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Effect of land configuration with different levels of spacing and fertilizers on yield and economic studies of onion (*Allium cepa* L.) cultivation

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Abstract
The present investigation entitled "Effect of land configuration with different levels of Spacing and fertilizers on yield and economic studies of onion (*allium cepa L.*) Cultivation," was conducted at experimental 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 weight of fresh bulb and weight of cured bulb recorded with raised bed configuration (P_2) at 15x15 cm spacing (S_3) and 125:75:75 kg NPK/ha (F_3). While, the significantly highest yield per plot, yield per hectare and economical parameters *viz.* gross monetary return, net monetary return and benefit: cost ratio recorded with raised bed configuration (P_2) at 15x7.5 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) 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) [7]. 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 yield and economic studies of onion cultivation".

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.

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Treatment Details: (three factors)

(Main factor) 1. Land configuration	(Sub factor) 2. Spacing	(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

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 Yield attributes of onion
The data in respect of yield attributes of onion are presented in Table-1. Significant differences were observed with land configuration in case of weight of fresh bulb, cured bulb, average yield per plot and yield per hectare in onion. Raised bed configuration recorded maximum weight of fresh bulb (86.88 g), cured bulb (82.38 g), yield per plot (14.14 kg) and yield per hectare (31.42 t/ha), followed by flatbed configuration (83.13g, 78.63g, 13.47 kg and 29.94 t/ha respectively). Raised bed was found to be significantly superior over flatbed. Bulb weight increased in raised bed planting probably due to availability of adequate nutrients and favourable environment for growth as a result of which bulbs stored more food for vegetative as well as reproductive growth. These findings are in accordance with Dodake (2005) [2], Kaur *et al.* (2017) [5] and Sarker *et al.* (2017) [12].

Spacing differed significantly in yield attributes, the wider spacing of S_3 (15x15 cm) reported maximum fresh weight of bulb (98.95 g) and cured weight of bulb (94.45 g). While, the highest average yield per plot (16.17 kg) and yield per hectare (35.94 t/ha) was recorded with closer spacing of 15x7.5 cm (S_1). The yield per plot and per hectare was highest in closer spaced plants which might be due to accommodation of more plants per unit area, followed by intermediate spacing and the lowest yield was observed with wider spaced plants. Similar findings have been reported by Singh (1995) [14], Kumar *et al.* (2001), (2011) [6], Thirupathi *et al.* (2014) [17], Misra *et al.* (2014) [8].

Significant results were obtained with different fertilizer levels. The Maximum weight of fresh bulb (93.75 g), cured bulb (89.29 g), yield per plot (15.36 kg) and yield per hectare (34.14 t/ha) in onion was observed with fertilizers level F_3 (125:75:75 NPK kg/ha). However, the minimum weight of fresh bulb (77.66 g) cured bulb (73.12 g), yield per plot (12.49 kg) and yield per hectare (27.76 t/ha) in onion was noted with application of 75:50:50 NPK kg/ha (F_1). This might be due to application of NPK fertilizers improving the vegetative growth and accelerating the photosynthesis in storage organs of bulbs and increased allocation to the bulbs resulting in an increased bulb yield. These findings are also in close agreement with those of reported by Sharma *et al.* (2003) [13], Ahmad *et al.* (2009) [1], Jahan *et al.* (2010) [3], and Shah *et al.* (2013) [15].

In Interaction effect, the interaction of spacing and fertilizers (S x F) was found significant in weight of fresh bulb, yield per plot and yield per hectare. However the interaction P x S (Land configuration and spacing) was found to be significant in influencing average yield per plot and yield per hectare in onion. Other interactions did not show any significant influence on yield attributes of onion.

Effect of land configuration, spacing and fertilizers on economic studies of onion
The data (Table 2 and 3) revealed that the maximum net realization of Rs.1,67,750/ha and benefit: cost ratio (4.19) were recorded under raised bed configuration, followed by flat bed with Rs.1,57,306/ha net returns and 3.99 B:C ratio. The increase in net profit and benefit: cost ratio was only due to yield differences under both treatments. Similarly, Sarker *et al.* (2017) [12] also recorded higher net realization and B:C ratio from onion raised through similar land configurations.

