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Study on Efficacy of Planting Methods and Spacing on Growth and Yield Attributes of Onion Produced through Bulb Sets

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ABSTRACT: A study titled effect of planting method and spacing on the growth and yield of onion (*Allium cepa* L.) variety N-53 in Southern Telangana Region was conducted during the late kharif season of 2021-2022 at the research field of the Vegetable Block, College of Horticulture, Rajendranagar, Hyderabad in 2022. The research aimed to assess the production potential of late-kharif onion using bulb sets with various planting methods and spacing configurations. The experiment followed a Factorial Randomized Block Design (FRBD) with two factors: planting methods and spacing. Several growth parameters, including plant height (measured at 15, 30, 45, 60, and 75 days after planting), number of functional leaves, and pseudo stem diameter, were recorded during the study. Notably, the study found that the raised bed planting method (M_1) significantly influenced these growth parameters, with plant height ranging from 14.2 cm to 39.6 cm, the number of functional leaves ranging from 3.62 to 17.45, and pseudo stem diameter ranging from 0.2 cm to 1.4 cm at different stages of growth. Regarding spacing, a planting configuration of 30 cm × 20 cm demonstrated significantly higher plant height (ranging from 15.1 cm to 41.7 cm), number of functional leaves (ranging from 4.9 to 19.7), and pseudo stem diameter (ranging from 0.5 cm to 1.7 cm) at various stages of growth. The study also evaluated yield parameters, including fresh weight of bulbs, bulb diameter, double bulbs percentage, bolted bulbs percentage, bulb yield per plot, bulb yield per hectare, and marketable yield. Notably, the raised bed planting method (M1) resulted in significantly higher fresh weight of bulbs (80.2 g), bulb diameter (6.6 cm), bulb yield per plot (6.44 kg), total bulb yield per hectare (19.35 t), and marketable bulb yield per hectare (17.28 t). In terms of spacing, a planting configuration of 30 cm × 20 cm showed significantly higher fresh weight of bulbs (84.9 g) and bulb diameter (6.85 cm), while a spacing of 15 cm × 10 cm resulted in significantly higher bulb yield per plot (6.87 kg), total bulb yield per hectare (20.07 t), and marketable bulb yield per hectare (16.9 t). Additionally, the percentage of double bulbs (16.5%) was significantly lower when using a spacing of 15 cm × 10 cm, and the percentage of bolted bulbs (5.1%) was reduced with a spacing of 30 cm × 20 cm. Furthermore, the interaction between planting method and spacing significantly influenced plant height, number of leaves, fresh weight of compound bulbs, and overall yield. The *kharif* crop is the most important in regulating market prices because if it is delayed or spoiled by whimsy monsoon, prices rise quickly in October and remain high until January or February. To combat the rise in onion prices, grow onions in the late *kharif* season using a technique known as bulb set technique. These findings highlight the importance of selecting appropriate planting methods and spacing configurations to optimize onion growth and yield in the southern Telangana region.

Keywords: Planting method, spacing, Late *kharif*, Bulb Sets, Onion.

INTRODUCTION

Onion (*Allium cepa* L.) belongs to the Amaryllidaceae family (Welbaum, 2015) and is a crucial monocotyledonous, cool-season vegetable crop that is cross-pollinated. It holds great significance globally, cultivated commercially in more than a hundred countries (Umamaheswarappa *et al*., 2018), and it holds a special place in the daily diets of Indians. Known as the "Queen of the Kitchen" (Selviraj, 1976) and sometimes referred to as the "poor man's musk", onions are primarily grown for local consumption, with some exports. They are exceptionally resilient, capable of enduring rough handling for an extended period. Besides imparting a distinctive flavor and taste to dishes, onions contribute to overall health. They are rich in bioactive compounds and flavonoids that reduce the risk of cardiovascular diseases. Onions are well-

known for their anti-inflammatory, antibacterial, antiviral, and antihistamine properties. According to Gorrepati *et al.* (2017), the antioxidants in onions help prevent DNA damage, manage type-2 diabetes, and reduce insulin resistance.

