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EFFECTS OF SET SIZE AND PLANTING DATE ON YIELD, QUALITY AND SHELF LIFE OF KHARIF ONION UNDER LOW HILL REGION OF HIMACHAL PRADESH

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Keywords: Bulb weight, Bolting, Kharif onion, Set size, Yield

Abstract

The experiment was conducted at an experimental farm to find out the optimum set size and suitable planting date of onion during kharif season for obtaining the maximum yield. The trials had three replications and 16 treatment combinations on Agrifound Dark Red. The treatments included four set sizes (small 1-1.5 cm, medium 1.5-2.0 cm, large 2.0-2.5 cm, and extra-large >2.5 cm) and four planting dates (July 10, July 25, August 10 and August 25). The treatment combination of 1.5-2.0 cm set size and 10th August planting was advantageous for several characteristics. Small sets (1-1.5 cm) produced small bulbs and also the yield was reduced. Large and exceptionally large size sets (2.0-2.5 cm and >2.5 cm) produced more twins, triplets, split bulbs, and bolting, which were undesirable features. Considering net profit and economic yields, medium set size and planting on August 10th was found to be more profitable (1: 3.84).

Introduction

Onion (*Allium cepa* L.) originated in central Asia, is one of the most important commercial vegetable crop grown throughout the world. India is the second largest producer of onion with an area of 1434 thousand ha and production of 26738 thousand MT. In Himachal Pradesh total area and production of onion were around 3.41 thousand hectare and 74.82 thousand MT out of which under kharif or rabi season area 0.135 and 3.27 thousand hectare with a production of 2.16 thousand MT and 72.82 thousand MT, respectively (Anonymous 2020). Onion is a very common crop grown all over India and consumed by every family either as raw in the salad form or as cooked along with spices and vegetables. In India, onion is mainly produced in rabi season. However some states like Maharashtra, Gujarat, Karnataka and Rajasthan also produce kharif onion. Sixty per cent production of total onion production comes from rabi crop while kharif and late kharif crops contribute twenty per cent each. The production of rabi season is mainly stored, which lasts upto the end of September. Hence, onion price are comparatively higher during winter. The kharif crop plays an important role in fulfilling consumers demand and stabilizing the prices of onion in the country. But to raise healthy nursery during rainy season for kharif onion production is a tedious task. Higher soil moisture, humidity and frequent rains create conducive condition for disease occurrence. To avoid this one should go for kharif onion production through sets. Sets are small onion bulblets which are produced in summer and replanted in fields after heavy rains are over. This technique prevents the disease occurrence in nursery as well as in newly transplanted seedlings Sharma and Jarial (2017). These replanted sets regain their growth and get ready for harvesting after one month as green onion which is liked as vegetable by consumers. Fully developed bulbs get ready to harvest at the end of November to December.

The set's diameter is important factor affecting bulb or flower stalk production. A large onion set used for planting produces flowering stalk more rapidly the small one. A small onion set requires more time to complete vegetative growth period (juvenile stage). Therefore, selection of

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appropriate set size is important parameters to study. Kharif onion produced in short day length and moderate temperature condition. Late transplanting, low temperature and use of large sized sets restrict the bulb development and leads to bolting. Sprouting is the most important storage disorder in kharif onion. It is due to excessive soil moisture at maturity. So the time of planting of sets should be adjusted in such a way that harvesting can be done in dry period. Date of planting is important factor, which influences the growth, yield and quality of kharif crop as a climatic factor. So, planting at different dates to find out the suitable dates for good bulb production is important aspect. Thus the present study was aimed to find out the optimum set size and suitable planting date of onion during kharif season for obtaining maximum yield.

Material and Methods

The present study was carried out on the experimental farm of Department of Vegetable Science, Dr. Yashwant Singh Parmar UHF, College of Horticulture and Forestry, Neri, Hamirpur during the kharif season. The experimental farm was located at an altitude of 620 m above mean sea level with average mean maximum and minimum temperature levels of 31.3 and 12.4ºC, respectively, and represented the low hill region of Himachal Pradesh. The treatments consisted of four different sizes of sets and four different dates of planting. Onion sets of variety Agrifound Dark Red were categorized into four different classes on the bases of their size i.e. small 1- 1.5 cm (S_1), medium 1.5-2.0 cm (S_2), large 2.0-2.5cm (S_3) and extra large >2.5cm (S_4) and four dates of set planting were selected i.e. 10th July (D_1), 25th July (D_2), 10th August (D_3) and 25th August (D_4). The experiment was laid out in randomized block design (factorial) with three replications.

