

Effects of Seed bed, Cultivars and Seed rates on Yield and Quality of Onion Sets (*Allium cepa* L.)

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Abstract

Field experiments were conducted during three successive winter seasons 2010/11, 2011/12 and 2012 /13, at Shambat Research Station Farm on clay loam soil pH 7.8, to study the effects of seed bed, cultivars and seed rates and their interactions on onion set yield and quality. Two seed bed (flat and ridge), two cultivars Kamleen and Baftaim (S) and

three seed rates 4, 8, 12 g / m² (40, 80, 120 kg / ha) were tested. The experimental design used was 2*2*3 Factorial in split-split plot design with four replications. Yield was evaluated as set yield t / ha, whereas, quality was evaluated as percentage of large (2.9-2.0 cm) and medium (1.9-1.0 cm) set size according to diameter and average of single set weight (g). Cultivar Baftaim (S) gave the highest set yield t/ha and average of single set weight in the three seasons. The seed rate of 4 g/m² (40 kg / ha) resulted in highest average of single set weight and the highest number percentage of large set size. Increasing the seed rate increased set number and quality; the seed rate 12 g/m² (120 kg/ha) gave the highest percentage of medium set size.

Introduction

Onion (*Allium cepa* L.), is an important vegetable crop belonging to the family Alliaceae. It is the most widely grown as a popular crop among the alliums. Onion is considered the second most important vegetable crop grown in the world after tomato. It is popularly referred to as "Queen of Kitchen." Recently onion is being used by processing industry to a greater extent for preparing foods with vegetables, meat, fish...etc [1].

In the Sudan it ranks the first vegetable with

regard to the area grown and quantities produced. It grown in different states in the Sudan (Naher El -Neil, Gezira, Darfur States, Kassala, Northern State and Khartoum) [2]. Total area devoted for onion (212.9 thousand feddan) with production of 167.5 thousand tons [3].

Onion is grown by one of three methods: direct sowing, transplanting and sets [4]. Sets are small bulbs, typically weighing 2–3 g when fresh, produced by growing a crop from seed sown at very high density of 1000–2000 plants /m². They are < 25 mm in diameter and replanted to develop into larger bulbs. Because of their size, sets make a more robust plant at emergence than seeds, and do not need such meticulous seedbed preparation. It also easier to grow successfully and are widely used by amateur and small-scale growers. Sets also have a shorter growing season than plants from seeds and transplants are used where rapid, early-season production is important [5].

The present study is conducted to find a suitable combination of seed bed, cultivar and seed rate for the production of sets for onion off-season production.

Materials and Methods

The experiments were carried out during three successive winter seasons (2010/11, 2011/12 and 2012/13), at Shambat Research Station Farm on clay loam soil pH 7.8 (lat. 15° 39'N long. 32° 32' and 381m above sea level).

The experiments were designed to test the effect of two seed bed (flat vs. 60 cm ridges), three seed rates 4, 8 and 12 g /m² (40, 80 and 120 kg /ha) on the sets yield and quality of the two onion cultivars, Kamleen Yellow and Baftaim (S) Red. The experimental units were 2*2*3 Factorial in split-split plot design with four replications. The planting methods were assigned to the main plots, onion cultivars in the sub-plots and the seed rates in sub-sub plots. The total net area of each sub-sub plot was 10.44m² (1.8 m. * 5.8 m.).

Before laying out the experiments, the field was disc ploughed, well leveled and divided to flat and 60 cm

ridge plots. The seeds were drilled in rows 20cm apart (9 rows/plot) in flat and 3 rows/ridge on ridged plot.

The experiments were sowing in 6, 11 and 14-15 Januarys, and all agronomic practices (fertilization, irrigation and weeding... etc) were done as recommended in the three seasons.

All the experimental plots were fertilized with nitrogen (43 kg N/ha) in the form of Urea (46%N) in two equal doses.

At harvesting, an area of 1m² was harvested randomly to evaluate yield as set number and weight and yield/h and quality (percentage of different set size). Harvested sets were cured and graded large (2.9 – 2.0 cm) and medium (1.9 – 1.0 cm) according to the diameter, the yield per hectare was calculated as follow:

$$\text{Yield (t/ha)} = (\text{Yield/m}^2 * 10000) / 1000$$

The data were analyzed using GenStat (Computer Program) Version4 and the means were separated using Duncan Multiple Range Test (DMRT) at P≤0.05 [6].

