Effect of different crop spacing and fertilizer levels on growth and yield of onion under drip fertigation

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ABSTRACT:

Drip irrigation along with fertigation reduces the wastage of water and chemical fertilizers and subsequently optimizes the water and nutrient use by making them available at the point of their use and as per crop demand, which finally increase water and nutrient use efficiency. This modern agro-technique provides an excellent opportunity to maximize yield and minimize environmental pollution such as leaching of nutrients and chemicals by increasing fertilizer use efficiency, minimizing fertilizer application and increasing return on the fertilizer invested.120% recommended dose of fertilizer significantly improved the growth (plant height, number of leaves per plant, average weight of bulb, polar and equatorial diameter of bulb). Whereas, 120% RDF revealed maximum marketable yield and minimum neck thickness which showed good quality parameter. Yield attributes *i.e.* bulb yield per hectare was maximum with 120% RDF which was statistically at par with other two fertilizer levels.

Spacing and fertilizer levels showed significant effect on yield parameter (bulb yield per hectare and marketable yield) and their interaction was non-significant. The maximum bulb yield and marketable yield (q/ha) was recorded with F_3S_1 (120% RDF with 10 x 7.5 cm spacing) which was statistically at par with other treatment combination, except F_2S_1 (100% RDF with 10 x 7.5 cm spacing). Combine effect of two factors did not show any remarkable influence on growth parameter (plant height, no. of leaves and neck thickness), yield attribute (average weight of bulb, polar and equatorial diameter) and quality parameter (rotten bulb and TSS).

Keywords: Crop geometry, fertilizer levels, onion, drip fertigation

INTRODUCTION

India will be highly water stressed country 2020 onward. Population of India is expected to reach from 1027 million (Awurum, 2001) to 1930 million by 2025. Food grain requirement need to be raised to 350 million tons in 2025 to meet the requirement of population. To sustain the rapidly growing world population, agricultural production needs to be increased. Water is the most important and critical input in human life especially in agriculture and has made a significant contribution in providing stability to food grain production and self-sufficiency. The pressure for the most efficient use of water for agriculture is intensifying with the increased competition for water resources among various sectors with mushrooming population (Fanish, 2013). Globally 3790 km^3 of fresh water is annually used whereas 69 per cent of this fresh water use for agriculture.

India is vast country with extremes of climate. Average annual rainfall in India is about 1200 mm which amounts to 390 million hectares meters when considered over geological area of 328 million hectare. Onion *(Allium cepa* L.) is one of the most common and indispensable vegetable crops commercially grown in India. It is a member of Alliaceae family. Its genus is *Allium* and species is *cepa*. The crop was originated somewhere between western China and deserts lying east of the Caspian Sea. The name "Onia" is probably ranked to a city built by Onia in 1703 BC near the Gulf of Suez. Onion is a native of Asia. It is an established commercial bulbous crop and is one of the vegetable cum condiment crop grown and consumed widely across the world. It is used as salad or cooked in various ways in all curries, fried, boiled or baked, because of its importance in cookery, onion is called "queen of the kitchen" by Germans (Rajkumar, 2015).

MATERIAL AND METHODS

The field experiment was conducted to study the "Effect of spacing and fertilizer levels on onion production under drip fertigation", at Chilli and Vegetable Research Unit, Dr. PDKV, Akola, during *Rabi* season of 2017-18, which comes under Western Vidarbha region of Maharashtra. The experiment was carried out with an objective to assess the response of *Rabi* onion (*Allium cepa* L.) to different fertilizer level and crop geometry in term of growth and yield. Akola is situated in Western Vidarbha region of Maharashtra state and comes under sub-tropical zone. The source of water on the experimental plot was bore well at Chilli and Vegetable Research Unit, Dr. PDKV, Akola. The water was conveyed to the field through pipe line. Accordingly the layout was prepared and the pipeline for irrigation was installed. The water was conveyed to inline drip through the pipe lines installed at the experimental site. The irrigation system mainly consists of mainline, sub mainline, inline lateral, screen filter, fertigation tank, accessories such as control valve, Tee, reducer, elbow, coupling, G.T.O etc. The experiment was arranged in a factorial randomized block design with treatments split in two factors i.e. three levels of recommended dose of fertilizers and three different plant spacing, thus total nine treatment combinations with three replications.

