Effect of Plant Population Densities on Yield and Quality of White Dehydration Onion in the Northern Sudan

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Abstract

Field experiment were conducted at Hudeiba Research Station in the arid region of Northern Sudan during the three seasons: 1985-86, 1986-87 and 1987-88 to evaluate the effects of two plant population densities on yield and quality of three newly developed white dehydration onion varieties.

Results indicated that the three varieties were not significantly different (P= 0.05) in their total bulb yields in the three seasons. Closer in-row spacing of 5 cm consistently gave higher total bulb yield due to the increased plant population per unit area with a mean yield advantage of 19% compared to the wider in-row spacing of 10 cm. The varieties were comparable in their quality characteristics. However, 'Hudeiba White' consistently had small sized bulbs, and 'ElHilo' had less tendency for premature bolting. Wider in-row spacing gave larger bulbs. Interaction of variety X spacing consistently had no significant effects (P=0.05) on total bulb yield in the three seasons.

Introduction

Onion (*Allium cepa* L.) is the most important vegetable crop in the Sudan. An estimated area of 84000 ha is planted annually, primarily as a winter crop during September-May for fresh consumption, dehydration and a limited fresh market export. The marked seasonality of production and bulkiness of the produce render onions particularly suited for dehydration. In Sudan, onion dehydration industry dates back to 1965 when an onion dehydration factory was established at Kassala, a famous onion region in eastern Sudan.

The popular onion varieties grown in Sudan are red or reddish-brown in color with undesirable red pigmentation in the skin and flesh that lead to an inferior brownish dried product (Abdulla, 1965). At the early stages, the dehydration industry was dependent on onion introductions which were evaluated by several workers (Abdulla, 1965; ElHilo, 1976; Mohamedali, 1978). Later, local varieties were developed to replace the introductions (ElHilo, 1976; Mohamedai and Shafie, 1987; Mohamedali and ElHilo, 1987).

Onions for dehydration should possess a host of quality characters, viz., high dry matter content of more than 15%, high pungency, easily peeled bulbs, white colored flesh, preferably globe to deep globe shape to reduce trimming losses, good storability to help extend the dehydration season and reducing sugars not exceeding 3.5% on fresh weight basis, as high reducing sugars increase the tendency of browning of the dehydrated product (Abdulla, 1965; 1968). However, dry matter, pungency and storability characters are known to be positively correlated and in breeding programs,

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the three characters are tackled simultaneously (Jones and Bisson, 1934; Kehr, 1952; Foskett, 1949; Hanaoka and Ito, 1957; Toul and Pospisilova, 1966).

On the other hand, the two characters, dry matter content and bulb size are negatively correlated (McCollum, 1968; Mohamedali, 1977). Consequently, breeding onions high in dry matter for dehydration, often results in selecting medium-sized to small-sized bulbs, e. g. the leading two American dehydration varities 'White Creole' and 'Southport White Globe; the former a small-sized variety and the latter is a medium-sized one, both known to be high in dry matter content (>15%). In such medium and small-sized varieties manipulation of plant densities is critical and often high plant population densities are practised to compensate for the reduced bulb size to achieve high yields per unit area.

The study reported here is intended to study the effect of different plant population densities on the yield and quality characteristics of three newly developed white dehydration varieties.

Materials and Methods

The experiments were conducted at Hudeiba Research Station (Lat. 17°34′N, long. 33°56′E and elevation 350m) in the arid region of Northern Sudan during 1985-86, 1986-87 and 1987-88 seasons. Soils at Hudeiba are heavy clay, with some properties as indicated in Table 1. Three newly developed white dehydration varieties; 'El Hilo', 'Nasi High Globe' and 'Hudeiba White' were evaluated for yield and quality attributes under two in-row spacings of 5 and 10 cm, on ridges 60 cm apart planting on both sides of the ridge giving theoretical plant populations of 333000 and 666000 plants per hectare, respectively. The factorial treatments were arranged in a split-plot design replicated three times in 1985-86 and four times in 1986-87 season with the varieties in the main plots and the in-row spaces in the subplots. However, in 1987-88 season a randomized complete block design of four replicates was used. The experimental unit consisted of three ridges each of a net planting length of six meters.

The onion seedlings were usually raised in outdoor nurseries during the last week of September and field transplanted during the third week of December. Nitrogen fertilizer in the form of urea was applied' at the rate of 86 kg/ha in two equal broadcast doses, one and. two months after transplanting. The plots were irrigated every 7 -10 days and weeds and thrips infestation were kept at the lowest possible levels. Final plant. counts revealed that number per unit area was very well in agreement with. the theoretical plant population densities.

The onions. were usually harvested at full maturity during the second week of May, cured for 3-7 days, tops cut off and. sorted out into sound bulbs, doubles and bolters which were counted and weighed. The dry matter content of the bulbs was assessed after harvest, a random sample of five bulbs from each treatment was taken, the bulbs fresh weight was recorded, then the bulbs were chopped to small pieces and oven dried at 60°C to a constant weight.. The percent dry matter was calculated as : dry weight/fresh weight x 100. The collected. data was statistically analyzed where deemed necessary.

Results and Discussion

Total Bulb Yield:

Data on total bulb yield as affected by variety and in-row spacings are presented in Table 2. Yields varied from one season to another. Yields were highest during the 1986-87, intermediate in 1985-86 and lowest during 1987-88. Statistical analysis indicated that differences among the varieties were nonsignificant (P=0.05) in each of the three seasons, however, variety 'ElHilo' consistently out yielded the others.