The sets were planted on well prepared beds of 1.5 × 1.5 m at spacing of 15 ×10 cm. Data were recorded at 30, 60 and 90 days interval from ten randomly selected plants from each plot for number of leaves, leaf length and height of plant. The crop was harvested after attaining physiological maturity followed by manual neck fall of foliage. Marketable yield per plot, total yield, average weight of marketable bulbs, days to fifty percent sprouting, percentage sprouting, plant height, leaf length, bulb diameter (polar diameter and equatorial diameter), neck thickness, splitting percentage and bolting percentage of bulbs were recorded after harvesting. Bulb polar diameter and equatorial diameter were recorded with the help of digital vernier caliper. Crop was harvested in November and stored up to February to study the effect of set size and planting dates on shelf life. Harvested bulbs were cured and kept at room temperature in plastic baskets replicating thrice. Data were recorded at every 15 days interval on parameters like bulbs fresh weight loss (%), sprouted bulbs (%), and rotted bulbs (%). Sprouted and rotted bulbs were counted separately in each treatment combination with interval of 15 days for 90 days and divided by the total number of bulbs then multiplied by 100 to calculate sprouting and rotting percentage.

Results and Discussion

Data presented in Table 1 indicated that, the plant height was significantly affected by set size, date of sowing and their interaction effect at all the stages of crop growth i.e. 30, 60 and 90 days after replanting of sets (DAR), whereas, number of leaves were significantly affected by set size. Leaf length was significantly affected by interaction effect of dates of set planting and varieties at all stages of crop growth. At the stage of 30, 60 and 90 DAR, the maximum number of leaves per plant (6.73, 7.67 and 8.94, respectively) was recorded in treatment combination (S_4D_3), whereas minimum i.e. 4.69, 5.70 and 6.60 at 30, 60 and 90 DAR, respectively, was recorded in treatment combination of S_1D_1. The large sized sets produced more number of leaves per plant. Probable reasons for enhanced number of leaves by planting of large sized sets might be due to be more availability of reserved food material in sets which provided good initial boost for vegetative growth of plants. These findings are in agreement with the findings of Gupta *et al.* (2000). Treatment combination (S_4D_3) recorded maximum plant height (45.14, 56.29 and 60.73cm) at the stage of 30, 60 and 90 days, respectively, after planting, whereas minimum plant height (18.74, 33.23, 43.17cm) was recorded in S_1D_1 30, 60 and 90 DAR, respectively. Among the sowing dates maximum plant height was observed at D_3 i.e. 10th August (52.23cm) which was significantly higher than all other planting dates. Set size and interaction between set size and sowing dates also

Table 1. Response of different combinations of set sizes and planting dates on growth characters of kharif onion.