Table 1. Treatment Combination

Treatment Combination	Specification
F_1S_1	80% Recommended Dose of Fertilizer + 10 cm × 7.5 cm spacing
F_1S_2	80% Recommended Dose of Fertilizer + 10 cm × 10 cm spacing
F_1S_3	80% Recommended Dose of Fertilizer +10 cm × 12.5 cm spacing
F_2S_1	100% Recommended Dose of Fertilizer + 10 cm × 7.5 cm spacing
F_2S_2	100% Recommended Dose of Fertilizer + 10 cm × 10 cm spacing
F_2S_3	100% Recommended Dose of Fertilizer + 10 cm × 12.5 cm spacing
F_3S_1	120% Recommended Dose of Fertilizer + 10cm × 7.5 cm spacing
F_3S_2	120% Recommended Dose of Fertilizer + 10 cm × 10 cm spacing
F_3S_3	120% Recommended Dose of Fertilizer + 10 cm × 12.5 cm spacing

Drip system was scheduled on alternate day interval throughout the season. The water requirement of onion under drip irrigation at 100 % ET was worked out on the basis of pan evaporation.

RESULTS AND DISCUSSION

The field experiment was carried out at Chilli and Vegetable Research Unit, CRS, Dr. PDKV, Akola, during *Rabi* season of 2017-18. The observations on the different aspects viz., growth parameters, quality parameter, yield attributes, yield at the specified cropping periods. The treatment wise observations were recorded periodically and the data so obtained were subject to statistical computation as per table 1. The crop water requirement varies with the kind of crop, degree of maturity, water availability and atmospheric conditions such as humidity, wind velocity, sunshine hours and temperature.

Irrigation water applied during different growth stages and rainfall received during these stages summed up to determine the crop growth stage wise water requirement of onion as influenced in 100% replenishment of water and presented in table 2.

Table 2. Crop growth stage wise water requirement of onion

Sr. No.	Crop growth stage	Water applied, mm
1	Irrigation before transplanting	83.11
2	Initial stage	54.40
3	Crop development stage	109.66
4	Mid stage	230.60
5	Late stage	142.91
	Total	537.55

During the periods of present investigation of experiment plant height was recorded at 30, 60 and 90 DAT. The data obtained in respect to plant height were statistically analyzed, tabulated and graphically depicted in Fig 1and 2.

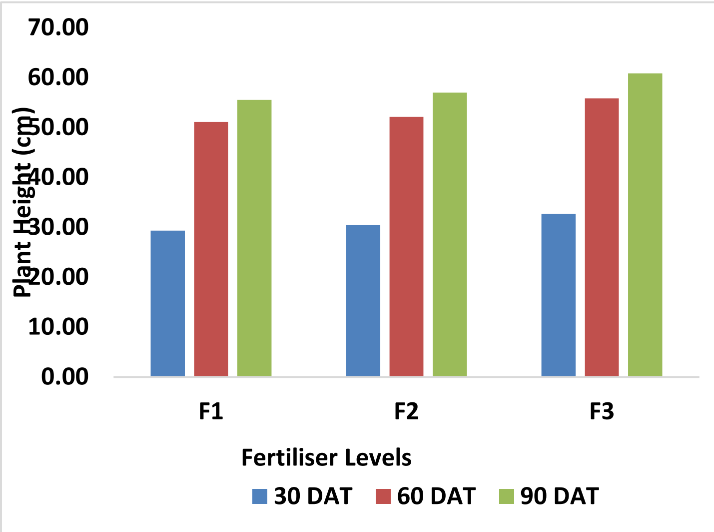


Fig. 1. Effect of fertilizer levels on plant height (cm)

