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SK Phor
KVK, Sonepat, Haryana, India

Hans Raj
Department of Vegetable Science, CCS HAU, Hisar, Haryana, India

Neeraj Pawar
RRS, Rohtak, Haryana, India

Makhan Lal
Department of Vegetable Science, CCS HAU, Hisar, Haryana, India

VPS Panghal
Department of Vegetable Science, CCS HAU, Hisar, Haryana, India

DS Duhan
Department of Vegetable Science, CCS HAU, Hisar, Haryana, India

Correspondence
SK Phor
KVK, Sonepat, Haryana, India

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Effect of spacing and bulb size on growth, yield and economics of onion seed crop in Haryana

SK Phor, Hans Raj, Neeraj Pawar, Makhan Lal, VPS Panghal and DS Duhan

Abstract
The field experiment entitled Effect of spacing and bulb size on growth, yield and economics of onion seed crop in Haryana was conducted with cultivar HO 4 at Vegetable Seed Production and Research Farm, Jagdishpur, Sonepat during *Rabi* season of 2015-16 and 2016-17. The nine treatment combinations comprising of three bulb size, *i.e*., big size (≥5.5 cm diameter), medium size (4.5 to 5.4 cm diameter) and small size (3.5 to 4.4 cm diameter) and three spacing, *i.e*., 45×45, 45×30 and 30×30 cm were laid out in randomized block design in plot size of 2.7×2.7 cm and replicated four times. Based on pooled data of two years, the increasing trend was observed in plant height with the increase in spacing. The results indicate that the significantly highest plant height at 30, 60 and 90 days after planting (38.72, 49.41 and 68.37 cm) was reported in crop raised with large size bulbs followed by medium size bulbs at each stage of crop growth except at 60 DAP, which was found at par, respectively. The crop at widest spacing had the tallest plants (35.47, 50.09 and 67.69 cm) irrespective of growth stages and these figures were found at par with plant height of crop at medium spacing. The crop raised with big bulbs recorded significantly maximum number of umbels per plant (9.82), which was significantly superior to the number of umbels per plant in crop raised with small bulbs but it was statistically at par with the number of umbels per plant crop raised with medium size bulbs. The interaction effect of these two parameters under study clearly shows that the crop raised with big bulbs at widest spacing gave significantly higher seed yield (5.90 q/ha) than rest of the treatment combinations. The data pertaining to economics of this crop reveal that the maximum net return and benefit to cost ratio was obtained from the crop raised with big bulbs (₹238140/ha and 2.26) and widest spacing (₹241168/ha and 2.27), respectively.

Keywords: Onion, bulb, size, spacing, cultivar HO4

Introduction
Onion (*Allium cepa* L.) is by far the most important vegetable crop grown in India. It is generally grown during winter season. It is valued for its distinct pungent flavour, and antioxidental components like, allicin, alliinthiosulfates, sulphites, *etc*. are present in onion, which have antiviral, antibacterial, antiallergenic, anti-inflammatory property, and it reduces the chances of cancer, heart disease and diabetes due to the presence of flavonoids (Belay *et al*., 2015) [5]. The area and production of onion in India are about 12.85 lakh hectare and 232.62 lakh tonnes of bulb, respectively with a productivity of 18.10 t/ha (Anonymous, 2019) [3], which is low as compared to the world average productivity. Lower productivity of onion in India could be attributed to the limited availability of quality seeds and associated production technologies used, among the others. The previous studies indicate that quality seed can be obtained from wider spacing, thus, the present research was undertaken to determine the optimum size of bulbs and plant spacing needed for getting higher and economically feasible seed yield of onion cultivar HO 4 in Haryana (India).