	Number of leaves			Plant height			Leaf length			Per cent germination/ sprouting of sets
	30 Days	60 Days	90 Days	30 Days	60 Days	90 Days	30 Days	60 Days	90 Days	
S_1D_1	4.69	5.70	6.60	18.74	33.23	43.17	14.39	33.17	42.56	71.54
S_1D_2	5.13	6.45	7.07	19.93	33.54	50.70	16.90	33.57	43.37	72.70
S_1D_3	5.43	6.51	7.26	21.89	33.61	54.14	18.05	34.21	47.60	79.54
S_1D_4	5.50	6.70	7.11	25.45	36.97	55.18	18.39	36.64	48.87	77.39
S_2D_1	5.45	6.83	7.37	21.38	34.29	53.03	17.68	33.29	43.03	81.81
S_2D_2	4.89	7.31	7.43	23.03	37.78	56.02	18.01	40.45	45.35	85.35
S_2D_3	6.45	7.25	7.58	26.69	42.67	57.80	19.93	39.34	48.13	89.50
S_2D_4	5.68	6.80	7.60	24.43	36.16	56.34	19.45	40.49	50.34	86.27
S_3D_1	6.20	7.12	8.52	31.62	43.26	55.46	18.69	43.26	50.46	87.89
S_3D_2	6.25	7.28	8.28	32.45	45.21	56.44	19.01	45.21	50.77	90.52
S_3D_3	5.34	7.39	8.53	37.34	46.73	58.48	19.59	45.53	53.55	90.65
S_3D_4	6.12	7.37	8.56	39.16	47.56	58.84	19.61	47.56	53.61	90.13
S_4D_1	5.78	7.41	8.08	42.17	50.77	57.69	19.23	48.44	46.69	91.66
S_4D_2	6.59	7.53	8.25	43.70	51.49	58.39	19.46	49.49	48.39	93.23
S_4D_3	6.73	7.67	8.94	45.14	56.29	60.73	20.24	52.63	54.71	95.66
S_4D_4	6.65	7.54	8.88	43.98	53.05	59.24	19.75	51.05	50.58	91.21
CD $_{(0.05)}$										
Set size	0.51	0.35	0.61	1.90	0.93	1.67	1.26	1.31	1.11	1.90
Date	NS	NS	NS	1.90	0.93	1.67	1.26	1.31	1.11	1.90
Set size* Date	NS	NS	NS	3.81	1.86	3.35	2.52	2.02	1.13	3.79

S_1: Set Size 1.0-1.5cm, S_2: 1.5-2.0cm, S_3: 2.0-2.5cm, S_4: >2.5cm. D_1: Planting date10th July, D_2: 25th July, D_3: 10th August, D_4: 25th August.

exhibited significant differences for plant height. This might be due to planting large size sets during lower temperature with long photoperiod which ultimately improved the plant height. Similar results were reported by Sharma and Dogra (2017). Maximum leaf length (20.24, 52.63, and 54.71cm) at 30, 60 and 90 DAR, respectively, was recorded in treatment combination (S_4D_3), whereas minimum leaf length (14.39, 33.17, 42.56cm) after 30, 60 and 90 DAR, respectively, was recorded in treatment combination (S_1D_1). In general leaf length increased with increase in set size, which may be due to use of large set size and availability of favorable environmental conditions on 10th August planting. Set size, sowing dates and interaction effect of set sizes and different dates of set planting had shown significant effect on per cent sprouting/ germination of the sets. Treatment combination S_4D_3 showed maximum per cent sprouting of sets (95.66%) followed by S_4D_2 (93.23%) whereas, minimum days were taken by S_1D_1 (71.54%) which was at par with S_1D_2 (72.70%). It was noticed that large sized sets with planting on 10th August showed more germination percentage as compared to small size sets. The data revealed that the sets planted around 10th July took more than a month for hundred percent sprouting across all size of sets whereas August planted sets sprouted in 7-14 days depending upon the set size. Similar observations were recorded by Dhar *et al.* (2019).

