EFFECT OF PLANT DENSITY AND NITROGEN ON ECONOMIC YIELD OF ONION (Allium cepa var. ascalonicum)

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ABSTRACT

An experiment was carried out at the Crop Farm, Eastern University, Chenkalady, Sri Lanka during the period May-July 2013 to investigate the effect of different plant densities and nitrogen on growth and economic yield of onion (cv. Vethalan). Three densities viz. 156, 100 and 83 plants/m^2 and three levels of nitrogen namely 120, 150 and180 kg N/ha were used. This experiment was carried out using a 3 x 2 Factorial Randomized Complete Block Design (RCBD) replicated three times. All other agronomic practices were adopted as recommended by the Department of Agriculture. The dry weight of leaves/ha, total plant weight/ha and bulb yield/ha were the highest at the density of 1,560,000 plants/ha (8 x 8 cm) with 150 kg N/ha.

The results suggest that at the plant density of 1,560,000 plants/ha, the application of nitrogen at the rate of 150 kg N/ha could increase the bulb yield by 22%. Further increase in nitrogen level to 180 kg N/ha could decrease the yield by 34%.

Keywords: Onion, Plant Density, Nitrogen, Yield

Introduction

Onion is one of the most important bulb crops cultivated across the world for trade both for consumption and export. It is the most important vegetable, cash and a condiment crop grown in Sri Lanka, and used in traditional cuisine and culinary preparations. Onions not only provide flavor, they also provide important nutrients and health-promoting phytochemicals (Onion Health Research, 2013). These characteristics of onions found to contribute to high demand. High yielding onion cultivars and appropriate/correct agronomic practices can encounter the increasing demand for onions (Malik, et al., 2003). Evidence in the literature indicates that increases in plant density

enhance yield up to a point. Thereafter, any further increase in density reduces yield. The effect of plant density on growth and yield of row planted crops would depend on the inter row spacing and intra row spacing. Optimum plant density is a pre-requisite for maximum yield. Increasing plant density leads to the reduction in biological yield of an individual plant, but production increases on per plant basis of unit land area (Caliskan ET AL,2007).Higher bulb yield was obtained at 120 kg ha^{-1} (Kumar et al., 2001 and Mohanty and Das, 2001).Higher yields are associated with agronomic and management practices. Among them, number of plants per unit area and the rate of nitrogen are the factors that influence emergence, growth and yield. Therefore, to increase the performance of the onion, this study was initiated to study the effect of different plant densities in combination with different levels of nitrogen on the economic yield of onion.

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Materials and methods

The experiment was carried out at Crop Farm, Eastern University, Chenkalady (Latitude between 7^0 43' and 7^0 431/2' N and the Longitude between 81^0 42' and 81^0 43' E) during the period from May to July 2013 to study the effect of plant density and levels of nitrogen on economic yield of red onion (cv. vethalan).

The experiment was laid out in 3 x 2 Factorial randomized complete block design (RCBD) with three replications. Experimental treatments comprised of three densities viz. 156,000, 100,000 and 833,000 plants/ha and three levels of nitrogen (180, 150 and 120 kg N/ha). There were 27 treatment combinations. All other agronomic practices were carried out in accordance with the Department of Agriculture. Nitrogen was applied at the rate of 120, 150, and 180 kg N /ha, and P_2O_5 and K_2O were applied at the rate of 100 and 85 kg/ha respectively (Department of Agriculture, 1990). Out of total nitrogen, 50 kg N/ha was applied basally and rest of them were divided into two halves and applied in two top dressings at 3^{rd} and 6^{th} weeks after planting (WAP).

Sampling was done at fortnight intervals starting from one month after planting (MAP). At each occasion, five plants were randomly uprooted for assessment from each plot for growth measurements. At harvest, bulb yield was recorded from an area of 1 sq. m**.** Dry weights were determined by drying the samples in oven at 80^0C for a period of 48 hours. The data were analyzed and the means were compared by using LSD at 5% level.

Results and discussion

1. Dry weight of leaves

1.1. Plant density

Dry weight of leaves/ha at 30, 60, 75 and 90 DAP increased with increasing with plant density (Table. 1). The dry weight of leaves at the highest density (1,560,000 plants/ha) was double than that at the lowest density (833,000 plants/ha).

At 60, 75 and 90 DAP, plant density did not influence the dry weight of leaves/ha (Table. 1). However, at 30 DAP, the dry weight of leaves/plant was affected by density (Table. 1). Hence, increase in dry weight of leaves per unit area (ha) with increasing density may be mainly due to additive leaf dry weight of a larger number of plants per unit area.

1.2 Levels of nitrogen

Levels of nitrogen did not affect the plant density at any stages of crop growth except at 30 DAP (Table. 1). This may be due to leaching because of the low nutrient retention capacity of sandy soil.

1.3 Interaction

There was an interaction between plant density and levels of nitrogen at 30 DAP per ha (Table. 1).

2. Dry weight of total biomass

2.1 Plant density

Total biomass of plants is presented in Table.1. At harvest (90 DAP), Plant density did not affect the total biomass. This may be due to the death of onion leaves during later stages of the plant growth. In general, total weights of plants at all densities gradually increased up to harvest. However, at each sampling dry weight was increased significantly with increase in plant density. The higher rate of dry matter production per plant did not compensate for dry matter production by a large number of plants at the highest density.

