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Effects of Sowing Dates and Seed Rates on Sets Yield and Quality of the Red Onion (*Allium cepa*) cv. 'Saggai Improved'

Abdalla H. Nourai, Khadiga A.B. Hassan and Huda A.M. Musa

Shambat Research Station, Agricultural Research Corporation, P.O. Box 30, Khartoum North, Sudan

Abstract: An experiment was conducted at Shambat Research Station, Khartoum North for two growing seasons (2003/4 and 2004/5) to investigate the effects of three sowing dates (15 Dec., 15 Jan. and 15 Feb.) and five seed rates (90, 100, 110, 120 and 130 kg ha^{-1}) on the yield and quality of the sets of red onion cultivar "Saggai Improved" .The first season gave the best vegetative growth, high total number and weight of sets ha^{-1} as well as improved set quality. High levels of seed rates increased the total number of sets ha^{-1} in the first season, while they had no effect on growth attributes and size grades per m^{-2}. However average set weight decreased when high levels of seed rates were used. Early planting date (15 Dec.) resulted in better plant growth as reflected in increased leaf number $plant^{-1}$, fresh and dry weight of sets and total fresh and dry weight. Significant increases in the total number and weight of sets ha^{-1}, improved set quality and set weight due to early planting were also realized.

Key Words: onion sets; *Allium cepa;* sowing date; seed rate.

INTRODUCTION

Onion is a very important vegetable crop all over the world. In the Sudan, it ranks first among the vegetable crops in area grown and quantities produced. In the Sudan, onion is produced predominantly in the winter season from transplants.

Intensive research on onion crop was carried out at in the Sudan. The research concentrated mainly on crop improvement and management practices of transplanted onion and seed production (Nourai 1984; El-Hilo

and Nourai 1988a, 1988b; Hersi 2000 and Mohamedali 2007). Research in the future should be directed to the production of directly sown onion, particularly after the involvement of big agricultural companies in production .For instance, onion production from sets for the production of green onion for use in salad consumption and dry bulbs for fresh consumption.

An alternative production method for onion production is using onion sets. Onion sets are small, dry onion bulbs of 2-3 g fresh weight and less than 25 mm diameter. They are produced by growing a crop from seeds sown at very high density of 1000-2000 plants m^{-2}. The post- dormant sets can start growth very fast and produce stronger plants at emergence than seeds (Brewster 1994; Bosch Serra and Currah 2002).

The main advantages of production of onion from sets include easiness of storage, handling and planting. Moreover, earliness and consequently off-season production which fetches high prices. On the other hand, the disadvantages include contamination of sets with soil-borne pests and diseases, *e.g*., stem and bulb eelworm (*Ditylenchus dipsaci*), onion white rot (*Sclerotium cepivorum*), and virus diseases particularly yellow dwarf virus (Brewster 1990 and Walkely 1990). In addition, the disadvantages include poor quality due to high incidence of doubles, splits and bolters (Nourai 1992 and Nourai 1993), and high cost of production of onion from sets as the production of onion from sets involves two steps; first production of sets and their storage and second, production of onion from sets.

Production of onion from sets is practiced by few farmers in "Naher El-Neel", Northern and Darfour States and for the production of early onion in some other areas of production. The technology of onion production from sets is a specialized industry practiced on large scale in Western Europe, U.S.A, Canada and Egypt (Brewster 1990).

In Sudan the research on onion sets is meagre. It started in the early eighties and nineties of the last century (Mohamedali 1981; Nourai 1992 and Nourai 1993).

The present study was undertaken to investigate the effects of sowing date and seed rate on yield and quality of onion sets using the red onion cultivar " Saggai Improved".

MATERALS AND METHODS

An experiment was conducted for two consecutive seasons (2003/4 and 2004/5) at Shambat Research Station (Lat.15^{o}39′ N, Long. 32^{o} 32′ E. and 381 m above sea level). The treatments comprised three planting dates (15 Dec., 15 Jan. and 15 Feb.) and five seed rates (90, 100,110, 120 and 130 kg ha^{-1}). A split - plot design was adopted where the planting dates were assigned to the main plots and seed rates to the sub - plots.