In India, only a small portion of onions are grown during the kharif season due to low productivity caused by biotic stress and poor bulb storage quality resulting from heavy rains that encourage diseases like anthracnose and bulb rot. The kharif crop plays a pivotal role in stabilizing market prices, as any delay or damage due to unpredictable monsoons leads to a rapid price increase from October until January or February. To address the issue of onion price hike, late kharif season cultivation using the bulb set technique has gained prominence. Successful cultivation of kharif onions depends on cultural practices, including plant spacing and planting techniques. Further, plant spacing significantly influences plant growth, bulb size, yield, and onion quality. Optimal spacing enhances bulb quality and size (Nichols and Heydecker 1966). While closer spacing can yield more per unit area due to increased plant density up to a certain threshold, many researchers have observed that wider spacing results in higher yield per individual plant (Nehra *et al*., 1988).

Thus to investigate the impact of plant spacing and planting methods on kharif onion cultivation, this current study has been initiated with an objective "To evaluate the efficacy of planting methods and spacing on growth and yield attributes of onion produced through bulb sets" (Panse *et al*., 1985).

MATERIALS AND METHODS

The experiment was conducted during the year 2022 in Vegetable block at College of Horticulture, Rajendranagar, Sri Konda Laxman Telangana State Horticultural University, Telangana which is situated at a Latitude of 18.1124^{o} N and Longitude 79.0193^{o} E and at an altitude of about 536 meters above the mean sea level (MSL).The field experiment was laid out in factorial randomized block design with two factors (planting methods and spacing). The two planting methods were M_1-Raised bed and M_2-Ridge and furrow and seven different spacing were S_1 - 15 cm ×10 cm, S_2 - 15 cm ×15 cm, S_3 - 20 cm ×15 cm, S_4 - 20 cm ×10 cm, S_5 - 20 cm × 15 cm, S_6 - 30 cm × 10 cm and S_7 - 30 cm × 20 cm. These fourteen treatment combinations were replicated twice. Data on plant height (cm), number of leaves per plant, pseudo stem diameter (cm), fresh weight of bulb(g), bulb diameter (cm), double bubs (%), bolted bulbs (%), days to maturity, days to harvest, bulb yield per plot (kg), bulb yield per hectare (t) and marketable yield (t). were recorded and subjected to statistical analysis, the test of significance (F-test) and critical difference (C. D.) at 0.05 probability (Sundararaj *et al*., 1972).

RESULTS AND DISCUSSION

A. Growth parameters

Plant height (cm): The data revealed that the planting methods had shown significant difference among the treatments with respect to plant height. The plant height was significantly higher when onion was planted on raised bed (M_1) method (14.2 cm, 19.8 cm, 25.3 cm, 33.5 cm and 39.6 cm) than that was planted on ridge and furrow (M_2) planting method at all the stages *i.e.*, 15, 30, 45, 60 and 75 DAP respectively.

Significant variations were also observed among the treatments in plant heights with different plant spacing. It was observed that there was an increase in plant height with increase in spacing. Maximum plant height (15.1 cm, 20.6 cm, 25.9 cm, 34.6 cm and 41.7 cm) were recorded when onion is spaced at wider spacing S_7 (30 cm × 20 cm) which was significantly superior over rest of the treatments and it was followed by a spacing level S_6 (30 cm × 10 cm). While, minimum plant height (12.8 cm, 17.6 cm, 22.5 cm, 30.65 cm and 35.2 cm) were recorded in closer spacing S_1 (15 cm × 10 cm) at all the stages *i.e.*,15, 30, 45, 60 and 75DAP respectively.

The increased plant height could be attributed to the favourable conditions in the raised bed during the *kharif* season, which will be free of water logging and enable optimum soil aeration. The results of this study are similar to the findings of Saini and Walia (2012), who discovered that the raised bed method of planting was superior in terms of growth qualities. Al-Sahaf (2002); Aboukhadrah *et al*. (2017) in onion.