Results

Onion Set Yield (t/ha)

Both cultivars differed significantly in their yield irrespective of seed bed or seed rate (Table 1). The cultivar Baftaim (S) out yielded Kamleen. Although no significant difference were noticed between sowing methods and seed rates except in the second season (Table 2), sowing on ridges at a moderate seed rate (8 g/ m²) gave the highest set yield, Both cultivars showed no significant response to seed bed or seed rate.

Quality

Percentage Set Size (Large and Medium)

As in Table 3 significant differences were noticed between seed bed on percentage of large set size during 2010/11 and 2012/13, flat sowing recorded the highest percentage except in season 2011/12, while no significant differences were noticed between cultivars except in season 2010/11, Baftaim (S) gave the highest percentage of large set size. Generally cultivar Kamleen recorded the highest percentage of large set size (Table 3). The

Table 1. Effect of sowing methods, cultivars and seed rates on set yield (t/ha)

Sowing Methods	Season			Mean
	2010/11	2011/12	2012/13	
Flat	39.69 a	48.29 a	31.52 a	39.84 a
Ridge	37.58 a	52.56 a	30.26 a	40.13 a
Sig.	NS	NS	NS	NS
S.E	1.72	1.405	0.625	0.844
Cultivars				
Kamleen	28.72 b	43.93 b	24.09 b	32.25 b
Baftaim(S)	48.55 a	56.92 a	37.70 a	47.72 a
Sig.	***	***	***	***
S.E	1.82	1.159	0.805	0.844
Seed rates				
4 g/m ²	37.01 a	51.68 a	28.68 a	39.12 a
8 g/m ²	40.48 a	50.26 a	31.77 a	40.84 a
12 g/m ²	38.43 a	49.34 a	32.23 a	40.00 a
Sig.	NS	NS	NS	NS
S.E	1.94	1.160	1.529	1.033
C.V.%	20.1	9.2	19.8	17.9

Table 2. Interaction effects of sowing methods and seed rate on set yield (t/ha)

Sowing Methods	Seed rates	Season			Mean
		2010/11	2011/12	2012/13	
Flat	4 g/m ²	36.67 a	47.43 bc	28.36 a	37.49 a
	8 g/m ²	40.63 a	49.41 abc	26.80 a	40.89 a
	12 g/m ²	41.83 a	50.13 abc	24.52 a	41.44 a
Ridge	4 g/m ²	37.34 a	55.92 a	36.43 a	40.76 a
	8 g/m ²	40.08 a	53.21 ab	36.74 a	41.14 a
	12 g/m ²	35.31 a	48.54 c	39.93 a	38.61 a
Sig.		NS	*	NS	NS
S.E		2.82	1.941	1.873	1.461

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively.

Means with similar letters are not significant at P=0.05 according to DMRT.

Table 3. Effect of sowing methods, cultivars and seed rates on number percentage of large set/m²:

Sowing Methods	Season			Mean
	2010/11	2011/12	2012/13	
Flat	40.13 a	43.66 a	38.89 a	40.89 a
Ridge	31.00 b	39.16 a	32.13 b	34.10 b
Sig.	*	NS	*	***
S.E	1.95	1.69	1.47	0.843
Cultivars				
Kamleen	33.03 b	44.19 a	36.23 a	37.82 a
Baftaim(S)	38.09 a	38.63 a	34.79 a	37.17 a
Sig.	*	NS	NS	NS
S.E	1.51	2.09	1.09	0.843
Seed rates				
4 g/m ²	53.31 a	52.13 a	47.38 a	50.94 a
8 g/m ²	36.27 b	42.27 b	35.80 b	38.11 b
12 g/m ²	17.12 c	29.82 c	23.35 c	23.43 c
Sig.	***	***	***	***
S.E	1.71	2.05	1.40	1.032
C.V.%	19.3	19.8	15.8	19.1

Table 4. Interaction effects of sowing methods and cultivars on number percentage of large set/m²