Seeds were broadcasted evenly in flat plots with a net area of 8 m^{2} in 2003/4 and 6.89 m^{2} in 2004/5 seasons. Then the seeds were mixed thoroughly with the soil by a rake. Nitrogen fertilizer, in the form of urea at a rate of 43 kg N ha,$^{-1}$ was applied in two equal doses; at approximately 4 and 8 weeks after seed sowing. Irrigation, weeding and pest control were applied as recommended for the crop (El Hilo and Nourai 1988).

Before the signs of sets' maturity (bulb neck fall) and while the leaves were still green (three months after planting), 20 plants were selected randomly from each plot for the determination of leaf number plant^{-1}. The plants were then cut into leaves and set for the determination of the fresh weight of leaves, sets and their total fresh weight .Then the leaves and sets were oven dried at 80°C for 48 hours in order to assess the dry weight of leaves, sets and their total dry weight.

Two weeks after the last irrigation, an area of one m^{2} was randomly harvested from each plot and was kept in plastic netted sacks for the determination of the number and weight of sets m^{-2}. Then the harvested plants were taken to an open place for curing. After that, the foliage was cut off. The sets m^{-2} were graded into small (bulb diameter ≤1.0 cm), medium (bulb diamter1.1-≤2.0 cm) and large (bulb diameter> 2.0 cm). Off - types and physically injured sets were sorted out.

The rest of the plot was harvested separately and after complete dryness and removal of leaves and roots the number of sets was counted and

weighed. The sample number and weight and the number and weight of sets harvested from the one m^{-2} were then added to the number and weight of sets of the remainder of the plot yield to have the total number and weight of sets per plot. Then the total number of sets ha^{-1} and total yield (tons ha^{-1}) were calculated. Average set weight (g) was determined by dividing the total sets weight by the total sets number.

Data collected were analyzed to test the significance of the treatments effects following Fisher's protected LSD at $P \leq 0.05$. (Gomez and Gomez 1984). Means were separated according to Duncan Multiple Range Test (DMRT) at $P \leq 0.05$.

RESULTS

Vegetative growth

There were no significant effects of seed rates on leaf number $plant^{-1}$, sets and leaves fresh and dry weights and their total fresh and dry weights (Tables 1, 2 and 3).

Table 1 shows that the leaf number $plant^{-1}$ recorded in 2003/4 season was significantly different. Planting on 15 Dec. resulted in significant increases in sets fresh and dry weights and total fresh and dry weights (Tables 2 and 3)

Total sets' yield

Total number of sets ha^{-1}: Table 4 shows that the total number of sets ha^{-1} was higher in 2003/4 (7.5 million ha^{-1}) than in 2004/5 season (4.9 millions ha^{-1}); reduction in the total number of sets ha^{-1} of 35 % was recorded in 2004/5.The effects of seed rate on total number of sets ha^{-1} was significantly different in the first season where the total number of sets ha^{-1} increased when higher seed rates were used (Table 4).

The effect of sowing date on the total number of sets ha^{-1} was highly significant ($P \leq 0.001$) in both seasons. Early sowing (15 Dec.) consistently gave higher total number of sets ha^{-1}. An overall reduction percentage of 29% and 89% were obtained for Jan. and Feb. plantings, respectively, compared with the 15 Dec. (Table 4).

Total set weight ha^{-1}: The effect of season on the total set weight ha^{-1} followed the same pattern as their effect on total number of sets ha^{-1}. The

highest set weight of 27.0 tons ha^{-1} was obtained in the first season (Table 5). The effect of seed rates on the total weight of sets ha^{-1}were not significant ($P \leq 0.05$) in both seasons. The effect of sowing date on total weight of sets $ha^{-1}$was significant ($P \leq 0.01$) in both seasons (Table 5). Pronounced reduction in total weight of onion sets was encountered when the sowing date was delayed after 15 Dec. Reductions of 32 % and 87% percent were realized when sets were sown on 15 Jan. and 15 Feb., respectively, as compared to sets planted on 15 Dec. (Table 5).

Sets quality (size distribution)

Number of large, medium and small set m^{-2}: Table 6 shows that the effects of seed rate and sowing dates were significantly different regarding the number of large, medium and small grades of sets m^{-2} for both seasons. The number of all sets' grades were higher when sets were planted on 15 Dec., than when planting was delayed.

