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Effect of land configuration with different levels of spacing and fertilizers on growth and quality of onion (*Allium cepa* L.)

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Abstract
The present investigation entitled "Effect of land configuration with different levels of Spacing and fertilizers on growth, yield and quality of onion (*allium cepa* L.)," was conducted at educational farm Department of Horticulture, V.N.M.K.V., Parbhani during *rabi* season of 2017-2018. There were three factors studied in this experiment one major factor *viz.,* A) Land configuration include two levels (P_1- Flat Beds and P_2- Raised beds) and two sub factors *viz.,* A) Spacing include three levels (S_1- 15x7.5cm, S_2- 15x10cm and S_3-15x15cm) and B) Fertilizers Include three levels (F_1- 75:50:50, F_2-100:50:50 and F_3-125:75:75kg NPK/ha). Overall there were eighteen treatment combinations. The experiment was laid out in split plot design with two replications. The results revealed that maximum values of growth attributes in terms of plant height, number of leaves per plant, neck thickness, diameter of bulbs and quality attributes *viz.* total soluble solids, ascorbic acid content and volume of bulb recorded significantly with raised bed configuration (P_2) at 15x15 cm spacing (S_3) and 125:75:75 kg NPK/ha (F_3). However, the minimum values of all these characters were noted with flatbed configuration (P_1) at 15x7.5 cm spacing (S_1) and 75:50:50 kg NPK/ha (F_1).

Keywords: land configuration, fertilizers, spacing, raised bed, flat bed

Introduction
Onion (*Allium cepa* L.) popularly known as "Queen of the kitchen" is one of the most important and commercially valuable vegetable as well as spice crop cultivated extensively in India. It is used in almost all food preparation and is an integral part of Indian diet. Consumption is believed to benefit health in that onions contain phenolics and flavonoids that have potential anti-inflammatory, anti-cholesterol, anticancer and antioxidant properties. Land configuration is very important aspect to study. It plays a major role in maximizing infiltration, minimizing soil erosion and improving water use efficiency of different crops. Raised bed and flatbed system is an effective land configuration in onion to improve water use efficiency. Spacing determines the plant density and is generally dependent upon the expected growth of particular crop plant variety in a given agro-climatic region. Therefore, optimum plant population is one of the important factors for optimum utilization of solar energy and soil nutrients to increase the yield per hectare of onion crop. Nutrients play a significant role in improving productivity and quality of vegetable crops. Among the nutrients Nitrogen (N), phosphorus (P) and potassium (K) are often referred to as the primary macronutrients because of the large quantities taken up by plants from the soil relative to other essential nutrients (Marschner, 1995) [12]. Considering all these things in a view present study is undertaken to investigate the "Effect of land configuration with different levels of spacing and fertilizers on growth, yield and quality of onion.

Materials and Methods
The experiment was undertaken at Department of Horticulture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *rabi* season of 2017-2018. The experiment was laid out in split plot design with two replications. There were three factors studied in this experiment one main factor *viz.,* A) Land configuration include two levels (P_1- Flat Beds and P_2- Raised beds) and two sub factors *viz.,* A) Spacing include three levels (S_1- 15x7.5cm, S_2- 15x10cm and S_3-15x15cm) and B) Fertilizers Include three levels (F_1- 75:50:50, F_2-100:50:50 and F_3-125:75:75kg NPK/ha). Thus, overall there were eighteen treatment combinations were formed.