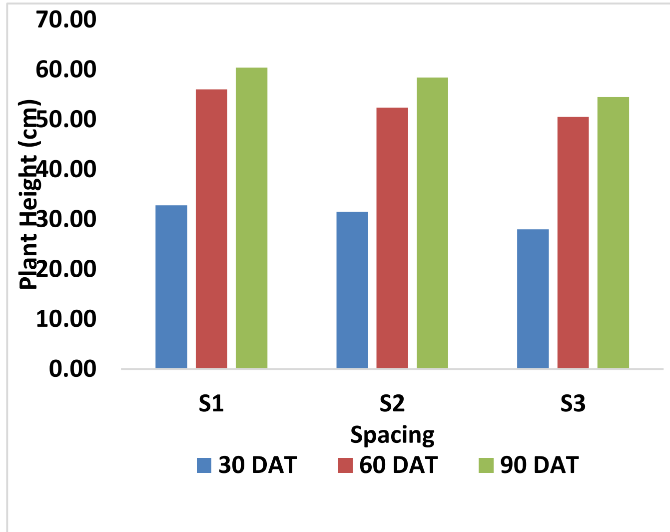


Fig. 1. Effect of Spacing on plant height (cm)

The plant height of onion was influenced significantly due to fertilizer levels. Different fertilizer levels exhibited significant effect on plant height at 30, 60 and 90 DAT. Treatment of F_3 (120 per cent RDF ha^{-1} recorded significantly higher plant height over 100 per cent RDF ha^{-1} and 80 per cent RDF ha^{-1} at 30, 60 and 90 DAT treatment 120 per cent RDF ha^{-1} was superior over 80 per cent RDF ha^{-1} and at par with application of 100 per cent RDF ha^{-1}. The increase in the plant height might be due to the positive effect of fertilizer levels on plant growth that leads to progressive increase in length and consequently plant height.

Plant height recorded at 30, 60 and 90 DAT indicated significant effect of fertilizer levels. There was a linear increase in plant height at all the stages from F_1 to F_3 in ascending order. It showed that application of fertilizer levels exerted the positive effect on plant height which may be due to the role of nitrogen in chlorophyll structure which is responsible for photosynthesis and manufacture of food material in the plants. These findings are in line with findings of Tiwari *et al.* (2002), Haque *et al.* (2004) and Nasreen *et al.* (2007).

Data presented in Table 3 revealed that the number of leaves $plant^{-1}$ at 30, 60 and 90 $plant^{-1}$ increased significantly due to various treatments of fertilizer levels. Whereas 120 per cent RDF ha^{-1} recorded significantly maximum number of leaves $plant^{-1}$ i.e.5.86, 8.87, 12.73 over other treatments at 30, 60 and 90 days. Treatment F_3 i.e. 120 per cent RDF ha^{-1} was found superior over 80per cent RDF ha^{-1} and at par with 100 per cent RDF ha^{-1}. This might be due to better growth condition on account of availability of more fertilizer**.**

Table 3. Effect of spacing and fertilizer levels on no. of leaves per plant at successive crop growth stages in onion

