onion.

MATERIAL AND METHODS

Description of experimental site :

The study was conducted at State Agricultural Research Station (SARS), Yisemyong, Mokokchung Nagaland during November 2015 to May 2016 under irrigated condition. The experimental site lies about 26.395778° N latitude and 94.593747° E longitude at an altitude of 1050 m above sea level.

The area experiences rainfall that stretches from April to October with the main rainy season from June to early September. The area receives average annual rainfall between 2000 - 2500 mm with annual minimum and maximum temperature ranging from 11.5 to 27.5°C, respectively.

Experimental design and treatment :

The experiment was laid out in a Randomized Block Design (RBD). The whole field was first divided into 3 blocks (replications) each containing 8 plots. In total there were 24 unit plots. The treatment combinations were assigned randomly in each unit plot so as to keep only one treatment in each block. The size of each unit plot was 5.57 Sq.m. The space left between plots and replication was 50 cm. The experiment consisted of 8 different spacings (Row x Plant) *viz.*, 20x10 cm, 20x15 cm, 20x20 cm, 25x10cm, 25x15 cm, 25x20 cm, 30x10 and 30x15cm and variety used was Nasik Red.

Fertilizer application :

Fertilizer @ 100:50:100 NPK kg/ha was applied. During land preparation half dose of N and full dose of P and K fertilizers were applied according to the recommended experimental design as a basal dose. The selected 3 fertilizer combinations were applied in the treatment of unit plots. Remaining half dose of N was applied as top dressing in two equal splits at 25 and 60 days after transplanting.

Gap filling :

Gap filling was done using healthy plants as per requirement.

Intercultural operation :

Various intercultural operations *viz.*, weeding, earthing up etc. were accomplished for better growth and development of the plants.

Irrigation :

Irrigation was given by both watering can and hose pipe as and when required. Seedlings were first irrigated just after transplanting and then they were irrigated whenever necessary to conserve the optimum moisture level of the soil.

Harvesting :

The crop was harvested on 9th May, 2016 when more than 75 per cent of the tops had fallen over. The tops were removed by cutting off the pseudo-stem keeping 2.5 cm with the bulb.

Data collection :

Data of the following parameters were recorded from the sample plants. Five plants were selected randomly form each plot in such a way so that the border effect could be avoided.

Plant height (cm) :

Plant height was measured in centimeter from then ground level to the tip of the matured leaf in the plant at maturity with a measuring tape.

Number of leaves per plant :

It refers to the mean number of leaves produced by the sampled plants and was calculated by dividing the total number of leaves counted from the sampled plants to the number of sampled plants to get the mean leaf number per plant.

Leaf length (cm) :

The length of leaves was measured in centimeter with a scale measuring tape at maturity from the 5 randomly selected sampled plants from each plot and the average leaf length was taken.

Bulb diameter (cm) :

Bulb diameter was measured at right angles to the longitudinal axis at the widest circumference of the bulb from 5 randomly selected plants in each plot.

Bulb circumference (cm) :

The circumference of bulb at harvest was measured at the middle portion of bulb taken from 5 randomly selected plants.

Individual bulb weight (g) :

Five plants were selected from each unit plot. The top was removed by cutting the pseudo-stem keeping only the 2.5 cm from the bulb. 5 bulbs were weighed by a simple balance and the average was taken.

Yield per plot (kg) :

Yield per plot was measured by weighing the sampled bulbs from each individual unit plots and multiplied by number of plants.

Total yield (t/ha) :

Total yield of bulb per unit plot was converted into tons per hectare.

Statistical analysis :

The collected data from each plot on various parameters were measured and the mean values subjected to statistical analysis by adopting Complete Randomized Block Design (Panse and Sukhatme, 1967).

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Plant height :

The result of the experiment revealed significant difference among treatments with regard to plant height. Plant height was significantly influenced by spacing such that plant height increased when the spacing of the plant and row increases. The highest plant height (41.6 cm) was obtained from plants spaced at 30x15 cm followed by 30x10 cm (40.59 cm) while the lowest plant height (32.06 cm) was recorded from 20x10 cm spacing (Table 1). Khan *et al*. (2002) also reported that due to higher competition amongst the lowest plant spacing, it produce least response for plant height in onion. The reduction in plant height at increased plant density might be attributed to the possible competition for soil moisture and nutrients as in the case with Ibrahim (1994); Bodnar *et al*. (1998) and Karaye and Yakubu (2006). Results are also in

Table 1 : Effect of plant spacing on growth parameters of onion

Treatments	Plant height (cm)	No. of leaves /plant	Leaf length (cm)
20 x 10 cm	32.06	6.11	28.31
20 x 15 cm	33.35	8.44	28.5
20 x 20 cm	35.33	6.44	28.67
25 x 10 cm	38.67	6.45	29.17
25 x 15 cm	34.08	7.56	29.72
25 x 20 cm	40.03	8.89	32.55
30 x 10 cm	40.59	9.34	36.28
30 x 15 cm	41.6	9.67	36.89
C.D. (P=0.01)	1.06	1.9	0.76

agreement with the findings of Kantona *et al.* (2003) on onion.