Average Set weight: Table 7 indicates that the effect of seed rate and sowing date were significant ($P \leq 0.05$) in the first season, but in the second only sowing date was significant. Set size increased when seed rate was low or when sowing date was on 15 Dec. and 15 Feb.

Table 1. Effect of sowing dates and seed rates on leaf number $plant^{-1}$ during 2003/4and 2004/5 seasons

	Season		Mean
	2003/4	**2004/5**	
Sowing dates (SD)			
15 December	5.7a	4.8a	5.3
15 January	4.7b	4.7a	4.7
15 February	4.8b	4.6a	4.7
Seed rate(kg ha^{-1}) (SR)			
90	5.3a	4.7a	5.0
100	5.1a	4.6a	4.9
110	5.0a	4.7a	4.9
120	5.0a	4.7a	4.9
130	5.0a	4.7a	4.9
SD*SR	N.S	N.S	

- Means followed by the same letter(s) are not significantly different according to DMRT at $P \leq 0.05$.
- NS = Non significant

Table 2. Effect of sowing dates and seed rates on the fresh weight of sets, leaves, and total fresh weight (g) for seasons 2003/4 and 2004/5

	Sets		Mean	Leaves		Mean	Total		Mean
	2003/4	2004/5		2003/4	2004/5		2003/4	2004/5	
Sowing dates (SD)									
15 December	11.2a	4.5a	7.9	3.4a	2.7a	3.1	14.6a	7.1ab	10.9
15 January	5.6 c	5.4a	5.5	2.4a	3.6a	3.0	8.0 c	9.0a	8.5
15 February	8.1b	2.5b	5.3	3.6a	2.6a	3.1	11.7b	5.1b	8.4
Seed rate(kg ha-^{1}) (SR)									
90	9.0a	4.0a	6.5	3.3a	2.7a	3.0	12.2a	6.7a	9.5
100	8.8a	4.6a	6.7	3.5a	3.2a	3.4	12.3a	7.8a	10.1
110	8.4a	4.0a	6.2	3.1a	2.9a	3.0	11.5a	6.9a	9.2
120	7.8a	4.1a	6.0	3.0a	3.0a	3.0	10.9a	7.2a	9.1
130	7.6a	3.9a	5.8	2.7a	2.9a	2.8	10.2a	6.8a	8.5
SD*SR	N.S	N.S		N.S	N.S		N.S	N.S	

- Means followed by the same letter(s) are not significantly different, according to DMRT at $P \leq 0.05$.
- NS = Non significant

Table 3. Effect of sowing date and seed rate on the dry weight of sets, leaves, and total dry weight (g) for seasons 2003/4 and 2004/5

	Sets		Mean	Leaves		Mean	Total		Mean
	2003/4	2004/5		2003/4	20040/5		2003/4	2004/5	
Sowing dates (SD)									
15December	1.7a	0.7a	1.2	0.7a	0.4a	0.6	2.4a	1.1a	1.8
15 January	0.8b	0.9a	0.9	0.5a	0.5a	0.5	1.3b	1.3a	1.3
15 February	1.3a	0.4b	0.9	0.6a	0.3a	0.5	1.9ab	0.7a	1.3
Seed rate(kg ha^{-1}) (SR)									
90	1.4a	0.6a	1.0	0.7a	0.4a	0.6	2.1a	1.0a	1.6
100	1.3a	0.7a	1.0	0.6a	0.4a	0.5	1.9a	1.1a	1.5
110	1.2a	0.6a	0.9	0.6a	0.3a	0.5	1.9a	1.0a	1.5
120	1.0a	0.6a	0.8	0.6a	0.4a	0.5	1.6a	1.0a	1.3
130	1.2a	0.6a	0.9	0.5a	0.4a	0.5	1.8a	1.0a	1.4
SD*SR	N.S	N.S		N.S	N.S		N.S	N.S	

- Means followed by the same letter(s) are not significantly different, according to DMRT at $P \leq 0.05$.
- NS= Non significant

Table 4. Effect of sowing dates and seed rates on total number of sets ha^{-1} for seasons 2003/4 and 2004/5