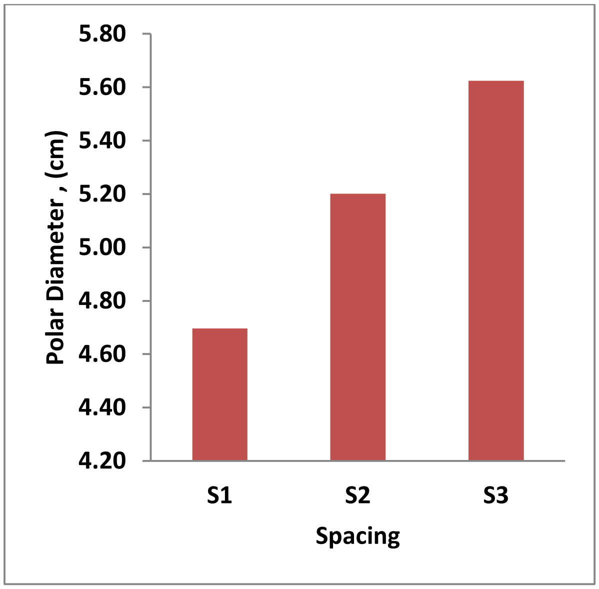
Treatments	No. of leaves		
	30 DAT	60 DAT	90 DAT
A) Fertilizer Levels			
F_1 -80% RDF	5.27	8.23	11.64
F_2 -100% RDF	5.56	8.76	12.00
F_3 -120% RDF	5.86	8.87	12.73
SE(m) ±	0.09	0.18	0.24
CD (5%)	0.28	0.53	0.73
B) Spacing (cm)			
S_1-10 cm × 7.5 cm	5.40	8.27	11.58
S_2-10 cm × 10 cm	5.53	8.54	12.38
S_3-10 cm × 12.5 cm	5.74	9.04	12.42
SE(m) ±	0.09	0.18	0.24
CD (5%)	0.28	0.53	0.73
Interaction effect	NS	NS	NS
SE(m) ±	0.16	0.31	0.42
CD (5%)	--	--	--

Each incremental dose of nitrogen caused significant increase in number of leaves at all the stages. Higher dose of fertilizer with nitrogen might have stimulated the initiation of more number of leaves in the plant. Similar finding have been reported by Yadav et al. (2003), Haque et al. (2004), joshi at al. (2005) and EI-Tantway and EI-Beik (2009).

Interaction effect

From the data presented in Table 3, it is found that interaction effects between fertilizer levels and spacing individually in respect of number of leaves plant^{-1} were found to be significantly influence at 30, 60 and 90 DAT and their interaction was found to be non- significant.

Data presented fig 3 revealed that the polar diameter of bulb at the time of harvest increased significantly due to various treatments of spacing. Whereas S_3 i.e. (10 X 12.5 cm) recorded significantly maximum i.e. 5.62 cm diameter of bulb over other treatments. Treatment S_3 i.e. (10 X 12.5 cm) was found superior over S_1 i.e. (10 X 7.5 cm) 4.70 cm and at par with S_2 i.e. (10 X 10 cm) 5.20 cm this might be due to better growth condition on account of availability of more spacing**.**



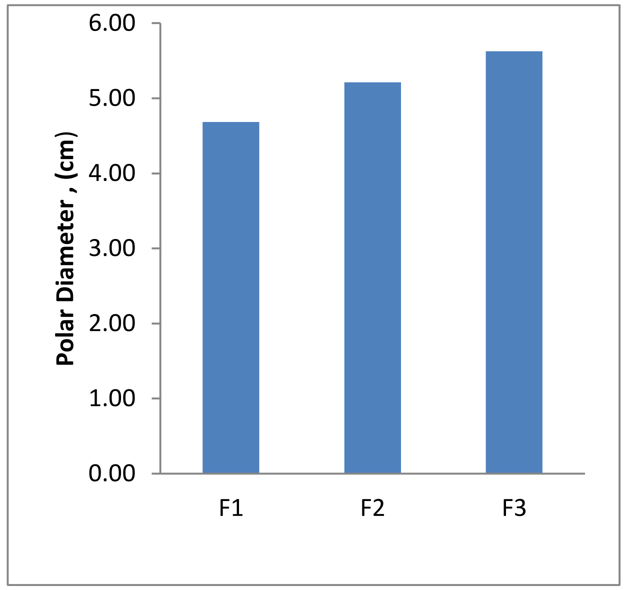


Fig.3. Effect of spacing on polar diameter

Fig. 4. Effect of fertilizer levels on polar diameter

The data presented in table 4 revealed significant effects of crop geometry and fertilizer levels on average weight of bulb. However, combined effect of crop geometry and fertilizer levels did not show any remarkable effect.

