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Effect of Set Size and Fertilizer Type on Off- Season Onion (Allium cepa. L) Production

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Abstract

Two off-season experiments were conducted during 2015/16 and 2017/18 at Shambat Research Station Farm, Khartoum, Sudan, to investigate the effects of large (2-3 cm) and small (1-2 cm) sets size of onion variety Baftaim (S) and two chemical fertilizer (Urea 240 kg/ha) and NPK(15:15:15) (120 kg/ha) in addition to organic fertilizer (Elkhaseeb 20 tons/ha) and their combinations (Urea+ Elkhaseeb and NPK+Elkhaseeb) on off-season production. The experimental units were in split plot design, with set size and fertilizers as main and sub plots, respectively, with three replications. The yield was evaluated as bulb weight and yield/ha, whereas, the quality was evaluated as marketable and percentage of double and bolted bulbs, TSS and dry matter. The results reflected no significant differences in bulb weight due to set size, fertilizer type and their interactions, however, the heaviest bulbs were obtained by Elkhaseeb + urea and its interaction with the large set size in both seasons. The small set size gave the highest yield, organic fertilizer (Elkhaseeb) alone or in combination with urea gave the highest yield, whereas, the lowest one was obtained with the combination of organic fertilizer with N P K. The bulb quality was also affected by set size and fertilizer type as the highest marketable yield was obtained by small set size and fertilizer combination (organic + urea) or urea alone. No significant effects on TSS and dry matter percentage due to set size, fertilizer type and their interactions were noticed. The highest marketable yield, TSS and dry matter were obtained by Elkhaseeb (organic fertilizer) with mineral fertilizers (urea or NPK) with the small set size rather than organic or mineral fertilizer alone. It could be concluded and recommended that onion set size of about 1-2cm

diameter with an organic - mineral fertilizer combination could improve off-season onion yield and quality. However, further studies are required to find the proper fertilizers dose.

Introduction

Common onion (*Allium cepa* L.) is one of the main important vegetable crops in the world. It is grown for many purposes, namely, fresh shoots for salad or cooked, pickled, processed and dehydrated bulbs for enhancement of other food flavor or sets for seed production [1] [2] .

The world onion production increases with the extreme increases of onion demands and consumption [3]. The world total area under onion is 364.04 million hectares with production of 742.51 million tons [4].

In Sudan the area under onion is 33% (102 thousand hectares) of the total area devoted for vegetables with production of 158.3 thousand tons [5].

Direct seeding is not adopted due to short winter season and scarcity of machinery. However, one of the most important methods of off-season production is from onion sets, produced by direct seeding at very high seed rate (1000-2000 plants/m^2). The sets are typical bulbs of about 2-3g weight and 1-3cm in diameter which make more robust plants compared to seeds [2] [6]. [7] Found that the diameter of the set was the primary factor that affects bulb or flower stalk production. They showed that the ideal size of the set should be 1.5-2.0 cm in diameter to have the highest marketable yield.

Onion is highly sensitive to nutrient deficiency because of its shallow and un-branched root system. It requires fertile, well drained, non-crusting and light acidic (pH 6-6.8) soil. [8] Found that the application of nitrogen with farmyard manure gave the highest marketable yield. [9] and [10] reported high onion yield with fertilizer combination (organic + nitrogen) compared to single fertilizer.

Therefore this study was carried out to achieve the following objectives:

- To find the best set size to have the highest yield and quality of off- season onion.
- To study the effect of fertilizer type (organic and chemical fertilizers) and their combinations on yield and quality of off-season onion.
- To find best fertilizer type or combination to have high onion yield and quality.

Materials and Methods

Two off-season experiments were conducted in August-October 2015 and 2017 at Shambat Research Farm (lat. 15° 39'N long. 32° 32' and 381m above sea level), with clay loamy Soil of pH 7.8.

The treatments were designated to test the effect of two set sizes, large (2-3 cm) and small (1-2 cm) in diameter and four fertilizer combinations, namely urea (240 kg/ha), NPK, 15:15:15 (120 kg/ha) and Elkhaseeb (20 tons/ha) alone and their combination (urea+ Elkhaseeb and NPK+ Elkhaseeb).