	Seasons		Mean	Change(%)
	2003/4	2004/5		
Sowing dates (SD)				
15 December	12.4a	8.2a	10.3	-
15 January	8.9a	5.7b	7.3	-29
15 February	1.4b	0.8	1.1	-89
Seed rates (kg ha^{-1}) (SR)				
90	6.3c	4.5a	5.4	-
100	7.0bc	3.8ab	5.4	-
110	7.8abc	5.1a	6.5	20
120	9.0a	3.5ab	6.3	17
130	7.5abc	5.4a	6.5	20
SD*SR	N.S	N.S		
Season mean	7.5	4.9		
Change (%)	-	-35		

- Means followed by the same letter(s) are not significantly different, according to DMRT at $P \leq 0.05$.
- NS= Non significant

Table 5. Effect of sowing dates and seed rates on total weight of sets ha^{-1} for 2003/4 and 2004/5 seasons

	Seasons		Mean	Change (%)
	2003/4	2004/5		
Sowing dates(SD)				
15 December	27.0a	17.3a	22.2	-
15 January	14.7b	15.4a	15.1	-32
15 February	3.9c	1.6 b	2.8	-87
Seed rates (kg ha^{-1}) (SR)				
90	15.0a	11.0a	13.0	-
100	15.2a	10.0a	12.6	-3
110	16.5a	12.0a	14.3	10
120	14.7a	11.4a	13.1	1
130	14.5a	12.8a	13.7	5
SD*SR	N.S	N.S		
Season mean	15.2	11.4		
Change (%)	-	-25		

- Means followed by the same letter(s) are not significantly different, according to DMRT at $P \leq 0.05$.
- NS= Non significant

Table 6. Effect of sowing dates and seed rates on size distributions number of large, medium, and small sets m^{-2} for seasons 2003/4 and 2004/5

	Large		Mean	Medium		Mean	Small		Mean
	2003/4	**2004/5**		**2003/4**	**2004/5**		**2003/4**	**2004/5**	
Sowing dates(SD)									
15 December	155.4a	78.1b	116.8	773.1a	373.4 a	573.3	260.4a	415.0a	33.7
15 January	48.9b	107.4a	78.2	563.6a	283.1 a	423.4	224.3a	290.5a	257.4
15 February	36.0b	12.6c	24.3	53.6 b	38.4 b	46	27.3b	56.4b	41.9
Seed rate(kg ha^{-1})(SR)									
90	94.4ab	68.8b	81.6	367.6b	167.9a	267.8	123.3b	205.2ab	164.3
100	85.3b	92.0a	88.7	450.6ab	161.5a	306.1	131.5b	110.6b	121.1
110	98.7a	59.4b	79.1	500.0ab	295.1b	397.6	146.9b	249.8a	198.4
120	59.3c	61.1b	60.2	522.1a	220.2b	371.2	280.8a	340.2a	310.5
130	62.8c	48.7b	55.8	476.8ab	313.4b	395.1	171.2b	364.0a	267.6
SD*SR	N.S	N.S		N.S	N.S		N.S	N.S	

- Means followed by the same letter(s) are not significantly different, according to DMRT at $P \leq 0.05$
- NS= Non significant

Table 7. Effect of sowing dates and seed rates on average set weight (g) for 2003/4 and 2004/5 seasons

	Seasons		Mean	Change (%)
	2003/4	2004/5		
Sowing dates(SD)				
15 December	2.3b	1.9b	2.1	-
15 January	1.9b	3.4a	2.7	-32
15 February	3.2a	2.2b	2.7	-87
Seed rates (kg ha^{-1})(SR)				
90	3.0a	2.4a	2.4	-
100	2.5a	3.5a	3.5	-3
110	2.1ab	2.1a	2.1	10
120	2.0ab	2.2a	2.1	1
130	2.6a	2.2a	2.4	5
SD*SR	N.S	N.S		

- Means followed by the same letter(s) are not significantly different, according to DMRT at P ≤0.05.
- NS= Non significant

DISCUSSION

The results reported above indicated that the total number and weight of onion sets ha^{-1} were higher in the first season than in the second season. The seasonal variation in set yield and quality could be attributed to temperatures prevailing during the growing season. High onion sets yield and improved set quality were realized when temperatures prevailing during the growing season were cooler.