Leaf number per plant :

Data in Table 1 revealed that the wider the plant spacing the higher was the leaf number. Maximum number of leaves per plant (9.67) was obtained at the widest spacing of 30x15 cm and minimum number of leaves per plant (6.11) was found at the lowest spacing of 20x10 cm. The results are similar to those of Weerasinghe *et al.* (1994), They reported that increasing plant competition significantly decreases seedling leaf number. Mari *et al.* (1997) and Rizk (1997) also reported that lower planting density resulted in higher number of leaves per plant. The assumptions are also similar to Singh and Sachan (1999) who stated that greater number of leaves was found at wider spacing.

Leaf length :

Highly significant variation in leaf length was recorded at different plant and row spacing treatments. Plant spacing of 30x15 cm produced the longest leaf length (36.89 cm) and the shortest (28.31 cm) was recorded at the narrow 20x10 cm spacing (Table 1). This might be due to less competition for light in wider spacing and higher competition occurred in closer plants. Jilani and Ghaffor (2003) suggested that plant densities could affect length of leaves. Jilani *et al.* (2010) also reported that highest leaf length was recorded at wider spacing whereas shortest leaves correspond to the closest plant spacing.

Bulb diameter (cm) :

Effect of spacing showed statistically very highly significant difference in bulb diameter. Spacing of 30x15 cm showed the highest bulb diameter (6.66 cm) followed by 30x10 cm (5.71 cm) and 25x20 cm (5.69 cm) while the lowest was recorded from 20x10 cm (4.13cm) plant spacing (Table 2). The increase in bulb diameter at wider plant spacing could be probably attributed to more nutrients, space and moisture availability. Bulb diameter contributes significantly to yield component of a crop (Cheema *et al.*, 2003 and Jilani and Ghaffor, 2003). The present findings are in line with those reported by Rashid and Rashid (1978); Quadir and Boulton (2000); Jan *et al.* (2003); Kantona *et al.* (2003); Akoun (2005); Hyder *et al.* (2007) and Jilani *et al.* (2009). Mohamedali (1988) also reported wider plant spacing gave larger bulbs of onion.

Bulb circumference :

Results on the bulb circumference were also highly significant. Data in Table 2 revealed that increasing plant density resulted in reduced bulb circumference. The reason for reduction in bulb circumference with an increase in plant density may be due to space and nutrient availability which was more in lesser populated plots as compared to greater populated plots. Closer spacing among the plants also did not allow the bulb to expand. Highest bulb circumference was observed in plants spaced in 30x15 cm (16.69 cm) followed by 30x10 cm (16.44 cm). On the other hand, the lowest bulb circumference was observed from 20x10 cm spacing (12.31 cm). The general trend observed was as the plant spacing increased from 20x10 cm to 30x15 cm, the bulb circumference was also increased. The decrease in bulb circumference in response to decreased plant spacing could be attributed to the availability of progressively lower amount of photosynthesis due to the increasing competition among plants for growth factors.

Table 2 : Effect of plant spacing on yield parameters of onion

Treatments	Bulb diameter (cm)	Bulb cir. (cm)	Bulb wt (g)	Yield /plot (kg)	Yield/ha (T)
20 x 10	4.13	12.31	45.56	9.85	17.69
20 x 15	5.04	13.58	46.11	8.68	15.63
20 x 20	5.3	14.08	48.14	7.73	13.88
25 x 10	5.3	14.4	47.44	8.27	14.84
25 x 15	5.62	15.4	49.56	7.77	13.96
25 x 20	5.69	15.5	51.11	6.72	12.07
30 x 10	5.71	16.44	51.44	6.13	11.02
30 x 15	6.66	16.69	53.00	5.3	9.51
C.D.(P=0.01)	0.26	0.11	0.52	0.73	0.34

Average bulb weight (g) :