Maximum plant height was recorded in wider spaced treatment this may be due to less inter and intra row competition for growth factors such as water and sunlight, as well as an increase in nutrient status, which may have lead to better growth and significantly taller plant height when compared to narrow intra-row spacing. Similar results have been reported by Awas *et al*. (2010); Misra *et al*. (2014); Ali *et al*. (2015) in onion.

Number of functional leaves: The data pertaining to number of number of functional leaves in onion as influenced by planting methods, different spacing and their interactions at 15, 30, 45, 60 and 75DAP were presented in Table 1.

The data revealed that the planting methods had shown significant difference among the treatments with respect to number of functional leaves per plant at 15, 30, 45, 60 and 75 DAP. The number of functional leaves per plant at 15, 30, 45, 60 and 75 DAP was significantly higher when onion was grown on raised bed (M_1) (3.62, 7.7, 11.9, 15.6, 17.45) than on ridges and furrows (M2) method of planting.

Different spacing also showed significant variation among the treatments with respect to number of functional leaves per plant at 15, 30, 45, 60 and 75DAP. It was observed that number of functional leaves increased with increase in inter and intra row spacing. Maximum number of functional leaves was recorded when onion was spaced at wider spacing S_7 (30 cm × 20 cm) which was significantly superior over rest of the treatments at 15, 30, 45, 60 and 75 DAP and it was followed by spacing level S_6 (30 cm × 10 cm) while, the minimum number of functional leaves per plant was recorded in closer spacing S_1 (15 cm × 10 cm).

Soil air may have had an important role in root respiration and root multiplication, resulting in maximum nutrient and water uptake. Friable soil

particles retain moisture, with a continual supply of water may have attained in the raised bed planting method, perhaps resulting in the more number of functional leaves. Similar results have been obtained by Ali *et al*. (2015); Aboukhadrah *et al.* (2017) in onion.

The increased number of functional leaves with wider plant spacing could be attributed to lower plant population, which results in less competition for space and other resources such as water, nutrients, sunlight, and aeration. Light is one of the most essential variables in enhancing crop productivity. As a result, increased light penetration might have lead to increased photosynthesis. Similar results have been observed by Khan *et al*. (2002); Awas *et al*. (2010); Kishor *et al*. (2017) in onion.

Pseudo stem diameter (cm): The data pertaining to pseudo stem diameter in onion as influenced by planting methods, different spacing and their interactions at 15, 30, 45, 60 and 75DAP were presented in Table 1.

Table 1: Effect of planting methods and spacings on Growth parameters of Late -*kharif* onion var. N-53.

