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ONION BULBS PRODUCTION GROWN BY SETS 1. EFFECT OF PLANT DENSITY AND SET-SIZE

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ABSTRACT

This study was conducted during the seasons of 2011/2012 and 2012/2013 at the Experimental Farm of Shandweel station to investigate the effect of plant density (100, 80, 60 and 40 plants/m^2) and set-size (10-15, 15-20 and 20-25 mm) on onion (*Allium cepa* L.) yield and some bulb characteristics of onion produced from sets under Sohag Governorate conditions. Results revealed that, total single bulbs and marketable yield were significantly increased at the density of 100 plants/m^2, while culls yield, doubling and average bulb weight decreased, also bolters reduced with plant density of 40 plants/m^2. Total marketable yields, average bulb weight and emergence were significantly increased by using large sets (20-25 mm). In the meantime, single bulbs were increased, while culls yield, doubling and bolters reduced by small sets (10-15 mm). Culls yield, bolters and bulb weight were significantly decreased by the interaction (100 plants/m^2 x small sets 10-15 mm).

Key words: Onion, plant density, set-size.

INTRODUCTION

Onion (*Allium cepa* L.) is one of the important crops in Egypt, not only for local consumption but also for export. Upper Egypt is the main producer of Egyptian onion for export.

Brewster (1994) described sets as small onion bulbs, ranged from 2 g to 3g fresh weight. They are produced by growing a crop from direct seed sown at a high population density of 1000 to 2000 plants per m^2. Sets less than 25 mm in diameter are planted to develop into larger bulbs. Owing to their size, sets produce a more robust plant at emergence as compared to seeds. This allows them to be grown successfully in less favourable growing conditions where the use of transplant and direct sowing are limited. Sets have a shorter growing season than plants from seeds and this vantage is often exploited when early season production is required. In fact it is possible to advance the crop three weeks when sets are used to raise a crop as compared to direct sowing.

Jones and Mann (1963) elaborated that choice of cultivar is very important in growing of onion from set. It must be rapid growing, early maturing and attractive.

Yamaguchi (1980) reported that ideal size of set should be 1.5-2.0 cm in diameter. Bulb greater than 2.5cm in diameter became vernalized at low temperature and prone to bolting. Bulb less than 2.5 cm in diameter is still juvenile stage and less apt to be vernalized. Onion set of 1.0-1.5 cm are less sensitive to cold.

Size of set is closely to subsequent bulb yield and it has been observed that large sets produced greater yields (Khokhar, 2008a).

Rizk (1997) observed that the highest sowing rate (planting density) produced a noticeably higher yield of good quality bulbs than the lower sowing rate.

Farrag (1995) emphasized that high planting density increased significantly single-bulb, double bulb and total yields, as well as reducing bulb weight diameter.

Coelo *et al.* (1996) reported that the highest commercial bulb yield was recorded at higher planting density, while the highest proportion of

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large bulbs and average bulb weight were examined at lower planting density.

Stoffella (1996) apprehended that the percentage of small and medium-size bulbs increased and the percentage of large bulbs decreased as row spacing decreased.

Viegas (1996) found that close of larger bulbs decreased on contrast to the yield of small bulbs, which was highest at the highest density.

Keeping in view the above facts. Therefore, the present research work was initiated to determine the optimum planting density and set-size which give higher yield with qualitative characters under climatic conditions of Sohage Governorate.

MATERIALS AND METHODS

The present study was carried out at the Experimental Farm of Shandweel Station for two successive seasons 2011/2012 and 2012/2013 to study the effect of plant density and set size on production bulb from dry onion sets cv. Shandweel 1. The soil was loamy clay in texture having a pH of 8.

The experiment consisted of 12 treatments which were the combinations of four densities; *i.e.,* 100, 80, 60 and 40 plants/m2 and three sizes of sets; *i.e.,* 10-15 mm (small), 15-20 mm (medium) and 20-25 mm (large). The onion sets were planted on early September in both seasons.

The experimental design was split plot with four replications. The main plots contained the plant densities, while the sub-plots included set-sizes. Each sub plot was 2x3 m (1/700 faddan). The sets were planted on both sides of ridges.

Normal cultural practices of growing onion by sets were followed. Harvesting took place when about 75 percent of tops had fallen over. The harvested onions were left in the field for about two weeks to cure. Roots and tops were removed.

Measurements were taken for: total yield of bulbs (ton/fad.), marketable yield (ton/fad.), culls yield (ton/fad.), external doubling (percentage), bolters (%), average bulb weight (g), single bulb (%) and plant emergence (%).