Data presented in table 4 revealed that the average weight of bulb at the time of harvest increased significantly due to various treatments of spacing. Whereas S_3 i.e. (10x 12.5 cm) recorded significantly maximum average weight of bulb i.e. (70.26 g) over other treatments of spacing. Treatment S_3 i.e. (10x 12.5 cm) was found superior over S_1 i.e. (10x 7.5 cm) 59.08 g and spacing S_2 i.e. (10x 10 cm) 64.96 g. This might be due wider spacing between plants proved advantageous in increasing the average weight of bulb.

Data presented in table 4 revealed that the average weight of bulb at the time of harvest increased significantly due to various treatments of fertilizer levels where as 120 per cent RDF ha^{-1} recorded significantly maximum average weight of bulb over other treatments at fertilizer levels. Treatment F_3 i.e. 120 per cent RDF ha^{-1} was found superior average weight of bulb i.e. (70.53) over 80per cent RDF ha^{-1} i.e.(60.26) and with 100 per cent RDF ha^{-1} i.e.(63.51). This might be due to better growth condition on account of availability of more fertilizer**.**

Table 4 Average Weight of bulbs (g)

Average weight of bulbs (g)	
A) Fertilizer Levels	
F_1 -80% RDF	60.26
F_2 -100% RDF	63.51
F_3 -120% RDF	70.53
F test	Sig.
SE(m) ±	2.18
CD (5%)	6.53
B) Spacing (cm)	
S_1- 10 cm × 7.5 cm	59.08
S_2- 10 cm × 10 cm	64.96
S_3- 10 cm × 12.5 cm	70.26
F test	Sig.
SE(m) ±	2.18
CD (5%)	6.53
Interaction effect (A × B)	
F test	NS
SE(m) ±	3.77
CD (5%)	--

Interaction effect

It is found that interaction effects between fertilizer levels and spacing in respect of equatorial diameter of bulb where found to be significant but their interaction effect where non-significantly influenced.

The bulb yield per plot at the time of harvest increased significantly due to various treatments of spacing. Whereas S_1 i.e. (10x 7.5 cm) recorded significantly maximum yield (276.92 q/ha) which was statistically at par with S_2 (212.18 q/ha). S_1 and S_2 were statistically at par to each other. Minimum bulb yield (156.15 kg/plot) was recorded in S_3 (10 x 12.5 cm) due to less number of plant accommodate per unit area and it was statistically at par with S_2 (10 x 10 cm). The per cent marketable yield increased from 78.83 % to 81.64 % with the increase in fertilizer levels from F_1 (80% RDF) to F_3 (120% RDF). Spacing S_3 (10 cm x 12.5 cm) recorded significantly highest per cent marketable yield *i.e.* 81.64% and S_1 (10 cm x 7.5 cm) recorded lowest weight of per cent marketable yield *i.e.*78.83%. The maximum per cent marketable yield was recorded in F_1S_1 (80% RDF with 10 cm x 7.5 cm) *i.e.* 86.33% followed by F_2S_1 (100% RDF with 10 cm x 7.5 cm) *i.e.* 85.94% and F_3S_1 (120% RDF with 10 cm x 7.5 cm) *i.e.*85.88%. Minimum yield was recorded in F_1S_3 (80% RDF with 10 x 12.5 cm) *i.e.* 72.02%.

CONCLUSIONS:

The observations on growth parameters viz. plant height, number of leaves per plant and diameter of neck were recorded at the successive growth stages *i.e.* 30, 60 and 90 days after transplanting. The yield and yield attributing characters viz. average weight of bulb, bulb diameter (polar and equatorial), bulb yield per hectare and marketable yield were recorded. Looking to the statistical analysis it was found that combined effect of spacing and fertilizer level did not show any remarkable influence on different growth, yield and quality parameters (neck thickness, bulb yield, TSS and rotten bulb) except marketable yield.

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