Plant spacing has significantly influenced average bulb weight. As plant spacing increased from 20x10 cm to 30x15 cm, average bulb weight increased from 40.44 to 71.44 g (Table 2). The results are in line with the findings of Rashid and Rashid (1978) who noticed that onion bulb size and weight increases with increasing plant spacing, but recorded lower total bulb yield that increases with closer spacing. Densely populated plants produced lower bulb weight as compared to thinly populated plants. Increasing plant spacing resulted in heavier onion bulbs (Jilani *et al*., 2009). Mean bulb weight and plant height decreased as population density increased (Mohamedali, 1988 and Jan *et al.*, 2003) also found minimum bulb weight at narrower spacing (17 x 4.5 cm). In the same way, Kantona *et al*. (2003) reported a decrease in bulb weight as the plant population per square meter increased from 50 to 200 plants likely due to competition associated with closely spaced plants that resulted in lower bulb weight per plant. Abubaker (2008) also reported that the highest yield per plant of bean was obtained from 20 x 30 and 30 x 30 cm planting densities as compared to higher planting densities of 10 x 30 cm. When onions are planted at wider spacing, the emerged shoots get a better microenvironment that resulted in healthy and larger bulbs and high bulb weight per plant. Palada and Crossman (1998) also reported an increase in okra fresh weight per plant from 38 to 70 g with the increase in plant spacing from 31 to 41 cm due to increase in the number of stem and wider leaf area per plant at wider spacing.

Yield per plot :

Perusal of the data in Table 2 indicates highly significant results for yield per plot. Planting density of 20x10 cm gave the highest yield (9.85 kg/plot) followed by 20x15 cm and 25x10 cm plantings yielding 8.68 kg/plot and 8.27 kg/plot, respectively. The lowest yield per plot (5.3kg) was recorded from the widest spacing of 30x15 cm. All the treatments differed at 1 per cent probability level with each other. Higher yields at greater planting treatment may be attributed to greater number of bulbs per unit area. Results of this work support the findings of Vigai *et al*. (1976); Rashid and Rashid (1976); Wotaszek and Kmiecik (1977) and Miccolis *et al.* (1985).

Total bulb yield (t/ha) :

Data in Table 2 revealed that spacings significantly influenced total bulb yield of onion. From the table it can be observed that increased spacings from 20x10 cm to 30x15 cm decreased total bulb yield in tons/hectare. Significantly, the highest total bulb yields of 17.69 and 15.63 t/ha was recorded at lowest spacings of 20x10 and 20x15 cm, respectively. Widest spacing of 30x15 cm showed the lowest total bulb yield (9.51 t/ha) (Table 2). This is due to the reality that as plant spacing decreases, total plant population increases and this in turn contributes to increase in total bulb yield, but the bulb dimension and weight decrease. The current result is in agreement with works of different authors. Jan *et al*. (2003) recorded the highest yield (40.44 t/ha) at spacing of 17 x 4.5 cm, and the lowest yield (19.95 t/ha) at 27 x 14.5 cm spacing. Hassanm (1978); Mohamedali (1988) and Russo (2008) also found similar results. Hoque *et al*. (1979); Kumar *et al*. (1998) and Rashid and Rashid (1976) also obtained the highest yield with a spacing of 20 x 10 cm. Coelo *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. Rekowska and Skupien (2007) also reported significantly higher yield of bulbs and green leaves of garlic in closer plant spacing. Moreover, Kantona *et al*. (2003) noticed that onion yield increased from 17.4 to 39.5 t/ha as plant population per square meter increased from 50 to 150. Carlson *et al*. (2009) reported influence of plant density on the yield of two potato varieties, in which both varieties produced highest total yields at the closest plant spacing of 17.75 cm. Hemphill (1987) also reported that a fourfold increase in planting density doubled the yield of shallot.

Conclusion :

The study was conducted to investigate the best plant spacing for highest yield. The spacing used in the study showed significant variation among the different treatment. Growth parameters like plant height, number of leaves per plant, leaf length and yield parameters like bulb diameter, bulb circumference and individual bulb weight were significantly affected due to the different plant spacing. When the distance between plants increased the growth and yield related parameters were increased. Generally, the wider the plant spacing the better is the performance of the onion plant. Hence, it can be concluded from the study that the widest spacing of 30 x15 cm produced significantly the highest plant height, leaf number, leaf length, bulb diameter, bulb circumference and individual bulb weight but the value of these characters decreased with decreasing plant spacing and ultimately the lowest values were recorded at the closest spacing (20x10 cm). The plant growth under wider spacing received more nutrients, light and moisture compared to closer spacing which is probably the cause of better performance and yield of individual onion at wider spacing. On contrary, the total yield/ha, when evaluated, it was evident that the closest spacing (20x10 cm) resulted best performance producing 17.69 t/ha as compared to 9.51 t/ha from widest spacing (30x15 cm). Highest yield from the closest spacing is mainly due to the high plant density though the bulb size was comparatively smaller.

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