Amongst the different spacing level, closer 15x7.5 cm (S_1) spacing recorded highest net returns (Rs.1,97,770/ha) and benefit: cost ratio (4.66) in onion over rest of the other spacing levels. The lowest net returns (Rs.1,24,136/ha) and B:C ratio (3.44) was observed with wider spacing level of S_3 (15x15 cm). The highest net income due to 15x7.5 cm spacing was owing to the highest bulb yield in this treatment. Thus, the net income was found to be directly related with the bulb yield which fetched higher market value. Similar findings have been reported by Misra *et al.* (2015) [9], Patel (2008) [11] and Naik and Hosmani (2003) [10].

The net returns and benefit: cost ratio in onion increased with the increasing level of fertilizers. The maximum net returns (Rs.1,84,975/ha) and B:C ratio (4.40) was recorded with highest fertilizer level F_3 (125:75:75 NPK kg/ha), which was followed by F_2 (B:C 4.08). The lowest net returns (Rs.1,43,253/ha) and benefit: cost ratio (3.79) in onion was noted in case of fertilizer level F_1 (75:50:50 NPK kg/ha). The highest net income was due to the highest bulb yield obtained from 125:75:75 NPK kg/ha. The net income reduced with the reduction in NPK level. The results are in accordance with Jawadagi (2012) [4] and Singh *et al.* (2013) [16].

In interaction the treatment combination involving raised bed with 15x7.5 cm spacing and application of 125:75:75 kg NPK/ha (T_{12}- $P_2 S_1 F_3$) accrued the maximum net realization (Rs.2,34,400/ha) and benefit: cost ratio (5.21). Similar findings reported by Naik and hosamani (2003) [10].

Table 1: Effect of land configuration with different levels of spacing and fertilizers on Yield attributes of onion.

Treatment No.	Treatment Details	Weight of fresh bulb (g)	Weight of cured bulb (g)	Yield per plot (kg)	Yield per ha (t/ha)
Main treatment	**Planting system (P)**				
P_1	Flat Bed	83.13	78.63	13.47	29.94
P_2	Raised Bed	86.88	82.38	14.14	31.42
SE $\pm$		0.17	0.17	0.31	0.06
CD at 5%		3.17	3.17	1.17	1.23
Sub treatment (1)	**Spacing (S)**				
S_1	15x7.5 cm	74.54	70.04	16.17	35.94
S_2	15x10 cm	81.54	77.04	14.01	31.14
S_3	15x15 cm	98.95	94.45	11.23	24.96
SE $\pm$		1.20	1.14	0.62	0.91
CD at 5%		3.59	3.42	1.85	2.76
Sub treatment (2)	**Fertilizers (NPK kg/ha) (F)**				
F_1	75:50:50	77.66	73.12	12.49	27.76
F_2	100:50:50	83.62	79.12	13.56	30.13
F_3	125:75:75	93.75	89.29	15.36	34.14
SE $\pm$		1.20	1.14	0.62	0.91
CD at 5%		3.59	3.42	1.85	2.76
	Interaction Effect (P x S)				
SE $\pm$		1.69	1.61	0.87	1.14
CD at 5%		NS	NS	SIG	SIG
	Interaction Effect (P x F)				
SE $\pm$		1.69	1.61	0.87	1.14
CD at 5%		NS	NS	NS	NS
	Interaction Effect (S x F)				
SE $\pm$		1.86	1.89	1.07	1.36
CD at 5%		SIG	NS	SIG	SIG
	Interaction Effect (P x S x F)				
SE $\pm$		2.39	2.28	1.51	1.91
CD at 5%		NS	NS	NS	NS

Table 2: Economics of onion cultivation influenced by land configuration with different levels of spacing and fertilizers.