Sowing Methods	Cultivars	Season			Mean
		2010/11	2011/12	2012/13	
Flat	Kamleen	38.08 a	46.78 a	41.54 a	42.13 a
	Baftaim (S)	42.18 a	40.53 a	36.25 ab	39.65 a
Ridge	Kamleen	27.98 a	41.60 a	30.92 b	33.50 a
	Baftaim (S)	34.01 a	36.73 a	33.33 b	34.69 a
Sig.		NS	NS	*	NS
S.E		2.468	2.69	1.834	1.92

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively. Means with similar letters are not significant at P=0.05 according to DMRT.

percentage of large set size, however, was higher significantly on flat compared to ridge except in the second season (Table 3). Increasing seed rate decreased significantly the percentage of large set size (Table 3). No significant differences were noticed due to the interactions between sowing methods and cultivars except in the last season, generally both cultivars in flat sowing recorded the highest percentage of large than sowing on ridge (Table 4). Moreover, significant differences were also noticed on the percentage of medium set size due to sowing methods (sowing in ridge gave highest percentage than flat sowing), cultivar Kamleen differed significantly from Baftaim (S) in percentage of medium (Table 5). Increasing the seed rate

showed significant positive effect on the percentage of medium set size (Table 5), Moreover, the interaction between sowing methods and seed rates had no significant effect except in the first season (Table 6).

Single Set Weight (g)

The three seasons mean indicated significant effect was observed on single set weight between seed bed, flat sowing obtained highest single set weight. Also, the cultivar had high significant effect on the single set weight; Baftaim (S) gave the highest single set weight, also the three seed rates had highly significant effect on single set weight; the highest set weight was recorded by the low seed rate of 4 g / m² in all seasons (Table 7). Lowest seed

Table 5. Effect of sowing methods, cultivars and seed rates on number percentage of medium set/m²

Sowing Methods	Season			Mean
	2010/11	2011/12	2012/13	
Flat	41.96 a	36.50 a	36.37 a	38.28 b
Ridge	46.76 a	38.65 a	40.77 a	42.06 a
Sig.	NS	NS	NS	**
S.E	2.90	2.397	2.473	0.784
Cultivars				
Kamleen	46.64 a	37.97 a	40.18 a	41.60 a
Baftaim(S)	42.08 b	37.18 a	36.96 a	38.74 b
Sig.	**	NS	NS	*
S.E	0.89	1.349	1.755	0.784
Seed rates				
4 g/m ²	30.15 b	23.37 c	24.48 c	26.00 c
8 g/m ²	49.12 a	39.77 b	40.90 b	43.26 b
12 g/m ²	53.81 a	49.59 a	50.34 a	51.25 a
Sig.	***	***	***	***
S.E	2.47	1.715	1.563	0.960
C.V.%	22.3	18.3	16.2	20.4

Table 6. Interaction effects of sowing methods and seed rates on number percentage of medium set/m²

Sowing Methods	Seed rates	Season			Mean
		2010/11	2011/12	2012/13	
Flat	4 g/m ²	24.73 d	21.18 a	22.86 a	22.92 a
	8 g/m ²	43.74 bc	39.69 a	38.08 a	40.50 a
	12 g/m ²	57.41 a	48.62 a	48.17 a	51.40 a
Ridge	4 g/m ²	35.57 cd	25.55 a	26.09 a	29.07 a
	8 g/m ²	54.50 ab	39.85 a	43.72 a	46.02 a
	12 g/m ²	50.20 ab	50.56 a	52.50 a	51.09 a
Sig.		*	NS	NS	NS
S.E		4.07	3.109	3.061	1.672

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively. Means with similar letters are not significant at P=0.05 according to DMRT

Table 7. Effect of sowing methods, cultivars and seed rates on single set weight (g)

Sowing Methods	Season			Mean
	2010/11	2011/12	2012/13	
Flat	5.71 a	6.42 a	6.60 a	6.24 a
Ridge	4.76 a	6.58 a	5.62 a	5.66 b
Sig.	NS	NS	NS	**
S.E	0.381	0.348	0.284	0.205
Cultivars				
Kamleen	4.09 b	6.12 b	5.34 b	5.18 b
Baftaim(S)	6.39 a	6.89 a	6.89 a	6.72 a
Sig.	**	*	*	***
S.E	0.353	0.192	0.382	0.205
Seed rates				
4 g/m ²	7.90 a	9.17 a	9.06 a	8.71 a
8 g/m ²	4.71 b	6.11 b	5.72 b	5.52 b
12 g/m ²	3.10 c	4.22 c	3.55 c	3.62 c
Sig.	***	***	***	***
S.E	0.201	0.238	0.421	0.251
C.V.%	15.4	14.6	27.5	22.8