All data was subjected to statistical analysis using the normal F-test and the means of treatments were compared using the L.S.D. methods (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

Total Yield of Bulbs (ton/fad.)

Results in Table 1 show the effect of plant density and set size on total yield of bulbs. It is evident that density of plant population affected significantly total yield. Total yield increased by increasing the density.

Data indicate that set size affected significantly the total yield, large sets gave the highest total yield value in both seasons. Moreover, the interaction between plant density and set-size had no significant effect on total yield of bulbs in both seasons of study.

Marketable Bulb Yield (ton/fad.)

Results in Table 2 for this character show that marketable bulb yield were significantly affected by plant density. Marketable yield increased significantly by increasing the plant density, 100 plants / m^2 gave the greatest value of marketable yield compared to 80, 60 and 40 plants/m^2.

Moreover, marketable bulb yield was significantly affected by set-size. The marketable yield was high value at large set (20 mm) compared with the small size (10 mm).

The interaction effect of plant density x set size on marketable yield was insignificant in the two seasons of study.

Culls Yield (ton/fad.)

Presented data in Table 3 show clearly that culls yield was decreased by increasing density of planting. Culls yield was at the least value with 100 plants / m^2 compared with 80, 60 and 40 plants/m^2 in the two seasons of study. However, culls yield was significantly affected by set size. Small sets gave the lowest value compared with the medium and large sets.

The interaction between plant density and set-size reflected significant effect on culls yield in the second season only. The interaction between plant density (100/m^2) and small sets gave the lowest value, while the plant density (40/m^2) and large sets gave the highest value of culls yield.

Table 1. Effect of plant density and set size on total yield of bulbs (ton/fad.) in 2011/2012 and 2012/2013 seasons

No. of plants/m²	Set size (mm)							
	2011/2012				2012/2013			
	Small 10-15	Medium 15-20	Large 20-25	Mean	Small 10-15	Medium 15-20	Large 20-25	Mean
100	9.59	14.02	16.48	13.36	10.30	13.64	16.59	13.51
80	9.51	11.21	14.66	11.79	9.75	11.40	15.03	12.06
60	8.08	10.55	12.16	10.26	9.16	11.10	15.02	11.76
40	7.77	10.25	11.96	9.99	6.77	9.24	12.74	9.58
Mean	8.74	11.51	13.81		8.99	11.34	14.85	
L.S.D. 5%								
Plant density	0.51			0.54				
Set size	1.27			0.84				
Density x size	N.S.			N.S.				

Table 2. Effect of plant density and set size on marketable bulb yield (ton/fed.) in 2011/2012 and 2012/2013 seasons

No. of plants/m²	Set size (mm)							
	2011/2012				2012/2013			
	Small 10-15	Medium 15-20	Large 20-25	Mean	Small 10-15	Medium 15-20	Large 20-25	Mean
100	6.79	8.88	9.84	8.52	6.56	7.43	8.77	7.59
80	4.59	6.07	7.86	6.17	4.49	5.41	7.53	5.81
60	3.78	4.82	6.35	4.98	3.14	4.58	6.31	4.68
40	2.40	4.23	3.69	3.44	2.75	3.88	4.13	3.58
Mean	4.39	6.00	6.94		4.23	5.32	6.68	
L.S.D. 5%								
Plant density		0.80				1.00		
Set size		0.71				1.07		
Density x size		N.S.				N.S.		

Table 3. Effect of plant density and set size (mm) on culls yield (ton/fed.) in 2011/2012 and 2012/2013 seasons

No. of plants/m²	Set size (mm)							
	2011/2012				2012/2013			
	Small 10-15	Medium 15-20	Large 20-25	Mean	Small 10-15	Medium 15-20	Large 20-25	Mean
100	2.80	5.14	6.64	4.86	3.74	5.21	5.82	4.92
80	4.92	5.14	6.80	5.62	4.76	5.99	7.50	6.08
60	4.30	5.73	7.55	5.86	6.02	6.52	8.71	6.52
40	5.36	6.20	8.27	6.61	4.02	5.36	8.61	6.56
Mean	4.34	5.55	7.32		4.63	5.77	7.66	
L.S.D. 5%								
Plant density		0.53				0.88		
Set size		0.63				0.55		
Density x size		N.S.				0.96		

External Doubling (%)

As shown in Table 4 it is clear that plant density and set size affected significantly the percentage of external doubling. The density (100 /m^2) gave the lowest value of percentage of external doubling compared with 80, 60 and 40 plants/m^2 in both seasons. Data indicate also that set size had significant effect on percentage of external doubling, it was clear that small sets gave lower value of percentage of external doubling compared with large and medium sets. The interaction (density x set size) didn't reflect any significant effect on external doubling percentage.

