Evaluation of Field Performance and Storage of some Tropical Short-Day Onion (*Allium cepa* L.) Cultivars

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Abstract

The storage of bulbs of onion (*Allium cepa* L.) is very crucial to ensure its availability throughout the year. Experiments were conducted at Sokoine University of Agriculture to evaluate the growth and yield characteristics of some tropical short–day onion cultivars and the storability of their bulbs after harvest. The first experiment in 1994 involved 21 cultivars evaluated for their growth and yield variables. The second experiment, involving six cultivars, was carried out in 1996 and in addition to performance evaluation, the storability of bulbs was investigated. Results showed significant differences among the cultivars in yield, yield components and storability. Granex 429 had the highest yield among cultivars in both trials, but had very poor storability. Serrana and XPH 6074 had long storability and maintained more than 50% of their weight after 5 months of storage. These two cultivars are promising as good sources of genes to incorporate storage traits in other cultivars of onion.

Introduction

The dry onion (*Allium cepa* L.) is one of the world's most important vegetable crops. It is grown in a wide range of climatic conditions, from relatively hot and dry areas to fairly cool and humid zones (Tindall, 1983; Messiaen, 1992). Because of its distinctive pungent flavour, the onion is used almost daily as an essential seasoning for a wide variety of dishes and it is, therefore, a major trading vegetable commodity in all urban and peri-urban centres.

In Tanzania, the dry onion is the most important spice vegetable. The country produces about 56,000 tonnes of the crop per year, and this ranked tenth amongst onion producing countries in Africa (FAO, 2000). The crop is produced almost all over the country from the Southern Highlands through the Central Plateau to the Northern Highlands. Production is mainly for local consumption (Anon., 1991). Two common varieties, Red Creole and Bombay Red, are cultivated in Tanzania.

Low yields are a common experience in onion production in Tanzania. FAO (2000) statistics show that the average yield of onion in the country is about 2.9 t/ha while the world's average stands at 17.7 t/ha. One factor that contributes to low yields is the use of low yielding old varieties. Although high yielding varieties exist, most of them are adapted to the intermediate and long day climatic regions and cannot be grown successfully in Tanzania. The few varieties developed for the tropical short day climate have never been thoroughly tested under Tanzanian conditions.

The relatively constant day length in the tropics is generally favourable for the production of short day onions. However, prevailing high temperatures and relative humidity (RH) have strong influence on bulb formation and storability (Brice *et al.*, 1997). High temperatures, characteristic of many areas in Tanzania, accelerate bulb maturation, resulting in low yields due to small bulb size and high rates of formation of splits and doubles, which are low quality attributes. High RH favours post-harvest bulb sprouting and rots (Brewster, 1994) which further reduce the marketable yield of onions.

Storage of bulbs after harvest is crucial to ensure availability during off-season. Many cultivars do not keep long in ambient storage because they tend to sprout and rot shortly after harvest. Also, due to poor storage facilities, onion breakdown within 2–4 months after harvest is a common phenomenon (Rabinowitch, 1994). Never-theless, storage of some cultivars for more than 6 months under ambient conditions is possible. Kariuki & Kimani (1994) sug-gested that, where possible, selection of long storing cultivars is the best way of improving keeping quality of onions. This study was to evaluate some tropical short-day cultivars for both agronomic performance and post-harvest storage potential in a lowland area in Tanzania.

Materials and methods

Two experiments were conducted at the Horticulture Unit of the Sokoine University of Agriculture, Morogoro, Tanzania, at 525 m.a.s.l., 6^{o} 5' S and 37^{o} 38' E on sandy loam soil, during the periods of May to November (1994 and 1996) which is generally a period following the long rains. Onion seeds of the first experiment were sown in June 1994 and transplanted in July. The 1994 trial consisted of 21 cultivars while for the 1996 trial, six cultivars were evaluated (Table 1). Climatic data for the two experimental periods are shown in Table 2. Seeds for both trials were obtained from the vegetable Gene Bank of the Horticulture Research International, Wellsbourne, United Kingdom.

The onion plants were cultivated in raised beds with each cultivar replicated three times in a randomized complete block design (RCBD).

TABLE 1

Sources and characteristics of onion cultivars used in the study

Name of cultivar	*Seed source/company*	*Bulb colour*	*Bulb storability*
		1994 trial	
1. Agrifound Rose	AF – India	Pink	-
2. Agrifound dk Red	AF – India	Red	-
3. Agrifound lt Red	AF – India	Red	-
4. Arad (H)	Hazera	Light brown	Long
5. Creamgold (int)	Yates	Light brown	Long
6. Creole Red	Peto seed	Red	Long
7. Deko (H)	Hazera	White	Medium
8. Early Red	Hazera	Red	-
9. Galil/Grandstand	Hazera	Straw yellow	Long
10. Gladalan Brown	Yates	Brown	Medium
11. Granex 429	Asgrow	Yellow	Short
12. H – 489	-	-	-
13. Hazera	Hazera	-	-
14. Jenin	Hazera	Brown	Long
15. Perla white	-	-	-
16. Red Creole (control)	Asgrow	Red	Long
17. Red synthetic	Hazera	Dark red	Long
18. Rouge de Tana	Technisen	Red	Long
19. Sivan (H)	Hazera	Pinkish brown	Long
20. Superex (H)	Takii	Yellow/Brown	Medium
21. Texas Grano 438	Asgrow	Yellow	Medium
		1996 trial	
1. Red Creole (control)	Starke Ayres	Red	Long
2. XPH 6074	Asgrow	Red	-
3. Granex 429	Asgrow	Yellow	Short
4. Serrana	Asgrow	Yellow	Long
5. Texas Grano 438	Asgrow	Yellow	Medium
6. Red bone	Asgrow	Red	Long