2.2 Levels of nitrogen

At 90 DAP, levels of nitrogen significantly influenced the total biomass at 90 DAP (Table. 1). At 90 DAP, Dry weight of total biomass was significantly higher at 180,150 kg N/ha compared to 120 kg N/ha (Table. 1).

Highest total biomass was obtained with the application of 180 and 150 kg N/ ha at the highest plant density (1,560,000 plant/ha). The lowest total biomass was observed with the lowest density (833,000 plant/ha) with the lowest level of nitrogen application (150 kg N/ ha).

2.3 Interaction

Interaction between density and nitrogen was observed at 30, 45, 60 and 75 DAP (Table. 1). At 90 DAP, no interaction was observed between plant density and levels of nitrogen. However, the interaction was closer to the significant value. This may be due to decreased number of leaves at harvest, which is in agreement reported by Narseen et al. (2007).

3. Yield

3.1 Interaction

At 90 DAP, fresh weights of bulbs increased with increasing in plant density (Table.1). It was evident that when the plant density was increased from 833,000 to 1,000,000 plants/ha, yield increased by 18% and further increase of plant density from 1,000,000 to 1560,000 increased the yield by another 4%. Under the conditions of the present investigation, maximum bulb yield was obtained at the highest density. These results are in consonance with the findings of Kumar et al., (1998), Resendle et al. (1999) and Jilani et al. (2010) who reported that increasing the plant density increases the total yield of onion.

There was an interaction ($P<0.05$) between plant density and levels of nitrogen (Table 1). The yield was higher at the plant density of 1,560,000, 1,000,000 and 833,000 plants/ha at 150 kg N/ ha (Table.1). It may be possible that at highest densities, the contribution from each plant toward bulbs formation is greater than that from widely spaced plants at low densities. The results also indicated that nitrogen application at 150 kg N/ha could increase the bulb yield by 28%. Further increase in nitrogen level could decrease the yield by 54 %. The beneficial effect of nitrogen on growth rate at the rate of 150 kg N /ha was reported by khan et al. (2002).

The findings of the present study are in line with those of Diaz-Perez et al. (2003), Singh et al. (2004), Rahman et al. (2004) and Zaman et al. (2011) who documented that application of nitrogen at the rate of 150 kg N/ha resulted in higher yield. In contrast, Kumar et al. (1998), Samaila (2000), Aliyu et al. (2007), and Khan et al. (2002) investigated that bulb yield of onion increased with 100 kg N/ha and 200 kg N/ha reported by Neeraja et al. (2001) and Al-Moshileh (2001).

Conclusions

The plant density of 156,000 plants/ha (8 x 8 cm) recorded better bulb yield than 833,000 plants (the recommended spacing of 10 cm × 12 cm) due to the effective utilization of land, space and nutrients.so the plant density (8 x 8 cm) can be adopted in order to obtain maximum bulb yield in combination with 150 kg N/ha.

Table 1: Effect of plant densities and levels of nitrogen on dry weight of leaves, dry weight of total biomass and the bulb yield of plants at different stages of growth

Density (Plants/ha)	Levels of Nitrogen (kg/ha)	Days After Planting								
		Dry weight of leaves (Mt/ha)				Total biomass (Mt/ha)				Yield (Bulbs weight) (Mt / ha)
		30	60	75	90	30	60	75	90	90
1,560,000 (S_1)	180	5.2[a]	5.1	4.5	2.0	7.4[b]	10.5[a]	8.9[a]	8.4[a]	18.58[bc]
	150	5.4[a]	2.9	2.4	1.4	8.3[a]	6.4[c]	6.5[b]	6.7[b]	22.63[a]
	120	3.4[b]	5.4	3.1	1.2	6.3[c]	8.6[b]	6.7[b]	6.4[b]	14.83[c]
1,000,000 (S_2)	180	2.7[c]	2.3	1.8	1.1	3.6[d]	4.0[d]	4.1[c]	4.3[b]	17.33[c]
	150	3.4[b]	2.2	1.3	0.7	4.3[e]	3.8[d]	3.5[c]	3.8[c]	22.17[ab]
	120	2.5[b]	2.2	1.4	0.3	3.4[b]	3.8[d]	3.4[c]	3.3[c]	8.017[d]
833,000 (S_3)	180	2.6[b]	1.9	1.4	0.5	4.1[d]	3.2[d]	1.0[d]	1.9[d]	16.17[c]
	150	2.8[b]	1.5	1.1	0.3	3.4[b]	2.7[d]	1.2[d]	1.7[d]	23.70[a]
	120	3.0[b]	2.8	1.1	0.1	3.5[b]	3.3[d]	1.7[d]	1.4[d]	7.67[d]
Plant density		0.05	0.4177	0.3754	0.2184	<.0001	<.0001	<.0001	0.09	0.0168
Nitrogen		0.05	0.8637	0.4099	0.4688	<.0001	<.0001	<.0001	0.0014	<.0001
Interaction		0.05	0.0939	0.7808	0.2822	<.0001	<.0001	<.0001	0.066	0.0337

*Means followed by the same letter in each column are not significantly different to Duncan s multiple range test at 5% level

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