Bolters (%)

Results in Table 5 show that the two studied factors; *i.e.,* plant density and set-size affected significantly the percentage of bolters in the two experimental seasons. It was clear that the best results were achieved by lower plant densities (40 or 60 plants/m^2) compared with the highest densities (80 or 100 plants/m^2) in both seasons. Moreover, small sets gave the lowest value of bolters percentage, while the large sets gave the highest values in the two studied seasons.

The interaction (plant densities × set size) affected significantly the bolters percentage. It is evident that the interaction (100 plants / m^2 × large sets) gave the highest bolters percentage, while the interaction (100 plants / m^2 × small sets) gave the lowest value of bolters percentage in first season.

Average Bulb Weight (g)

Data in Table 6 show the effect of plant density on average bulb weight. Results indicate that plant density (40 plants /m^2) gave maximum average bulb weight. The same data reveal that sets size affected significantly the average bulb yield in both seasons. Large sets enhanced average bulb weight compared with small or medium sets.

The interaction between plant density and sets-size was significant in the two studied seasons, 40 plants/m^2 with large sets gave high values of bulb weight in both seasons.

Single Bulb (%)

Data in Table 7 show the effect of plant density and set size on percentage of single bulb. Results indicate that the plant density (100/m^2) and the small sets size gave the highest value in both seasons. Moreover, the interaction between plant density and sets-size was insignificant in both seasons of study regarding single bulb percentage.

Plant Emergence (%)

Results in Table 8 indicate that the plant density had no significant effect on percentage of plant emergence.

However, the sets size reflected a significant effect on emergence (%), heaviest emergence (%) was obtained from large sets compared with medium and small sets in both seasons. The interaction between plant density and set size did not significantly affect the emergence (%) in both seasons. In respect of adapting some cultural practices which might affect the production of high-quality onion bulbs grown by sets, it was found, in the present study that Shandweel I cv., affected by plant density and set-size. These results are supported by many workers such as Yamaguchi (1980) and Viegas (1996). It found also that using combination between plant density and set-size could be helpful in onion bulbs production grown by sets. These obtained results were in harmony with those obtained by Rizk (1997), Coelo *et al.* (1996), Jones *et al.* (1963) and Khokhar (2008b).

Table 4. Effect of plant density and set size (mm) on % external doubling in the 2011/2012 and 2012/2013 seasons

No. of plants/m^2	Set size (mm)							
	2011/2012				2012/2013			
	Small 10-15	Medium 15-20	Large 20-25	Mean	Small 10-15	Medium 15-20	Large 20-25	Mean
100	13.98	22.47	30.16	22.20	13.58	17.53	23.47	18.19
80	24.07	30.72	41.84	32.21	31.22	37.35	43.26	37.28
60	44.84	50.47	53.59	49.63	45.71	57.50	61.96	55.06
40	50.93	58.64	64.68	58.08	46.91	58.90	63.92	56.58
Mean	33.46	40.57	47.57		34.36	42.82	48.15	
L.S.D. 5%								
Plant density		8.49				8.15		
Set size		2.38				3.34		
Density x size		N.S.				N.S.		

Table 5. Effect of plant density and set size (mm) on (%) of bolters in the 2011/2012 and 2012/2013 seasons

No. of plants/m^2	Set size (mm)							
	2011/2012				2012/2013			
	Small 10-15	Medium 15-20	Large 20-25	Mean	Small 10-15	Medium 15-20	Large 20-25	Mean
100	0.74	2.20	5.11	2.68	2.13	2.70	5.56	3.46
80	1.19	4.04	5.58	3.60	2.53	3.86	4.89	3.76
60	1.36	1.90	2.05	1.77	1.14	2.35	4.37	2.62
40	1.01	1.36	1.85	1.41	1.08	2.31	2.87	2.09
Mean	1.07	2.38	3.65		1.72	2.81	4.42	
L.S.D. 5%								
Plant density		1.24				0.64		
Set size		1.00				0.61		
Density x size		1.73				1.06		

Table 6. Effect of plant density and set size on average bulb weight (g) in 2011/2012 and 2012/2013 seasons