Treatments	Plant height(cm)					Pseudo stem diameter(cm)					Number of functional leaves				
	15DAP	30DAP	45DAP	60DAP	75DAP	15DAP	30DAP	45DAP	60DAP	75DAP	15DAP	30DAP	45DAP	60DAP	75DAP
Raised beds	14.2	19.8	25.3	33.5	39.6	0.29	0.49	0.87	1.1	1.4	3.62	7.7	11.9	15.6	17.4
Ridges and furrows	13.8	18.6	23.1	31.5	35.8	0.17	0.34	0.59	0.8	1.2	3.2	7.05	10.9	14.5	16.9
S.E.m±	0.04	0.08	0.07	0.12	0.14	0.006	0.008	0.01	0.01	0.007	0.01	0.02	0.05	0.03	0.05
CD	0.14	0.26	0.23	0.37	0.44	0.019	0.023	0.03	0.03	0.02	0.05	0.08	0.16	0.11	0.17
S1	12.8	17.6	22.5	31.1	35.2	0.05	0.09	0.35	0.6	0.9	2.2	6.3	9.9	13.0	14.7
S2	13.7	18.5	23.6	31.7	36.5	0.09	0.25	0.65	0.9	1.2	3.05	6.9	11.1	14.5	16.6
S3	14.1	19.1	24.1	32.5	37.2	0.1	0.39	0.75	1	1.3	3.3	7.5	11.4	15.0	17.4
S4	13.4	18.3	22.7	30.6	35.7	0.09	0.15	0.5	0.75	1.1	2.7	6.4	10.3	13.6	15.6
S5	14.5	20.0	24.8	33.4	38.2	0.3	0.60	0.85	1.1	1.4	3.7	7.9	12	16.0	17.9
S6	14.5	20.2	25.5	33.8	39.4	0.4	0.62	0.9	1.2	1.5	3.9	8.2	12.2	16.2	18.0
S7	15.1	20.6	25.9	34.6	41.7	0.57	0.82	1.12	1.3	1.7	4.9	8.5	13	17.4	19.7
S.E.m±	0.08	0.16	0.14	0.23	0.20	0.01	0.01	0.02	0.02	0.01	0.03	0.05	0.09	0.06	0.10
CD	0.26	0.50	0.43	0.70	0.82	0.03	0.04	0.063	0.06	0.04	0.10	0.15	0.30	0.21	0.33
M × S															
S.E.m±	0.12	0.23	0.20	0.33	0.38	0.01	0.02	0.02	0.02	0.02	0.04	0.07	0.14	0.09	0.15
CD	0.37	0.71	0.61	0.99	1.16	0.05	0.062	0.089	0.06	0.06	0.14	0.22	0.43	0.30	0.03

S1 -15 × 10 cm, S2- 15 × 15 cm, S3 - 20 × 15 cm, S4 - 20 × 10 cm, S5 - 20 × 20 cm, S6 - 30 × 15 cm, S7 - 30 × 20 cm

The Pseudo stem diameter was significantly higher when onion was grown on raised bed (M_1) method of planting than on ridges and furrows (M2) method of planting.

Different spacing also showed significant variation among the treatments with respect to pseudo stem diameter at 15, 30, 45, 60 and 75DAP. It was observed that pseudo stem diameter increased with increase in inter and intra row spacing. Maximum pseudo stem diameter was recorded when onion is spaced at wider spacing S_7 (30 cm × 20 cm) with (0.57 cm, 0.82 cm, 1.12 cm, 1.30 cm and 1.70 cm) which was significantly superior over rest of the treatments and it was followed by spacing level S_6 (30 cm × 10 cm) while, the minimum pseudo stem diameter was recorded in closer spacing S_1 (15 cm × 10 cm).

The raised bed planting method resulted in the higher pseudo stem diameter, which could be attributed to favourable soil conditions such as good soil aeration, friability and effective soil drainage, as well as assisting plant growth with good water continuum and better soil air exchange for effective shoot growth. Similar results were reported by Khan *et al.* (2010); Awas *et al.* (2010); Aboukhadrah *et al.* (2017) in onion.

Maximum pseudo stem diameter was obtained under wider plant spacing due to less inter row and intra row plant competition for light, moisture, nutrients, and aeration which might have resulted in more cell division and cell elongation which in turn enhanced pseudo stem diameter. These results are in agreement with the findings of Kumar *et al*. (2001); Kishor *et al.* (2017) in onion.

B. Yield parameters

Fresh weight of the bulb (g): The data pertaining to fresh weight of the bulbs influenced by planting method, different spacing and their interactions were presented in Table 2.

The data revealed that the planting methods had shown significant difference among the treatments with respect to fresh weight of the bulb. Maximum fresh weight of the bulb (80.2gm) was recorded when onion was grown on raised bed (M_1) method of planting which was significantly superior to ridge and furrow (M_2) planting method.

Different spacing also showed significant variation among the treatments with respect to fresh weight of the bulb. Maximum fresh weight of the bulb (84.9 g) was recorded when onion was spaced at wider spacing S_7 (30 cm × 20 cm) which was significantly superior over rest of the treatments and it was followed by spacing level S_6 (30 cm × 10 cm). While, the minimum fresh weight of the bulb (72.2 g) was recorded at closer spacing S_1 (15 cm × 10 cm).