Materials and Methods
The field experiment entitled *Effect of spacing and bulb size on growth, yield and economics of onion seed crop in Haryana* was conducted with cultivar HO 4 at Vegetable Seed Production and Research Farm, Jagdishpur, Sonepat during *Rabi* season of 2015-16 and 2016-17. The nine treatment combinations comprising of three bulb size, *i.e*., big size (≥5.5 cm

diameter), medium size (4.5 to 5.4 cm diameter) and small size (3.5 to 4.4 cm diameter) and three spacing, *i.e*., 45×45, 45×30 and 30×30 cm were laid out in randomized block design in plot size of 2.7×2.7 cm and replicated four times. The bulbs of cultivar HO 4 procured from the bulbs produced in previous year at Vegetable Seed Production and Research Farm Jagdishpur, Sonepat were planted on 20th of October during both the years of experimentation. All the cultural practices including manure and fertilizers were followed as per the university package of practices. The observations on plant height, umbels per plant, seed yield per plot and per hectare parameters were recorded. For yield per plot, harvesting, threshing and weighing of seed yield per plot were done treatment wise separately.

The data recorded on different parameters were subjected to statistical analysis in OPSTAT, statistical software developed by CCS Haryana Agriculture University, Hisar (Haryana), India and the mean differences were evaluated by critical difference (C.D.) test at 5% level of significance (Sheoran, 2010) [10]. The benefit to cost ratio was worked out taking the cost of cultivation and net return into consideration.

Results and Discussion

Effect on plant height

The effect of bulb size and spacing on height of onion plants at 30, 60 and 90 days after plating stage (Table 1) reveals that the significantly maximum plant height (38.72 and 68.37 cm) was observed with plant raised from big bulbs as compared to other treatments at 30 and 90 days after planting, however, the plant height at 60 days after planting (49.41 cm) was found at par with the plant height of crop raised with medium bulbs. The crop from smallest bulbs had the shortest plants at each growth stage, which might be due to the influence of relatively greater amount of internal food reserves stored in large than smaller bulbs, leading to vigorous vegetative growth with enhanced plant height. The present results are in close agreement with the findings of Verlag (2013) [12] who also reported significant influence of bulb size on enhancement of plant height, which can also be supported by the finding of Kumar *et al*. (2015) [8].

Table 1: Effect of bulb size and spacing on plant height and number of umbels in onion (pooled data)

Treatment	Plant height (cm)			Umbels/plant
	30 DAP	60 DAP	90 DAP	
Bulb diameter (cm)				
≥5.5	38.72	49.41	68.37	9.82
4.5 to 5.4	34.92	49.23	65.17	7.71
3.5 to 4.4	33.46	46.63	63.14	6.07
CD at 5%	2.19	1.8	2.31	0.96
Spacing (cm)				
45×45	35.47	50.09	67.69	8.90
45×30	34.74	48.72	66.37	7.76
30×30	33.70	46.46	62.61	6.93
CD at 5%	2.19	1.8	2.31	0.96

The increasing trend was observed in plant height with the increase in spacing. Plant spacing showed pronounced effect on plant height and it was reported maximum in crop planted at widest spacing, *i.e*., 45×45 cm at 30, 60 and 90 days after planting (35.47, 50.09 and 67.69 cm, respectively), which was significantly higher than the plant height of crop planted at narrowest spacing and at par with plant height of crop spaced at 45×30 cm. The increase in plant height with the increase in spacing might be due to the effect of wider spacing, in which, plant could grow freely due to proper utilization of nutrients, water, space and light, resulting in vigorous crop growth. The results of present study are in conformity with the findings of Ahmed *et al*. (2017) [2] and Kumar *et al*. (2018).

Effect on seed yield parameters

Profound effect of bulb size on number of umbels per plant, seed yield per plot and seed yield per hectare was recorded (Table 1 and 2). The crop raised by planting bigger bulbs, which showed significantly maximum number of umbels per plant (9.82), seed yield per plot (433.9 g) and seed yield per ha (5.35 q), was significantly superior to crop raised by planting medium and small bulbs. The lowest values for these parameters were recorded in crop raised with smaller bulb. The interaction effect of bulb size and spacing (Table 3) also depicts that the crop raised by planting bigger bulbs at widest spacing produced seed yield significantly higher (5.90 q/ha) than the seed yield under other treatment combinations followed by big bulbs × medium spacing (5.37 q/ha), widest spacing × medium bulbs (5.35 q/ha) and medium bulbs × medium spacing (5.09 q/ha). Corroborative results regarding influence of bulb size were also reported by Asaduzzaman *et al.* (2012) who obtained the highest seed yield per plant from the crop raised by planting large bulbs. The effect of bulb size on seed yield per hectare is analogous to the findings of Agarwal *et al.* (2010) [1] and Khan *et al.* (2005) [7] who stated that the crop raised by planting larger bulbs produced higher seed yield per hectare. These results might be due to the production of greater number of flowering stalks by larger bulbs and strong root system, which absorbed more nutrients, resulting increased number of umbels per plant, weight of seeds per umbel and increased seed yield per plant.