Table 1: Treatment Details: (Three factors)

(Main factor) 1. Planting system	(Sub factor) 2. Spacing's	(Sub factor) 3. Fertilizers application
P_1 – Flat bed	S_1 – 15x7.5cm	F_1 – 75:50:50 kg NPK/ha
P_2 – Raised bed	S_2 – 15x10cm	F_2 – 100:50:50 kg NPK/ha
	S_3 – 15x15cm	F_3 – 125:75:75 kg NPK/ha

Table 2: Treatments combination

Treatments	Treatments combination
$T_1 = P_1 S_1 F_1$	FLAT BED + 15X7.5cm + 75:50:50NPK
$T_2 = P_1 S_1 F_2$	FLAT BED + 15X7.5cm + 100:50:50NPK
$T_3 = P_1 S_1 F_3$	FLAT BED + 15X7.5cm + 125:75:75NPK
$T_4 = P_1 S_2 F_1$	FLAT BED + 15X10cm + 75:50:50NPK
$T_5 = P_1 S_2 F_2$	FLAT BED + 15X10cm + 100:50:50NPK
$T_6 = P_1 S_2 F_3$	FLAT BED + 15X10cm + 125:75:75NPK
$T_7 = P_1 S_3 F_1$	FLAT BED + 15X15cm + 75:50:50NPK
$T_8 = P_1 S_3 F_2$	FLAT BED + 15X15cm + 100:50:50NPK
$T_9 = P_1 S_3 F_3$	FLAT BED + 15X15cm + 125:75:75NPK
$T_{10} = P_2 S_1 F_1$	RAISED BED + 15X7.5cm + 75:50:50NPK
$T_{11} = P_2 S_1 F_2$	RAISED BED + 15X7.5cm + 100:50:50NPK
$T_{12} = P_2 S_1 F_3$	RAISED BED + 15X7.5cm + 125:75:75NPK
$T_{13} = P_2 S_2 F_1$	RAISED BED + 15X10cm + 75:50:50NPK
$T_{14} = P_2 S_2 F_2$	RAISED BED + 15X10cm + 100:50:50NPK
$T_{15} = P_2 S_2 F_3$	RAISED BED + 15X10cm + 125:75:75NPK
$T_{16} = P_2 S_3 F_1$	RAISED BED + 15X15cm + 75:50:50NPK
$T_{17} = P_2 S_3 F_2$	RAISED BED + 15X15cm + 100:50:50NPK
$T_{18} = P_2 S_3 F_3$	RAISED BED + 15X15cm + 125:75:75NPK

Results and Discussion

Effect of land configuration, spacing and fertilizers on growth attributes of onion

The data in respect of growth attributes of onion are presented in Table-3. Land configuration differed significantly for plant height, number of leaves per plant, neck thickness and diameter of bulb in onion. Maximum plant height (71.70 cm), number of leaves per plant (9.60), neck thickness (2.83 cm) and diameter of bulb (53.45 mm) were recorded in case of raised bed configuration as compared to flatbed system. Raised bed configuration was found significantly superior over flat bed in respect of all these growth characters. This might be due to raised bed configuration improves water use efficiency and will help to improve better aeration and drainage as compared to flat sowing. These findings corroborates with those of Farrag (1995) [5], Haque *et al.* (2002) [6], and Dodake (2005) [4].

Spacing exhibited significant effect of growth attributes at all the growth stages. Maximum plant height (72.52 cm), number of leaves per plant (9.91), neck thickness (2.89 cm) and diameter of bulb (56.22 mm) were found under wider spacing level of S_3 (15x15 cm) which was followed by S_2 (15x10 cm). Lowest values of plant height (69.26 cm), number of leaves per plant (9.12), neck thickness (2.67 cm) and diameter of bulb (50.06 mm) were noted under narrow spacing level of S_1 (15x7.5 cm). More spacing increased higher growth in plant this might be due to wider spacing help the individual plant to utilize more soil, space, water, nutrition, air and light which contributing for more photosynthesis for better growth as compare to closer spacing. These findings are in agreement with those of Khan *et al.* (2003) [8], Misra *et al*. (2014) [13] and Kishor *et al.* (2017) [9].