Fresh weight of the bulb was significantly higher under raised bed planting method, which could be attributed to favourable soil conditions such as good soil aeration, friability and effective soil drainage, which may have

provided the plant with a good water continuum and better soil air exchange for effective bulb growth. Similar results have been reported by Kumar *et al.* (2015); Ali *et al*. (2015); Aboukhadrah *et al.* (2017) in onion,

Maximum fresh weight was recorded under wider plant spacing that could be attributed to the accommodation of fewer plants for better nourishment and space for more feeding area per plant, as well as appropriate food, moisture, and sunlight, which contributed to enhance the average weight of the bulb. The results were in agreement with the findings of Dawar *et al*. (2007); Misra *et al*. (2014) in onion.

Bulb diameter (cm): The data pertaining to bulb diameter as influenced by planting methods, different spacing and their interactions were presented in Table 2.

The data revealed that the planting methods had shown significant difference among the treatments with respect to bulb diameter. Maximum bulb diameter (6.6 cm) was recorded when onion was grown on raised bed (M_1) method of planting which was significantly superior to ridge and furrow (M_2) planting method (5.5 cm).

Different spacing also showed significant variation among the treatments with respect to bulb diameter. Maximum bulb diameter (6.8 cm) was recorded when onion was spaced at wider spacing S_7 (30 cm × 20 cm) which was significantly superior over rest of the treatments and it was followed by spacing level S_6 (30 cm × 10 cm). Minimum bulb diameter (5.5 cm) was recorded in closer spacing S_1 (15 cm × 10 cm).

The raised bed method of planting produced the largest bulb diameter, this could be due to the porous nature of soil in the raised bed might have generated a favourable soil condition for the onion bulb to grow in size. Soil air also might have played a crucial role in root respiration and root multiplication, which may have resulted in maximal nutrient and water intake. Friable soil particles would have retained moisture and a continuous supply of water might have been maintained in the raised bed planting method, potentially resulting in maximum bulb diameter. Similar results have been obtained by Dawar *et al*. (2007); Jilani (2010); Aboukhadrah *et al.* (2017) in onion.

The highest bulb diameter was reached with wider spacing because there was less competition for nutrients among the plants and more space available for each plant. Bulb diameter was lowered with closer spacing due to insufficient space for bulb development. The results were agreement with the findings of Kumar *et al.* (2015); Ali *et al.* (2015) in onion.

Double bulbs (%): The data pertaining to per cent double bulbs as influenced by planting methods, different spacing and their interactions were presented in Table 2.

The data revealed that the planting methods had shown significant effect on the per cent double bulbs. The per cent double bulbs were significantly higher (29.2) when onion was grown on ridge and furrow (M_2) planting method which was significantly superior to raised bed (M_1) method of planting.

Different spacing also showed significant variation among the treatments with respect to per cent double bulbs. Maximum per cent double bulbs (33.6%) were observed when onion is spaced at a wider spacing S_7 (30 cm × 20 cm) which was significantly superior over rest of the treatments and it was followed by spacing level S_6 (30 cm × 10 cm). While, the minimum per cent double bulbs (16.5) was recorded in closer spacing S_1 (15 cm × 10 cm).

The higher per cent of double bulbs were observed in raised beds planting method than on ridges and furrow method because soil aeration will be less in raised beds when compared to ridges and furrows which results in heavier soils where splitting of bulbs takes place (Tegen and Jembere 2021).

Bolted bulbs (%): The data pertaining to per cent bolted bulbs as influenced by planting methods, different spacing and their interactions were presented in Table 2.

The data revealed that planting methods had shown significant effect on the per cent bolted bulbs. The per cent bolted bulbs (9.8%) was least when onion was grown on raised bed of planting method when compared to ridge and furrow method of planting.