No. of plants/m^2	Set size (mm)							
	2011/2012				2012/2013			
	Small 10-15	Medium 15-20	Large 20-25	Mean	Small 10-15	Medium 15-20	Large 20-25	Mean
100	70.86	89.94	106.83	89.21	55.92	71.02	80.29	69.07
80	107.45	121.12	145.84	124.80	100.61	124.47	144.57	124.88
60	137.56	159.07	181.65	159.43	162.74	167.23	192.60	174.19
40	167.25	215.51	249.34	210.70	181.90	201.34	234.30	205.85
Mean	120.78	146.41	170.92		125.29	141.01	164.19	
L.S.D. 5%								
Plant density		16.76				8.23		
Set size		6.42				4.75		
Density x size		11.11				8.22		

Table 7. Effect of plant density and set size (mm) on (%) of single bulbs in the 2011/2012 and 2012/2013 seasons

No. of plants/m^2	Set size (mm)							
	2011/2012				2012/2013			
	Small 10-15	Medium 15-20	Large 20-25	Mean	Small 10-15	Medium 15-20	Large 20-25	Mean
100	85.00	75.50	69.08	75.10	84.40	80.40	70.00	78.26
80	74.90	65.20	53.10	64.40	66.70	59.30	51.70	59.23
60	54.10	48.50	44.30	48.96	53.09	40.50	34.30	42.63
40	48.00	40.30	34.30	40.86	52.00	39.00	33.00	41.33
Mean	65.50	57.37	49.12		64.04	54.80	47.25	
L.S.D. 5%								
Plant density		9.04				8.64		
Set size		4.39				5.51		
Density x size		N.S.				N.S.		

Table 8. Effect of plant density and set size (mm) on percentage of plant emergence in 2011/2012 and 2012/2013 seasons

No. of plants/m²	Set size (mm)							
	2011/2012				2012/2013			
	Small 10-15	Medium 15-20	Large 20-25	Mean	Small 10-15	Medium 15-20	Large 20-25	Mean
100	65.14	75.29	81.78	74.40	69.17	77.15	87.66	77.99
80	69.41	74.70	81.94	75.35	71.73	75.52	82.36	76.53
60	69.78	75.37	80.37	75.17	65.74	75.70	78.52	73.32
40	71.38	74.44	80.27	75.37	74.44	80.42	80.35	78.40
Mean	68.93	74.95	81.34		70.27	77.19	82.22	
L.S.D. 5%								
Plant density		N.S.				N.S.		
Set size		3.02				4.51		
Density x size		N.S.				N.S.		

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إنتاج البصل بإستخدام البصيلات ١- تأثير الكثافة النباتية وحجم البصيلات

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أجريت الدراسة في محطة بحوث شندويل خلال موسمي ٢٠١٢/٢٠١١ ، ٢٠١٣/٢٠١٢ علي صنف البصل شندويل (١) وذلك لدراسة تأثير كلا من الكثافة النباتية وحجم البصيلات علي إنتاج البصل من البصيلات، واستخدمت في هذه الدراسة أربع كثافات نباتية هي ١٠٠، ٨٠، ٦٠، ٤٠ بصلة بالمتر المربع مع ثلاثة أحجام للبصيلات هي ١٠-١٥ مم ، ١٥-٢٠ مم، ٢٠-٢٥ مم، وقد وجد أنه في حالة الكثافة النباتية المرتفعة (١٠٠ نبات/متر مربع) قد إزداد معنوياً كل من المحصول الصالح للتسويق وكذلك نسبة الأبصال المفردة، بينما إنخفضت نسبة النقضة، والأزدواج، ومتوسط وزن البصلة في حالة الزراعة بنفس الكثافة، أما الكثافة المنخفضة (٤٠ نبات/متر^{٢}) فأدت إلي زيادة نسبة الازهار الحولي، أما بالنسبة لحجم البصيلة، فإن البصيلات الكبيرة (٢٠- ٢٥مم) أحدثت زيادة معنوية للمحصول القابل للتسويق، ومتوسط وزن البصلة، وكذلك نسبة الإنبات مقارنة بالأحجام المختلفة الأخرى، في حين أن نسبة الابصال المفردة قد إزدادت، وانخفض كل من محصول النقضة، ونسبة الأزدواج، ونسبة الازهار الحولي في حالة استخدام الأحجام الصغيرة للبصيلات في الزراعة، وبالنسبة لتأثير التفاعل بين المعاملات المختلفة فإن معامله التفاعل (١٠٠ نبات/ متر^{٢} × بصيلات صغيرة ١٠-١٥ مم) قد قللت كل من نسبة الأزهار الحولي، والنقضة، وكذلك وزن البصلة وذلك مقارنة بالتفاعلات الأخري.

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