Treatment Details	Gross monetary returns (Rs/ha)	Net monetary returns (Rs/ha)	B:C Ratio
Planting system (P)			
P_1 :Flat Bed	209607.2	157386.2	3.99
P_2 : Raised Bed	219971.1	167750.1	4.19
Spacing's (S)			
S_1: 15x7.5 cm	251591.7	197770.7	4.66
S_2: 15x10 cm	218017.9	165796.9	4.16
S_3: 15x15 cm	174757.9	124136.9	3.44
Fertilizers (F) (NPK kg/ha)			
F_1 : 75:50:50	194381.3	143253.3	3.79
F_2 : 100:50:50	210930.4	159475.4	4.08
F_3 : 125:75:75	239055.8	184975.8	4.40

Table 3: Economics of onion cultivation influenced by different treatment combinations.

Treat. No.	Treatment combination	Cost of cultivation (Rs/ha)	Gross monetary returns (Rs/ha)	Net monetary returns (Rs/ha)	B:C Ratio
T_1	$P_1 S_1 F_1$	52728.00	218225.0	165497.0	4.14
T_2	$P_1 S_1 F_2$	53055.00	239750.0	186695.0	4.52
T_3	$P_1 S_1 F_3$	55680.00	276587.5	220907.5	4.97
T_4	$P_1 S_2 F_1$	51128.00	191677.5	140549.5	3.74
T_5	$P_1 S_2 F_2$	51455.00	208740.0	157285.0	4.05
T_6	$P_1 S_2 F_3$	54080.00	237720.0	183640.0	4.39
T_7	$P_1 S_3 F_1$	49528.00	157692.5	108164.5	3.18
T_8	$P_1 S_3 F_2$	49855.00	168787.5	118932.5	3.38
T_9	$P_1 S_3 F_3$	52480.00	187285.5	134805.0	3.57
T_{10}	$P_2 S_1 F_1$	52728.00	231665.0	178937.0	4.39
T_{11}	$P_2 S_1 F_2$	53055.00	253242.5	200187.5	4.77
T_{12}	$P_2 S_1 F_3$	55680.00	290080.0	234400.0	5.21
T_{13}	$P_2 S_2 F_1$	51128.00	202352.5	151224.5	3.96
T_{14}	$P_2 S_2 F_2$	51455.00	219310.0	167855.0	4.26
T_{15}	$P_2 S_2 F_3$	54080.00	248307.5	194227.5	4.59
T_{16}	$P_2 S_3 F_1$	49528.00	164675.0	115147.0	3.32
T_{17}	$P_2 S_3 F_2$	49855.00	175752.5	125897.5	3.52
T_{18}	$P_2 S_3 F_3$	52480.00	194355.0	141875.0	3.70

Conclusion

Raised bed configuration recorded significantly maximum yield and economical parameters in onion, probably due to raised bed configuration improves water use efficiency and will help to improve better aeration and drainage as compared to flat sowing. In case of spacing, the wider spacing (S_3) 15x15 cm recorded maximum weight of fresh bulb and cured bulb. But the yield per plot, yield per hectare, net returns and benefit: cost ratio in onion was found maximum with closer spacing level of S_1 (15x7.5 cm). This might be due to accommodation of more number of plants per unit area in closer spacing. In fertilizers, Investigation revealed that with increasing rate of fertilizers all the yield and economical parameters were increased. It was noticed that significantly highest values of yield and economic studies observed with the application of (F_3) 125:75:75 kg NPK/ha. Thus, it is inferred that raised bed planting (P_2) at spacing 15x7.5 cm (S_1) with application of 125:75:75 kg NPK/ha (F_3) was found significantly superior for realizing higher yield in onion but to obtain big sized good quality bulbs then the treatment (T_{18}) i.e. raised bed at spacing of 15x15 cm with 125:75:75 kg NPK/ha ($P_2S_3F_3$) was more reliable.

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