Different spacing also showed significant variation among the treatments with respect to per cent bolted bulbs. Least per cent of bolted bulbs (5.1%) was observed when onion is spaced at wider spacing of S_7 (30 cm × 20 cm). While, the maximum per cent of double bulbs (18.9%) was recorded in closer spacing S_1 (15 cm × 10 cm).

The highest percentage of bolted bulbs were observed in planting method ridges furrows compared to raised beds because of too much water logged in ridges and furrows when compared to raised beds which results in bolting in onion (Tegen and Jembere 2021).

Bulb yield (kg plot^{-1}): The data pertaining to bulb yield per plot as influenced by planting method, different spacing and their interactions were presented in Table 2.

The data revealed that the planting methods had shown significant difference among the treatments with respect to bulb yield per plot. Maximum bulb yield per plot (6.4 kg) was recorded when onion was grown on raised bed (M_1) method of planting which was significantly superior to ridge and furrow (M_2) planting method.

Different spacing also showed significant variation among the treatments with respect to bulb yield per plot. Maximum bulb yield per plot (6.8 kg) was recorded when onion is spaced at closer spacing S_1 (15 cm × 10 cm) which was significantly superior over rest of the treatments and it was followed by spacing level S_4 (20 cm × 10 cm). Minimum bulb yield (4.8 kg plot^{-1}) was recorded in wider spacing S_7 (30 cm × 20 cm).

Enhanced photosynthetic ability of the plants on the raised bed might have resulted in maximum bulb yield per plot. Increased leaf area and assimilate storage in bulbs may have been the primary causes of higher bulb yield in these plants. Under raised bed conditions, higher amount of photosynthates might have been produced and may have been trans-located and stored in the bulbs, resulting in an increased overall bulb yield. These results were in agreement with the findings of Ali *et al*. (2015); Misra *et al.* (2014) in Onion,

Maximum yield obtained from closer spacing or bigger plant population would be because a greater number of plants were accommodated in closer spacing. Kumar *et al.* (2001) also reported that total yield of onion in closer spacing was significantly higher due to more accommodation of plants per ha^{-1} as compared to widest spacing. Similar results were reported by Jejurkar *et al*. (2002); Misra *et al*. (2014) in onion.

Total Bulb yield (t ha^{-1}): The data pertaining to bulb yield per hectare as influenced by planting method, different spacing and their interactions were presented in Table 2.

The data revealed that the planting methods had significant effect on the bulb yield per hectare. Maximum bulb yield per hectare (19.3 t) was recorded when onion was grown on raised bed (M_1) method of planting which was significantly superior to ridge and furrow (M_2) planting method.

Maximum bulb yield per hectare (20.0 t) was recorded when onion is spaced at closer spacing S_1 (15 cm × 10 cm) which was significantly superior over rest of the treatments and it was followed by spacing S_4 level (20 cm × 10 cm). Minimum yield per hectare (15.1 t) was recorded in wider spacing S_7 (30 cm × 20 cm).

Friable soil particles retain moisture and a continual supply of water might have been achieved in the bed planting method, potentially yielding the highest bulb output per hectare. Similar results were reported by Aboukhadrah *et al.* (2017); Jejurkar *et al*. (2002); Misra *et al*. (2014) in onion.

Total yield per hectare increased in plants planted at narrower plant spacing and declined in plants cultivated at broader plant spacing. This could be due to the ability to accommodate a greater number of plants at closer plant spacing than plants at broader spacing, resulting in the maximum number of bulbs produced per hectare. These results are in line with Kumar *et al.* (2001) who reported that maximum total number of bulbs per hectare was recorded at closer plant spacing whereas the minimum number of bulbs per hectare was obtained from wider plant spacing. Similarly, these results are in agreement with the findings of Jejurkar *et al*. (2002); Misra *et al*. (2014) in onion.