There were significant effects of different fertilizer levels on growth attributes of onion. Highest plant height (72.90 cm), number of leaves per plant (9.71), neck thickness (2.96 cm) and diameter of bulb (56.47 mm) were observed with fertilizer level F_3 (125:75:75 NPK kg/ha), followed by F_2 (100:50:50 NPK Kg/ha). Minimum values of all these growth attributes were noted with application of F_1 (75:50:50 NPK kg/ha). It showed that application of NPK fertilizers exerted the positive effect on plant growth characters 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. It promotes the leaf, stem and vegetative growth (Bungard *et al.* 1999) [2]. Phosphorus stimulates early root development and helps to establish seedling quickly. It gives rapid and vigorous start to plants. It also improves the quality of produce. Potassium helps to translocation of carbohydrates, increases disease resistance in plants and contract the injurious effect of excess nitrogen. Similar findings have been reported by Patel and Vachhani (1993) [16], Kumar *et al.* (1998) [11], Singh *et al.* (2000) [20], Aliyu *et al.* (2007) [1] and Shah *et al.* (2013) [17].

Combined effect of land configuration, spacing and fertilizers did not show any significant influence on growth attributes of onion.

Effect of land configuration, spacing and fertilizers on quality parameters of onion

The data regarding quality parameters of onion presented in Table-4. In quality attributes the T.S.S and ascorbic acid content of bulbs significantly influenced by land configuration but volume of bulb didn't affect significantly with this factor. The raised bed configuration recorded maximum T.S.S (10.14 %) and ascorbic acid content (8.90 mg) and was found superior over flatbed. Minimum T.S.S (9.94%) and ascorbic acid content (8.70 mg) recorded with flat bed. Similar findings have been reported by Chopade *et al.* (1998) [3] and Kahlon (2016) [42].

Spacing significantly affects T.S.S, ascorbic acid content and volume of bulbs in onion. The maximum T.S.S (10.51 %), ascorbic acid content (9.13 mg) and volume of bulbs (66.79 cc) recorded with the spacing level S_3 (15x15 cm), followed by S_2 (15x10 cm). While, the minimum values of T.S.S (9.62%), ascorbic acid content (8.49 mg) and volume of bulbs (59.62 cc) recorded with the spacing level of S_1 (15x7.5 cm). These parameters were recorded highest with 15x15 cm row spacing. This result might be due to in wider spacing there is lesser competition for nutrients and sunlight, increasing food assimilatory efficiency and thereby sunlight more food reserve in bulbs. Similar results have been reported by Naruka and Dhaka (2001) [14], Singh *et al*. (2013) [18] and Kishor *et al.* (2017) [9].

The data (Table 4) indicated that the quality parameters include T.S.S, ascorbic acid content and volume of bulbs differed significantly with various fertilizer levels. Application of 125:75:75 NPK kg/ha (F_3) recorded highest T.S.S (10.58%), ascorbic acid content (9.37 mg) and volume of bulbs (66.50 cc) in onion, which was followed by F_2 (100:50:50 NPK kg/ha). While, the lowest values of T.S.S (9.63%), ascorbic acid content (8.34 mg) and volume of bulbs (60.25 cc) in onion was recorded with (F_1) 75:50:50 NPK kg/ha. This might be due to nitrogen improves optimum vegetative growth and chlorophyll content in leaves which increases the mobilization and accumulation of photosynthates towards storage organs of bulbs. The results are in accordance with the findings of Singh and Dhankar (1989) [19], and Naik and Hosmani (2003) [15].

In Interaction effect, the interaction of spacing and fertilizers (S x F) found significant in total soluble solids and volume of bulbs. Other interactions did not show any significant influence on quality parameters of onion.

Table 3: Effect of land configuration with different levels of spacing and fertilizers on growth attributes in onion.