AF=National Horticultural Research and Development Foundation

TABLE 2

Mean monthly, maximum and minimum temperatures, relative humidity and rainfall for the field station, Sokoine University of Agriculture (Jun-Nov.1994, May-Oct. 1996), and store room temperature and RH .

Month	*Mean max. temp. ^oC*	*Mean min. temp. ^oC*	*Monthly mean temp. ^oC*	*Monthly mean RH (%)*	*Total rainfall (mm)*
1994 field trial					
June	27.6	14.3	20.9	57	8.2
July	27.5	15.2	21.3	48	37.0
August	28.1	15.8	21.9	48	18.7
September	30.1	16.8	23.4	42	5.6
October	31.6	18.5	25.0	46	26.0
November	31.3	19.5	25.4	48	43.5
1996 field trial					
May	28.0	19.9	23.9	68	132.0
June	27.3	16.5	21.9	58	2.0
July	26.7	15.5	21.1	54	Trace
August	27.9	15.7	21.8	49	Trace

September	29.3	17.2	23.2	43	Trace
October	30.0	18.1	24.0	45	Trace
Storage facility					
Nov. 1996	29.0	20.7	24.8	58.0	–
Dec. 1996	28.7	21.1	24.9	60.1	–
Jan. 1997	28.5	21.4	24.9	58.2	–
Feb. 1997	31.6	21.4	26.5	62.0	–
March 1997	32.1	21.3	26.7	63.6	–
April 1997	31.9	21.2	26.5	73.1	–
May 1997	30.7	21.6	26.1	75.3	–

***Source*:** Sokoine University of Agriculture Meteorological Station (Field trials)
Sokoine University of Agriculture Horticulture Unit (Storability trial)

Plots for the 1994 trial were 1.5 m × 1.8 m in beds 22.8 m long and 1.5 m wide with a plant spacing of 25 cm × 15 cm, hence each plot had six rows. There were 11 plots in each bed, and paths 30 cm wide separated the plots in each bed. Two beds made one replication in 1994 trial, with one plot in each replication not planted with the experimental test materials. Harvest area for each plot was 1.0 m × 1.7 m from four centre rows. Manure at the rate of 60 t/ha was incorporated into the beds followed by the application of calcium ammonium nitrate (26% N) at the rate of 200 kg/ha after transplanting. Seedlings were transplanted 52 days after sowing when they were at 4–5 leaf stage. The plants were watered thoroughly every other day using watering cans. Soon after transplanting, wood shavings were applied on the beds as mulch for moisture conservation and suppression of weeds. Emerging weeds were pulled by hand with the aid of a hand shovel.

The plants for the 1996 trial were planted on 1.9 m × 2.7 m plots in beds 18 m long at a spacing of 30 cm × 15 cm (six rows). Each bed was a replicate having six plots with paths 30 cm between plots. Harvest area was 1.5 m × 2.7 m from four centre rows. Seedlings were transplanted at 56 days after sowing. The RCBD with three replications was used as in 1994. The same cultural practices as in the first experiment were adopted.

For both experiments, field assessment of varietal characteristics including number of days to 50% maturity was conducted. Harvesting was done when about 75% top fall-over was reached in each plot. Bulbs of different varieties were characterized with respect to size (weight, diameter, height), marketable yield, number of scales, scale thickness and, especially for 1996 trial, bulb shape, skin and flesh colour, bulb structure (double or single), flavour (pungency) and resistance to damage. Bulbs were characterized according to the method of Currah (1995) (Table 3).

TABLE 3

Description of characteristics and evaluation criteria of onion bulbs

Characteristic	*Description*					*Notes*[a]
Bulb structure	Highly single centred					Slight internal doubling
	Highly double inside					Bulbs cut at middle for visual
	examination					
Bulb shape	Flat, Thick flat, Flat globe, Globe, High globe, Spindle, Cylinder, Flat top					Illustrated bulb shape drawings
	High top, Rhombic, Broad ovate, Broad elliptic, Ovate, Elliptic, Bottle, Pear					
External structure[1]	Single bulb	Doubled bulb	Multiple bulb			
Uniformity of bulb shape	Very uniform	Moderately uniform	Variable			
Bulb skin colour	White	Yellow/Brown	Red			
Intensity of skin colour	Pale	Medium	Intense	Dark and intense		
Flesh colour	White	Green white	Yellow	Red-white	Other	Traverse section of bulbs
Bulb skin number	<1–1	1–2	3–5			