Table 8. Interaction effects of cultivars and seed rates on single set weight (g)

Cultivars	Seed rates	Season			Mean
		2010/11	2011/12	2012/13	
Kamleen	4 g/m ²	6.06 b	8.89 a	8.28 a	7.74 b
	8 g/m ²	3.82 c	5.54 b	4.68 a	4.68 c
	12 g/m ²	2.39 d	3.92 b	3.05 a	3.12 c
Baftaim(S)	4 g/m ²	9.75 a	9.45 a	9.85 a	9.68 a
	8 g/m ²	5.61 b	6.69 a	6.76 a	6.35 b
	12 g/m ²	3.81 c	4.52 b	4.05 a	4.13 c
Sig.		**	**	NS	NS
S.E		0.423	0.335	0.618	0.355

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively. Means with similar letters are not significant at P=0.05 according to DMRT.

Table 9. Interaction effects of sowing methods, cultivars and seed rates on single set weight (g)

sowing methods	Cultivars	Seed rates	Season			Mean
			2010/11	2011/12	2012/13	
Flat	Kamleen	4 g/m ²	6.61 a	9.03 ab	9.00 a	8.24 a
		8 g/m ²	4.25 a	4.99 ef	4.85 a	4.70 a
		12 g/m ²	2.59 a	4.21 f	3.46 a	3.42 a
	Baftaim (S)	4g/m ²	10.32 a	8.27 bc	10.69 a	9.76 a
		8g/m ²	6.08 a	7.48 cd	7.29 a	6.95 a
		12g/m ²	4.43 a	4.55 ef	4.20 a	4.39 a
Ridge	Kamleen	4g/m ²	5.51 a	8.76 bc	7.48 a	7.25 a
		8g/m ²	3.39 a	6.08 de	4.51 a	4.66 a
		12g/m ²	2.18 a	3.63 f	2.63 a	2.81 a
	Baftaim (S)	4g/m ²	9.15 a	10.63 a	9.00 a	9.61 a
		8g/m ²	5.15 a	5.90 f	6.23 a	5.76 a
		12g/m ²	3.19 a	4.50 f	3.89 a	3.86 a
Sig.			NS	**	NS	NS
S.E			0.615	0.556	0.836	0.392

N.B.: NS, *, ** and ***, non significant at P=0.05 and significant at P=0.05, P=0.01 and P=0.001 respectively. Means with similar letters are not significant at P=0.05 according to DMRT.

rate with two sowing methods recorded the highest set weight (Table 8), although in both cultivars reported the highest set weight with low seed weight (Table 9).

Discussion

The results reflected that the set yield was significantly affected by cultivars, while there was no affect either due to seed bed or seed rate. These results agreed with [7], who recorded high onion yield of the cultivar Baftaim (S) compared to other onion cultivars. Moreover, the increase in yield on ridge sowing and moderate seed rate could be attributed to suitable plant population with ridge bed and moderate seed rate, which could not be obtained on flat sowing by lower or higher seed rates due to low plant population or higher competition for nutrients at higher seed rates, respectively. Similar results were obtained by [8] who reported that high plant population resulted in competition for nutrients and light thus resulting in short plants, while low plant population provided adequate space for growth and development.

Increasing of seed rate showed significant negative effect on set size, whereas the highest percentage of large set size was obtained by the lowest seed rate. The highest seed rate, however, gave the highest percentage of medium sets size (considered the optimum set size for off-season onion production). Similar results were also obtained by [9, [10] [11] who found that medium set size could be considered suitable for onion off-season production.

The single set weight affected significantly by cultivars and seed rate, this result confirmed with [7] who recorded high onion yield of the cultivar Baftaim (S) compared to other onion varieties and [12] who reported low plant population result in high set weight.

It can be concluded that in order to achieve high yield and quality of onion sets; sowing on ridge (60 cm) and seed rate 12 g/m² (120 kg/ha) irrespective of cultivars for high onion sets yield an quality for off-season production.

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