The experimental plot was ploughed, leveled, ridged into 60 cm ridges and divided into 24 experimental units (3*3 m).

The organic fertilizer was broadcasted once before planting. Then the sets were planted in August in three rows on 60cm ridge (20 cm a part) and 10 cm within row spacing.

Urea and NPK were applied in two doses after one and two months from planting, respectively. Other cultural practices (irrigation, weeding, and pest and disease control) were done as recommended.

The crop was harvested after signs of maturity were observed (at neck -fall). The bulb yield was evaluated as bulb weight and yield per hectare as follows:

Yield (t/ha) = Yield (kg) /m^2*ha (10000 m^2) /1000 kg

The bulb quality was evaluated as marketable yield, total soluble solids (TSS) and dry matter percentage. The data were analyzed using GenStat (Computer Program) Version4 and the means were separated using Duncan Multiple Range Test (DMRT) at P≤ 0.05 [11].

Results and Discussion

Yield and Yield Components:

Bulb Weight (g) and Yield t/ha:

Table 1. Effect of set size and fertilizer type on bulb weight and yield (ton/ha) of off-season onion cv. Baftaim (S)

Set size (cm) / Fertilizer Type	Season 2015/16						Season 2017/18					
	Bulb weight (g)			Bulb yield (ton/ha)			Bulb weight (g)			Bulb yield (ton/ha)		
	Small set (1-2)	Large set (2-3)	Mean	Small Set (1-2)	Large set (2-3)	Mean	Small set (1-2)	Large set (2-3)	Mean	Small Set (1-2)	Large set (2-3)	Mean
Urea	72.2a	83.3a	76.1a	43.8ab	24.5i	34.1cd	76.10a	70.2a	73.2a	45.9a	30.7a	8.3b
Urea +Elkhaseeb	81.1a	96.2a	79.1a	51.1a	37.6cde	44.3a	79.1a	82.0a	80.6a	52.5a	37.6a	45.0a
Elkhaseeb	78.2a	66.2a	67.5a	38.7d	37.9cde	38.3ab	67.5a	74.3a	70.9a	50.2a	40.0a	45.1a
Elkhaseeb+NPK	71.5a	65.5a	77.1a	26.9gh	31.5efg	29.2e	77.1a	64.7a	70.9a	35.6	36.8a	36.2b
Mean	75.7a	77.8a		40.1a	32.9b		75.0a	72.8a		46.0a	36.3b	
C.V. %	27.1			14.9			18.4			15.0		

Means having the same letter(s) within the same column or row were not significantly different using DMRT at P ≤ 0.05.

Table 2. Effect of set size and fertilizer type on bulb quality marketable bulbs (ton/ha), TSS and dry matter percentage of off-season onion cv. Baftaim (S)

Set size cm) / Fertilizer Type	Season 2015/16									Season 2017/18								
	Marketable bulb yield (ton/ha)			TSS (%)			Dry matter (%)			Marketable bulb yield (ton/ha)			TSS (%)			Dry matter (%)		
	Small set (1-2)	Large set (2-3)	mean	Small set (1-2)	Large set (2-3)	Mean	Small Set (1-2)	Large set (2-3)	Mean	Small set (1-2)	Large set (2-3)	Mean	Small Set (1-2)	Large set (2-3)	Mean	Small set (1-2)	Large set (2-3)	Mean
Urea	13.1a	8.5bc	10.8a	13.0b	13.3b	13.1a	16.1c	17.5bc	16.8 b	17.5A	13.4a	15.5a	12.0a	12.5 a	12.2a	12.7a	13.0a	12.9 a
Urea+Elkhaseeb	9.7ab	6.1b	9.7ab	15.8a	12.3b	14.1a	17.8abc	17.2bc	17.5b	14.4a	9.0a	11.7 b	12.0a	12.3 a	12.2a	12.9a	13.4a	13.13 a
Elkhaseeb	6.7bc	5.1c	5.9c	12.8b	12.7b	12.7a	19.4a	18.3ab	18.9a	10.3a	9.1a	9.7b	12.4a	12.6 a	12.5a	18.9a	14.5a	16.7a
Elkhaseeb+ NPK	8.3bc	9.7ab	9.0a	13.2 b	12.8b	13.0a	17.7abc	17.8abc	17.8a b	12.5a	13.1a	12.8a b	12.3a	13.1 a	12.7a	13.6a	14.5a	14.1a
Mean	9.4a	7.3b		12.8a	13.7a		17.7a	17.7a		13.7a	11.2 b		12.2a	12.6 a		13.9a	14.5 a	
C.V. %	27.0			19.7			5.5			10.8			4.3			20.8		

Means having the same letter(s) within the same column or row were not significantly different using DMRT at P ≤ 0.05.