The yield and quality parameters were significantly affected due to set size, different dates of sets planting and their interactions (Table 2). Results showed that in total yield the large size sets i.e. S_4 performed best while in marketable yield medium set size S_2 was best. The highest fresh bulb weight (53.32 g) was recorded in treatment combination (S_4D_4) followed by S_2D_3 (50.52g) whereas lowest (36.12 g) fresh bulb weight was recorded in treatment combination (S_1D_1). Probable reasons for this might be large sized sets produced bigger sized bulbs and small sized sets produced smaller bulbs. But large sized sets lead to the production of larger splitted bulbs (doubles or triplets) of poor quality which were not of economic significance. The percentage of damaged bulbs was also found to be more in large sized bulbs as compared to small sized bulbs. The sets lying in S_2 (1.5-2.0 cm) range produced compact, medium sized bulbs of good quality having highest marketable yield as well. These findings are in agreement with the findings reported by Poovamma *et al.* (2021) and Singh and Singh (2014). The difference in bulb diameter was significantly affected due to set size, sowing dates and interaction effect of set sizes and different dates of set planting. The highest equatorial diameter (6.11cm) as well as polar diameter (6.25cm) were observed in treatment combination S_4D_4. Minimum equatorial diameter (4.29cm) as well as polar diameter (4.21 cm) were observed in treatment combination $S_1D_{1.}$ The effect of set size, planting dates and their interaction was found to be significant on marketable bulb yield per plot. Highest marketable bulb yield (7.38 kg) was recorded in treatment combination (S_2D_3), whereas lowest marketable bulb yield (4.32 kg) was recorded in treatment combination (S_1D_1). Bulb yield per hectare was also significantly affected by set size, planting dates and their interaction. Treatment combination (S_2D_3) recorded highest marketable bulb yield per hectare (226.20q/ha) whereas lowest marketable bulb yield (144.23 q/ha) was recorded in treatment combination (S_1D_1). In general, significant higher yields of medium sized bulbs were recorded over small and large sized sets. Results showed that yields were increased with the increase in set size but it promoted the problem of premature bolting and twin bulbs. Small size sets were having minimum premature bolting and twin bulb but were poor in yielding ability. In such situation medium set size (S_2) showed moderate performance in all bulb characters, hence medium size sets should be used for kharif onion production. Yield parameter had showed the maximum values in planting date D_3 (10th August) which could be due to weather parameters like rainfall, humidity, temperature and photoperiod were in optimum range. Similar results were reported by Hirave *et al.* (2015). The different varietal characters of onion and availability of 11-12 hrs sunlight stimulated bulb formation as reported by Sharma and Jarial (2017).

Neck thickness was significantly influenced by the set size and planting time but their interaction showed no significant influence on this character. It was observed that neck thickness increased with the increase in set size used for planting kharif onion (Table 2). Treatment combination S_4D_4 (>2.5cm set size and 25th August planting) showed maximum neck thickness (1.43 cm) and minimum was recorded in treatment combination (S_1D_1). Variation in neck thickness might be due to different sizes of set used for planting. Lesser neck thickness is desirable trait of a variety. It also helped to increase the shelf life of the bulb. Present findings are supported by the findings of Thirupathi *et al.* (2014). A significant effect of set size, planting dates and interaction between set size and planting dates was observed on splitting of bulbs. No splitting was recorded in treatment combinations (S_1D_1) and (S_1D_2), whereas the maximum splitting (12.8%) were recorded in treatment combination (S_4D_1) and minimum in treatment S_2D_1 (0.4%). The maximum bolting (21.67%) was recorded in treatment combination (S_4D_1) and S_1D_2 (2.33%) resulted in minimum bolting. It was noticed that bolting percentage was the highest in plants grown using larger set sizes as compared to smaller set sizes. It might be due to temperature fluctuation due to different dates of replanting of sets and variation in set size. These results are in agreement with the findings of Singh *et al*. (2021).

Table 2. Response of different combinations of set sizes and planting dates on growth, yield and quality traits of kharif onion.

	Neck thickness (cm)	Equitorial diameter (cm)	Polar diameter (cm)	Bulb weight (g)	Marketable bulb yield per Plot (kg)	Marketable bulb yield per hectare (q)	Bolting (%)	Splitting (%)
S_1D_1	0.77	4.29	4.27	36.12	4.32	144.23	2.48	0.0
S_1D_2	0.83	4.83	4.21	36.88	4.86	148.17	2.33	0.0
S_1D_3	0.84	5.05	4.82	37.98	4.48	149.47	3.40	0.7
S_1D_4	0.85	5.19	5.26	39.01	5.49	152.54	3.06	1.0
S_2D_1	1.11	5.32	5.34	38.01	6.05	208.33	9.33	0.4
S_2D_2	1.12	5.39	5.45	43.19	6.11	211.56	9.18	0.6
S_2D_3	1.14	5.83	5.79	50.52	7.38	226.20	8.31	1.1
S_2D_4	1.18	5.72	5.35	43.23	6.25	214.67	8.75	0.7
S_3D_1	1.21	5.68	5.72	47.66	5.45	188.33	17.00	10.3
S_3D_2	1.24	5.62	5.58	47.15	5.71	191.23	15.62	7.0
S_3D_3	1.25	5.94	6.08	48.21	6.57	219.07	13.80	10.3
S_3D_4	1.28	5.38	5.79	49.78	5.47	207.33	15.94	8.7
S_4D_1	1.35	5.29	5.87	48.44	5.32	177.56	19.36	12.8
S_4D_2	1.40	5.95	5.97	49.33	5.77	192.25	19.75	10.3
S_4D_3	1.41	6.01	5.98	50.03	6.45	215.58	21.29	11.0
S_4D_4	1.43	6.11	6.25	53.32	6.25	208.46	21.67	9.0
CD $_{(0.05)}$								
Set size	0.09	0.13	0.17	1.63	0.36	1.00	0.78	0.86
Date	0.09	0.13	0.17	1.63	0.36	1.00	0.78	0.86
size *Date	NS	0.26	0.34	3.27	0.71	2.00	1.55	1.73