As for the plant population densities, the two in-row spacings gave significantly different (P=0.05) total bulb yields in 1985-86 season. Such differences were nonsignificant (P=0.05) in the two other seasons; however, closer in-row spacing of 5 cm in both. seasons gave higher total bulb yield compared to the wider in-row spacing of 10 cm. Increases in yield due to closer over wider spacing amounted to 42, 11 and 7% for the three seasons 1985-86, 1986-87 and 1987-88 seasons, respectively. Similar findings were reported by Nourai (1988) indicating that high yields of the variety 'ElHilo' were obtained with closer in-row spacing. of 5 cm compared to 10 and 15 cm. He realized yield increases of 15 and 24% with 5 cm in-row spacing compared to 10 and 15 cm, respectively. The .yield increase with closer in-row spacing is attributed to the increased number of plants per unit area.

Calculated average total dry matter yield indicated that the . three varieties were comparable, however, closer in-row spacing of 5 cm gave a higher total dry matter yield of 13% increase compared to the wider 10 cm in-row spacing.

Quality Attributes:

Average Bulb Weight:

Data summarized for different quality attributes presented in Table 3, indicated that the three varieties were of comparable with average bulb weight. However, the variety 'Hudeiba White' consistently had smaller bulb size compared to either of the other .two varieties. The varieties had medium to small-sized bulbs. This is related to the fact that they were exclusively high dry. matter selections for dehydration (Mohamedali and ElHilo, 1987); therefore, reduction in bulb size is expected (McCollum, 1968; Mohamedali, 1977).

Comparing the average bulb weight under the two in-row spacings reveals that, generally, wider spacing gave larger bulbs. These results are in agreement with the findings of Nourai (1988) who reported progressive shift to smaller bulb size with increased plant populations.

Percentages of Doubles and Bolters:

Percentages by weight of doubles and bolters,' presented in Table 3, indicated that, generally, the incidence of both doubling and bolting of the different varieties was low. These varieties were originally selected with intention to be double-free and resistant to premature bolting (Mohamedali and ElHilo, 1987). Variety 'ElHilo' proved to have low incidence of bolting. The incidence of doubling seemed to decrease with" closer in-row spacing; this trend is in agreement with the findings of Nourai (1988). Also high plant population competition was mentioned to result in smaller bulbs that are less susceptible to bolting (Hassan, 1988).

Dry Matter Content:

The three varieties are high in their dry matter content as evident in Table 3. Consequently, they are equally suitable for dehydration purposes. The mean dry matter percentages of the varieties were 17% for 'EIHilo', 17% for 'Nasi High Globe' and 18% for 'Hudeiba White'. The different in-row spacings seem to have no effect on the dry matter content and so provision of high' fresh total bulb yields would ultimately lead to high total dry matter production and dehydrated product. Results indicated seasonal variation in dry matter content. It was observed that during 1987-88 season when yields were particularly low, the dry matter content of the bulbs of the three varieties was reduced.

In conclusion, the three varieties proved to be comparable in their yield and quality attributes. However, higher yields could be realized by planting at high plant population densities.

Recommendations

1. The three genotypes: ElHilo variety and the two newly developed 'Nasi High Globe' and 'Hudeiba White' are equally suitable for dehydration, yield and quality wise.
2. It is recommended to plant the transplants at an in-row spacing of 5 cm on 60 cm ridges giving a mean yield advantage of 19% compared to the traditionally used in-row spacing of 10 cm.

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Table 1. Chemical and Physical Properties of Soil at Hudeiba Research Station*

Depth (cm)	pH	EC mmho/ cm	CEC me/ 100g	ESP	$CaCO_3$ (%)	N (ppm)	C (%)	Mechanical Sand	Analysis Silt	(%) Clay
0-20	8.2	0.51	50	9	4.0	733	0.41	18	40	42
20-40	8.1	0.55	52	10	3.1	478	0.36	15	41	44

* Anonymous 1983

Table 2. Effect of Variety and in-row Spacing on Total Bulb and Dry Matter Yields during the Seasons 1985-86, 1986-87 and 1987-88 (ton/ha)

Treatment	Season			Average Total Bulb Yield	Average Total Dry Matter Yield
	1985-86	1986-87	1987-88		
Variety:					
ElHilo	22.177	31.677	13.338	22.397	3.807
Nasi HG	21.031	29.763	13.093	21.296	3.620
Hudeiba W	18.693	30.796	12.731	20.740	3.733
SE±	1.155	1.405	0.845		
Sig. Level	NS	NS	NS		
Spacing:					
5 cm	24.229	32.370	13.488	23.362	3.972
10 cm	17.038	29.120	12.619	19.592	3.527
SE±	1.421	1.145	0.690		
Sig. Level		NS	NS		

NS*: Non-significant and significant at P = 0.05, respectively.

Table 3. Effect of variety and in-row spacing on average bulb weight, percentage of doubles, bolters and dry matter during the seasons 1985/87, 1986-87 and 1987-88

Treatment	Average bulb weight (g)	% by weight		% dry Matter
		Doubles	Bolters	
Variety:		1985-86		
ElHilo	60	10	1	18
Nasi HG	62	4	2	17
Hudeiba W	46	1	5	18
Spacing:				
5 cm	57	5	3	18
10 cm	54	5	2	18
Variety:		1986-87		
ElHilo	56	2	6	17
Nasi HG	59	1	16	19
Hudeiba W	54	1	13	18
Spacing:				
5 cm	50	1	12	18
10 cm	62	2	11	18
Variety:		1987-88		
ElHilo	39	5	2	16
Nasi HG	38	2	7	16
Hudeiba W	37	4	9	17
Spacing:				
5 cm	33	1	5	16
10 cm	42	5	7	17