Marketable bulb yield per hectare (t ha^{-1}): The data pertaining to marketable bulb yield per hectare as influenced by planting method, different spacing and their interactions were presented in Table 2.

Table 2: Effect of planting methods and spacings on yield parameters of Late -*kharif* onion var. N-53.

Treatments	Bulb diameter (cm)	Double bulbs (%)	Bolted bulbs (%)	Fresh weight of bulb (gm)	Bulb yield per plot (kg)	Total bulb yield per hectare (t)	Marketable yield per hectare (t)
Raised beds	6.6	29.2	9.8	80.2	6.4	19.3	17.2
Ridges and furrows	5.5	22.6	12.7	75.1	5.1	16.0	13.8
S.E.m±	0.03	0.28	0.06	0.21	0.02	0.05	0.04
CD	0.09	0.89	0.19	0.65	0.08	0.17	0.14
S1	5.5	16.5	16.8	72.2	6.8	20.0	18.5
S2	5.6	23.4	11.2	76.5	6.0	18.5	16.4
S3	5.8	24.5	13.4	78.1	5.8	17.9	14.3
S4	6.0	21.7	15	73.1	6.2	19.4	16.6
S5	6.2	28.2	7.5	80.9	5.4	17.2	14.3
S6	6.5	29.7	9.8	82.9	5.0	15.5	13.8
S7	6.8	33.6	5.1	84.9	4.8	15.1	13.0
S.E.m±	0.05	0.54	0.11	0.39	0.05	0.10	0.08
CD	0.17	1.6	0.36	1.21	0.15	0.32	0.27
M × S							
S.E.m±	0.08	0.76	0.16	0.55	0.07	0.14	0.12
CD	0.25	2.3	0.51	1.72	0.22	0.45	0.38

S1 -15 × 10 cm, S2- 15 × 15 cm, S3 - 20 × 15 cm, S4 - 20 × 10 cm, S5 - 20 × 20 cm, S6 - 30 × 15 cm, S7 - 30 × 20 cm

The data revealed that planting methods had shown significant difference on the marketable bulb yield per hectare. Maximum marketable bulb yield (17.2 t ha^{-1}) was recorded when onion was grown on raised bed (M_1) method of planting which was significantly superior over ridge and furrow (M_2) planting method.

Maximum marketable bulb yield (18.53 t ha^{-1}) was recorded in spacing level S_1 (15 cm × 10 cm) which was significantly superior over rest of the treatments and it was followed by spacing level S_4 (20 cm × 10 cm). Minimum marketable bulb yield per hectare (13.0 t ha^{-1}) was recorded in closer spacing S_7 (30 cm × 20 cm).

Friable soil particles retain moisture and a continuous supply of water might have been achieved in the raised bed planting method, potentially yielding the highest commercial bulb output per hectare. The results obtained are in agreement with the findings of Aboukhadrah *et al.* (2017) in onion.

Plants planted with closer plant spacing give a higher marketable tuber yield. This could be owing to the ability to accommodate a greater number of plants at closer plant spacing than plants at broader spacing, resulting in the largest number of marketable bulbs produced per hectare. Similar results have been reported by Ali *et al.* (2015); Misra *et al.* (2014); Tegen *et al*. (2016) in onion.

CONCLUSIONS

Raised bed method of planting which recorded significantly higher growth parameters (plant height, number of functional leaves, pseudo stem diameter), yield attributes and yield over ridge and furrow method along with a plant spacing of 15 cm x 10 cm which recorded higher yields and economic returns can be recommended for onion production through bulb sets during late *kharif* conditions of Southern Telangana region.

FUTURE SCOPE

One of the key factors that significantly effects onion growth, yield, and quality is planting time. Therefore, various planting dates from Early to Late *Kharif* can be tried at weekly intervals.

To improve bulb size in *kharif* onions, different bending techniques might be examined.

Thrips and purple blotch incidence are two specific problems in *kharif* onions that might be studied.

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Conflict of Interest. None.

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