The high seed rates increased the total number of sets ha^{-1} only in the first season. However, there was no significant effect of seed rate on growth parameters and quality of onion sets. The failure to detect differences between the seed rates on growth attributes and set quality might have been due to small increments in seed rates used which agrees with the finding of Hersi (2000) who found that increasing seed rate from 60 kg ha^{-1} up to 180 kg ha^{-1} resulted in a reduction in the total yield of sets, size of sets, average set weight, yield of large and extra large sets and the yield

of small sets. Yield of medium sets was significantly higher with seed rate of 120 kg ha^{-1} than the other seed rates.

Marked increases in growth attributes, set yield and improved set quality were detected when onion sets were sown on 15 Dec. The high set yield and improved set quality, realized from early set sowing, were associated with increased leaf number $plant^{-1}$, fresh and dry set weight and total fresh and dry weight. Increases in onion set yield due to early sowing were in accordance with the findings of El-Gammal and Ahmed (1971) and Cheema *et al.* (2003), who reported increases in set yield due to early sowing. Early sowing has been reported to increase the yield of transplanted onion (Mohamed 1987; Nourai 2005) and garlic (Nourai 2004). The early sowing was subjected to cool temperatures which induced vigorous vegetative growth with large leaf area, while the late sowing was subjected to shorter cool period which was not sufficient to stimulate and enhance vegetative growth. It is well known that onion plants require short days and cool temperature in the early stages of crop establishment to enhance vigorous vegetative growth prior to the onset of warm temperature and longer days later in the growing season which promote bulbing (Jones and Mann 1963).

CONCLUSION

Conclusions of the experiment were:

1. Seed rate effects is not significant regard all growth parameters of onion sets.
2. Sowing on15 December results in significant increases in leaf number plant,$^{-1}$ fresh and dry set weight and total fresh and dry weight.
3. High seed rate (130 kg ha^{-1}) increases total number of sets ha^{-1} and number and weight of small – sized sets m^{-2}.
4. High total number and weight of large, medium and small sized grades results when sowing for onion sets is on 15 December.
5. Average set weight increases with low levels of seed rates or when sowing for set production is on 15 of December.
6. There is no significant interaction between seed rate and sowing date for all parameters tested except for the small set size weight m^{-2} in the second season.

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تأثير مواعيد الزراعة ومعدلات البذر على إنتاجية ونوعية بصيلات صنف البصل الأحمر "سقاي محسن"

عبدالله حسين نوراي ، خديجة عبد الله بخيت حسن
وهدى على محمد موسى

هيئة البحوث الزراعية ، محطة بحوث شمبات ، ص. ب. 30
الخرطوم بحري ، السودان

المستخلص: أجريت تجربة بالمزرعة التجريبية بمحطة بحوث شمبات ، بحري لموسمين متتاليين (2004/2003 و 2005/2004) بهدف دراسة تأثير ثلاثة مواعيد للزراعة (15 ديسمبر و 15 يناير و 15 فبراير) وخمسة معدلات بذر (130 و 120 و 110 و100 و 90 كجم للهكتار) على إنتاجية ونوعية البصيلات للصنف الأحمر "سقاي محسن" . أعطى الموسم الأول أفضل نمو خضري وأعلى عدد ووزن كلي للبصيلات للهكتار؛ كما أعطي أحسّن نوعية للبصيلات . زاد أعلى معدل بذر العدد الكلي للبصيلات للهكتار في الموسم الأول بينما لم يظهر تأثير على سمات النمو والأحجام الكبيرة ، المتوسطة والصغيرة للبصيلات في المتر المربع . ومع ذلك نقص وزن البصيله مع أعلى معدل بذر . أدت الزراعه المبكره (15 ديسمبر) إلى أفضل نمو خضري وإنعكس ذلك فى زيادة عدد الأوراق للنبات الواحد ، والوزن الجاف والرطب للبصيلات والوزن الكلي الرطب والجاف . هناك زياده معنوية في العدد والوزن الكلي للبصيلات للهكتار وتحسّن نوعيه ووزن البصيله بسبب الزراعه المبكره .