Table 2: Effect of bulb size and spacing on seed yield of economics of onion (pooled data)

Treatments	Seed yield (g/plot)	Seed yield (q/ha)			Net return (□/ha)	B to C ratio
		2015-16	2016-17	Mean		
Bulb diameter (cm)						
≥5.5	433.9	4.86	5.84	5.35	238140	2.26
4.5 to 5.4	404.5	4.32	5.65	4.98	205170	2.07
3.5 to 4.4	380.9	4.27	5.12	4.69	193706	2.05

CD at 5%	26.7	0.27	0.37	0.32	-	-
Spacing (cm)						
45×45	437.1	5.04	5.74	5.38	241168	2.27
45×30	412.1	4.52	5.60	5.06	210576	2.09
30×30	387.2	3.90	5.28	4.57	185272	2.03
CD at 5%	26.7	0.27	0.37	0.32	-	-

Note: Onion seed was sold @ ₹1000/kg

Rate of onion bulb: Small size @ ₹8, medium size @ ₹10 and big size @ ₹12/kg.

Significant difference in number of umbels per plant, seed yield per plot and seed yield per hectare was observed due to planting of bulbs at different spacing. The significantly maximum number of umbels per plant (8.90) was obtained at widest spacing (45×45 cm) and the minimum number of umbels per plant (6.93) was observed at closest spacing (30×30 cm). The bulbs planted at the widest spacing the production of maximum number of umbels per plant might be due to less competition among the plants for nutrients, moisture, space and light and also due to the production of more photosynthates. Asaduzzaman *et al.* (2012) also found maximum number of umbels per plant under widest spaced crop. The yield per plot and yield per hectare exhibited decreasing trend with decreasing spacing. The significantly maximum yield per plot (437.1 g) and per hectare (5.38 q) was reported in the treatment where maximum spacing was maintained among the plants. The crop planted at 45×45 cm spacing gave yield at par with the yield obtained at 45×30 cm spacing, showing that the spacing between rows was more important than the spacing between the plants for getting higher seed yield from onion crop. These results are contradictory to the findings of Asaduzzaman *et al.* (2012) who obtained highest seed yield per hectare from the onion crop planted at closest spacing of 20×15 cm (781.12 kg) and lowest seed yield (644.06 kg) per hectare at widest spacing of 30×20 cm.

Table 3: Interaction effect of bulb size and spacing on seed yield (q/ha) of onion (pooled data)

Bulb size (cm)	Spacing (cm)			Mean
	45×45	45×30	30×30	
≥5.5	5.90	5.37	4.79	5.35
4.5 to 5.4	5.35	5.09	4.50	4.98
3.5 to 4.4	4.91	4.72	4.44	4.69
Mean	5.38	5.06	4.57	
CD At 5%	Bulb size= 0.32; Spacing= 0.32; Bulb size x Spacing= 0.48			

The maximum net return (₹238140/ha) was obtained when the crop was raised by planting bigger bulbs, while the maximum benefit to cost ratio (2.26 for bulb diameter and 2.27 for spacing) was obtained at widest spacing (₹241168/ha). These results are in close conformity with the findings of Ginoya *et al.* (2018) [6] who also obtained maximum net return from the crop raised by planting larger bulbs at 45×30-40 cm spacing.

Conclusion

Bulb size and plant spacing had significant influence on growth and seed yield of onion. The vegetative growth and seed production ability of the plants increased gradually with the increase in bulb size and spacing among the plants. Therefore, it is concluded that for getting higher seed yield and net return from onion, the bigger bulbs of cultivar HO 4 should be planted at 45×45 cm spacing under Haryana conditions.

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