S_1: Set Size 1.0-1.5cm, S_2: 1.5-2.0cm, S_3: 2.0-2.5cm, S_4: >2.5cm.

Planting date D_1: 10th July, D_2: 25th July, D_3: 10th August, D_4: 25th August.

Treatment combination S_2D_3 i.e. 1.5-2.0 cm set size and 10th August planting showed significantly lesser post-harvest losses as compared to all other treatments during the storage period (Table 3). This might be due to selection of appropriate set size which produced compact bulbs which were the least infected by various pathogens. Selection of suitable planting date also favored initial vegetative growth as well as contributed in enhancing shelf life by providing favorable climate at the time of harvesting of crop i.e. in November with relatively low rainfalls and less soil moisture which helped in getting healthy bulbs with low moisture content Sharma and Chauhan(2021). Further it aided in proper curing of bulbs. The storage life of kharif onion is generally lesser as compared to rabi season crop due to more moisture content in them. Therefore by reducing moisture content and by proper curing one can enhance its shelf life.

Table 3. Storage losses in different treatments after 90 days of storage.

Treatments	Weight loss (%)	Sprouting (%)	Rotting (%)
S_1D_1	35.26	65.23 (53.86)	4.99 (2.46)
S_1D_2	38.24	66.23 (53.87)	5.64 (2.64)
S_1D_3	39.25	69.35 (56.30)	3.45 (2.20)
S_1D_4	40.25	63.21 (53.03)	7.98 (2.94)
S_2D_1	39.56	62.59 (52.48)	5.23 (2.52)
S_2D_2	35.26	65.47 (53.95)	6.65 (2.75)
S_2D_3	31.42	61.78 (50.51)	3.11 (2.09)
S_2D_4	39.42	64.57 (53.27)	5.31 (2.55)
S_3D_1	45.24	79.68 (63.48)	8.16 (3.04)
S_3D_2	49.21	83.98 (67.64)	9.34 (3.18)
S_3D_3	47.13	85.69 (69.69)	7.13 (2.88)
S_3D_4	48.24	90.24 (71.79)	5.41 (2.56)
S_4D_1	47.02	90.38 (72.21)	8.42 (3.04)
S_4D_2	48.58	92.45 (73.61)	9.43 (3.20)
S_4D_3	49.52	93.54 (77.71)	10.54 (3.35)
S_4D_4	50.33	94.37 (78.22)	15.35 (4.06)
$CD_{(0.05)}$			
Set Size	1.93	0.95	0.082
Date	1.93	0.95	0.082
Set Size*Date	3.85	1.90	0.165

Values within parenthesis are transformed values

Table 4. Economics of kharif onion production using different treatment combinations.