As in Table 1 no significant differences in bulb weight were obtained due to set size or fertilizer type. The heaviest bulbs, however, were obtained by Elkhaseeb + urea (88.6 and 80.6 g) and its interaction (96.2 and 82.0 g) with the large set size in both seasons. The reverse was obtained by the combination of Elkhaseeb with NPK (68.5 and 70.9 g) and its interaction (65.5 and 64.7g) with the large set size.

Significant highest yield tons/ha (Table1), however, was obtained by the small set size (40.1 and 46.0 tons/ha) and the combination of Elkhaseeb + urea (44.3 and 45.0 tons/ha) and Elkhaseeb alone (38.3 and 45.1 tons/ha) and their interactions (51.2 and 52.5 tons/ha) in both seasons. No significant effect on yield due to other fertilizer types and their interactions with set size were noticed. However, the lowest yield (24.5 and 30.7 tons/ha) was obtained with large set size with urea alone in both seasons.

It was clear that the response of small set size to fertilizer combination (Elkhaseeb + urea) was reflected as higher yield than that of large set size. The highest yields, however, were obtained by small set size with Elkhaseeb alone and in combination with urea compared to other fertilizers. Similar results were obtained by [12] who found that the response of set size 1.1 – 2.0 cm to fertilizer was higher, showed better growth and gave the best yield of many cultivars. [13] and [7] also reported that small set size (1.5 – 2.0 cm) gave the highest bulb yield and quality.

Moreover, [14], [9] and [10] reported high onion yield with fertilizer combination (organic + nitrogen) compared to single fertilizer.

Bulb Quality

Marketable Bulb Yield

Using small set size (Table 2) resulted in significant increases in marketable bulb yield (9.4 and 13.7 tons/ha) compared to large set size (7.3 and 11.2 tons/ha) in both season, respectively. The highest significant marketable yield were obtained with urea (10.8 and 15.5 tons/ha) in both season, whereas, Elkhaseeb alone gave the lowest marketable yield in both season (5.9 and 9.7 tons/ha, respectively). Moreover, the highest marketable yield (13.1 and 17.5 tons/ha) were obtained by small set size with urea alone, the lowest marketable yield was obtained by large set size with Elkhaseeb alone (5.1 and 9.1 tons/ha) in both season.

As shown in (Table 2) the onion quality was also affected by set size and fertilizer type as the highest marketable yield was obtained by small set size and fertilizer combination (Elkhaseeb + urea) or urea alone. Similarly, [8] reported that the application of nitrogen with farmyard manure gave the highest marketable yield.

Percentage of Total Soluble Solids (TSS) and Dry Matter Percentage:

The results (Table 2) reflected no significant differences in total soluble solids due to set size, fertilizer type and their interactions in both seasons. The highest significant TSS, however, was obtained with the interaction of small set with urea and Elkhaseeb combination in the first season. Moreover, none significant effects on bulb dry matter percentage due to set size, fertilizer type and their interactions were noticed in both seasons. However, the highest dry matter percentage was obtained with the interactions of small set with Elkhaseeb alone in both seasons.

Nevertheless, application of Elkhaseeb alone or with minerals fertilizers and small set increased the bulb TSS and dry matter percentage. This result confirmed by the results of [15], [13] and [16] who reported that the highest bulb quality was obtained by medium set size. [17], and [18] reported that higher doses of nitrogen and medium set size increased onion dry matter. Moreover, [19], [20], [21], and [22] reported high bulbs dry matter with a combination of NPK alone or with organic fertilizer. It could be concluded that small set size (1-2 cm diameter) with an organic- mineral fertilizers combination could improve off-season onion yield and quality.

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