Treatment No.	Treatment Details	Plant height (cm)	No. of leaves/ plant	Neck thickness (cm)	Diameter of bulbs (mm)
Main treatment	**Planting system (P)**				
P_1	Flat Bed	69.75	9.42	2.72	52.68
P_2	Raised Bed	71.70	9.60	2.83	53.45
SE ±		0.07	0.19	0.04	0.12
CD at 5%		1.39	NS	0.13	0.39
Sub treatment (1)	**Spacing (S)**				
S_1	15x7.5 cm	69.26	9.12	2.67	50.06
S_2	15x10 cm	70.39	9.50	2.77	52.92
S_3	15x15 cm	72.52	9.91	2.89	56.22
SE ±		0.18	0.66	0.10	0.63
CD at 5%		0.55	1.97	0.33	1.89
Sub treatment (2)	**Fertilizers (NPK kg/ha) (F)**				
F_1	75:50:50	68.60	9.27	2.60	49.49
F_2	100:50:50	70.68	9.55	2.77	53.25
F_3	125:75:75	72.90	9.71	2.96	56.47
SE ±		0.18	0.66	0.10	0.63
CD at 5%		0.55	1.97	0.33	1.89
	Interaction Effect (P x S)				
SE ±		0.26	0.93	0.14	0.89
CD at 5%		NS	NS	NS	NS
	Interaction Effect (P x F)				
SE ±		0.26	0.93	0.14	0.89
CD at 5%		NS	NS	NS	NS
	Interaction Effect (S x F)				
SE ±		0.32	1.14	0.18	1.09
CD at 5%		NS	NS	NS	SIG
	Interaction Effect (P x S x F)				
SE ±		0.45	1.61	0.25	1.54
CD at 5%		NS	NS	NS	NS

Table 4: Effect of land configuration with different levels of spacing and fertilizers on quality parameters in onion.

Treatment No.	Treatment Details	Total soluble solids (%)	Ascorbic acid content (mg/100gm)	Volume of bulb (cc)
Main treatment	**Planting system (P)**			
P_1	Flat Bed	9.94	8.70	62.55
P_2	Raised Bed	10.14	8.90	63.66
SE ±		0.05	0.04	0.07
CD at 5%		0.08	0.07	NS
Sub treatment (1)	**Spacing (S)**			
S_1	15x7.5 cm	9.62	8.49	59.62
S_2	15x10 cm	10.00	8.78	62.91
S_3	15x15 cm	10.51	9.13	66.79
SE ±		0.12	0.18	0.13
CD at 5%		0.35	0.55	0.40
Sub treatment (2)	**Fertilizers (NPK kg/ha) (F)**			
F_1	75:50:50	9.63	8.34	60.25
F_2	100:50:50	9.92	8.70	62.58
F_3	125:75:75	10.58	9.37	66.50
SE ±		0.12	0.18	0.13
CD at 5%		0.35	0.55	0.40
	Interaction Effect (P x S)			
SE ±		0.16	0.26	0.18
CD at 5%		NS	NS	NS
	Interaction Effect (P x F)			
SE ±		0.16	0.26	0.18
CD at 5%		NS	NS	NS
	Interaction Effect (S x F)			
SE ±		0.20	0.32	0.23
CD at 5%		SIG	NS	SIG
	Interaction Effect (P x S x F)			
SE ±		0.29	0.45	0.32
CD at 5%		NS	NS	NS

Conclusion

Based on the obtained results it was concluded that in case of land configuration, raised bed planting improved the growth and quality attributes in onion, probably due to availability of adequate nutrients as a result of which bulbs stored more food for vegetative as well as reproductive growth. In case of spacing, the wider spacing (S_3) 15x15 cm recorded maximum growth and quality parameters because of wider spacing

provide more area, water, light and less nutrient competition among plants. Onion responds very well to the fertilizers. Investigation revealed that with increasing rate of fertilizers all the growth and quality attributes were increased. It was noticed that significantly highest values of growth and quality attributes observed with the application of (F_3) 125:75:75 kg NPK/ha compared to other treatments.

Thus it is inferred that raised bed planting at spacing 15x15 cm with application of 125:75:75 kg NPK/ha (T_{18}) was found significantly superior for higher growth and quality attributes in onion.

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