Treatments	Yield per hectare (q)	Cost of cultivation	Gross returns (Rs/ha)	Net returns (Rs/ha)	Cost: Benefit ratio
S_1D_1	144.23	185000	432690	247690	1:2.34
S_1D_2	148.17	185000	444510	259510	1:2.40
S_1D_3	149.47	185000	448410	263410	1:2.42
S_1D_4	183.54	185000	550620	365620	1:2.98
S_2D_1	188.33	192500	564990	372490	1:2.94
S_2D_2	179.56	192500	538680	346180	1:2.80
S_2D_3	246.20	192500	738600	546100	1:3.84
S_2D_4	183.67	192500	551010	358510	1:2.86
S_3D_1	190.33	197000	570990	373990	1:2.90
S_3D_2	188.23	197000	564690	367690	1:2.87
S_3D_3	219.07	197000	657210	460210	1:3.34
S_3D_4	182.33	197000	546990	349990	1:2.78
S_4D_1	177.56	200000	532680	332680	1:2.66
S_4D_2	215.58	200000	646740	446740	1:3.23
S_4D_3	192.25	200000	576750	376750	1:2.88
S_4D_4	208.46	200000	625380	425380	1:3.13

The costs of cultivation for planting kharif onion through sets of different sizes were found to range from Rs1,85,000 to Rs 2,00,000 per hectare (Table 4). The higher gross return (Rs 7,38,000), net return (Rs 5,46,100) and cost benefit ratio (1:3.84) were found with the plantation of medium sized sets (between1.5-2.0cm) in 2nd week of August (S_2D_3) as compared to all the other treatments used. Planting sets of medium size resulted in higher marketable yield of good quality bulbs with higher returns. Similar observations were recorded by Singh and Singh (2014).

From the present investigation it may be concluded that, selection of appropriate set size and planting date was a prerequisite in successful kharif onion production. Significantly higher yield was obtained by planting sets of 1.5-2.0 cm in size and the best date for sowing kharif onion sets was 10th August in low hills of Himachal Pradesh. This treatment combination was found significantly superior over others in respect of growth, yield and quality parameters, i.e. plant height (56.80cm), number of leaves per plant (7.58), leaf length (48.13 cm) at 90 days after planting, weight of fresh bulb (70.52 g), equatorial diameter (5.83cm), polar diameter (5.79cm), marketable bulb yield per plot (7.38 kg) at the time of harvesting. This treatment combination had also shown least postharvest losses in 90 days storage period with 31.42% weight loss, 61.78% sprouting and 3.11% rotting loss.

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References:

Anonymous 2020. Indian Horticultiure Database, National Horticulture Board, Gurgaon.

Dhar M, Mandal J, Maity TK and Mohanta S 2019. Evaluation of kharif onion (*Allium cepa* L.) varieties under different planting dates. J. Pharmacogn. Phytochem**. 8**: 1317-1321.

Gupta RS, Bhutani RD, Khurana SC and Bhatia AK 2000. Effect of age and size of sets on growth and yield of kharif onion, garlic production and post harvest management, challenges and strategies, NHRDF Nasik, pp. 56.

Hirave PS, Wagh AP, Alekar AN and Kharde RP 2015. Performance of red onion varieties in kharif season under akola conditions. J. Horticul. **2**: 1-3.

Poovamma BC, Bijaya AK and Singh KJ 2021. Effect of different levels of planting time and spacing on quality and economics of multiplier onion (*Allium cepa* L. var. *aggregatum* Don.) cv. Meitei Tilhou. Int. J. Curr. Microbiol. Appl. Sci. **10**: 2470-2477.

Sharma D and Chauhan A 2021. Effect of growth regulators on growth, yield and storage life of kharif onion (*Allium cepa* L.). Indian J. of Agr. **66**: 483-487.

Sharma D and Dogra BS 2017. Evaluation of Kharif onion varieties and transplanting time for production under North-Western mid Himalayan region. Indian J. Horticul. **74**: 405-409.

Sharma D and Jarial K 2017. Effect of different varieties and planting time on kharif onion production in lower shivalik hills of Himachal Pradesh. Curr. Agric. Res. J. **5:** 74-80.

Singh A and Singh RA 2014. Studies on plantation of onion sets in kharif season. Asian J. Horticul. **9**: 520-522.

Singh RK, Singh SK and Tailor AK 2021. Studies on selection of short day high yielding and good keeping quality onion (*Allium cepa* L.). Green Farm. **11**: 226-231.

Thirupathi R, Sunanda E, Nagare PK and Kumar S 2014. Effect of spacing and nitrogen levels on growth and yield of kharif white onion. Environ. Ecol. Res. **32**: 854-857.

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