Skin thickness	Thin	Medium	Thick	
Flavour rating/Pungency	Sweet	Moderately pungent	Very pungent	
	Organoleptic (taste/smell) test			
Damage resistance	Easily damaged	Moderately resistant		Very resistant to damage
		Compactness and yield to pressure		
	when pressed in between fingers			

Source: Currah, 1995

[1] Nature of storage organ

[a] Practical application of the original evaluation criteria from Currah, 1995

Bulbs harvested from the 1996 trial were subjected to a storage test. After harvesting, the tops were removed from the bulbs followed by curing of the bulbs for 10–14 days by spreading them on the floor in a storeroom. After the curing period, 50 bulbs were taken from each cultivar for a storage test. The bulbs were placed in perforated polyethylene bags which were laid on the floor in the store room. Daily records of temperature and relative humidity were taken, whose monthly averages are presented in Table 2. The experiment was replicated three times except for two cultivars where the number of bulbs could not allow a requirement of 150 bulbs for three replications. The bulbs were examined for weight loss every 2 weeks. Component weight losses due to rotting, sprouting and respiration were separated. All rotten and sprouted bulbs were removed from the bags each time data were taken and the observation continued for 30 weeks.

Results and discussion

Results for bulb yield, maturity and bulb characteristics for the 1994 trial are presented in Table 4. Marketable yield for the 21 varieties ranged from 7.0 (Hazera 508) to 28.9 t/ha (Texas Grano 438). Other high yielders were Granex 429 (26.3 t/ha), Perla White (24.4 t/ha), Arad (23.3 t/ha) and Gladalan Brown (22.9 t/ha). Performance of the control cultivar Red Creole (11.6 t/ha) was below average. Bulb maturity ranged from 107 days after sowing to 153 days. Deko, Jenin and Creamgold were latest to mature. Earliest maturing varieties included Superex, Early Red and Rouge de Tana. There was wide variability in bulb size. Texas Grano 438 had the largest bulbs with a mean bulb weight of 129.4 g/bulb, while Agrifound Rose had the lowest bulb weight of 39 g/bulb. Highest yield was recorded in Texas Grano 438 due to larger bulbs.

TABLE 4

Bulb yield, maturity and bulb characteristics of the 21 onion cultivars grown in 1994.

Name of cultivar yield (t/ha)	*Marketable 50% maturity*	*Days to weight (g/ bulb)*	*Bulb diameter (mm)*	*Bulb height (mm)*	*Bulb scales*	*No. of thickness (mm)*	*Scale*
Agrifound rose	7.4d	121.3e	39.0i	47.7def	51.7f	7.3de	6.6bc
Agrifound dk red	17.0bc	122.0e	79.6cdefg	59.0abc	58.7def	8.0cd	7.4abc
Agrifound lt red	17.3bc	139.0b	73.1cdefg	53.0bcde	64.7bcdef	7.7de	7.0abc
Arad	23.3ab	128.7d	101.1abc	54.3bcde	78.0ab	7.3de	7.6abc
Creamgold (int)	8.6cd	149.0a	40.9hi	31.7g	80.3a	12.7a	2.6e
Creole red	21.9b	126.3de	97.9abcd	59.0abc	71.0abcd	7.0de	8.6ab
Deko	13.7cd	153.0a	63.2defghi	41.3f	81.7a	9.3bc	4.5d
Early red	11.5cd	111.3g	61.9efghi	54.0bcde	74.0abc	7.0de	7.9abc
Galil/Grandstand	13.0cd	109.3g	68.8defghi	47.0ef	74.0abc	6.3e	7.4abc
Gladalan brown	22.9ab	116.3f	104.3abc	59.0abc	77.7ab	8.0cd	7.4abc
Granex 429	26.3ab	116.3f	112.3ab	63.3a	69.3abcde	7.7de	8.5abc
H – 489	19.7bc	123.3e	88.9bcde	58.7abc	68.7abcde	7.7de	7.8abc
Hazera 508	7.0d	122.0e	56.7fghi	47.0ef	73.0abc	7.0de	6.7bc
Jenin	7.4d	153.0a	55.4fghi	47.3ef	66.0bcde	10.3b	4.6d
Perla White	24.4ab	136.7bc	100.0abc	55.7abcde	72.0abcd	6.7de	8.4abc
Red Creole	11.6cd	122.3e	48.7ghi	50.0cdef	60.7cdef	7.3de	7.3abc
Red synthetic	15.0c	114.7f	72.3cdefgh	50.3cde	73.0abc	6.3e	8.1abc
Rouge de Tana	15.6bc	109.0g	72.3cdefgh	57.7abcd	56.0ef	8.0cd	7.3abc
Sivan	17.4bc	113.7fg	81.5cdef	49.3def	78.3ab	7.7de	6.4cd
Superex	18.5bc	107.0g	95.0bcd	47.7def	64.3bcdef	6.7de	9.1a
Texas Grano 438	28.9a	134.0c	129.4a	62.0ab	77.0ab	7.3de	8.5abc
Mean	16.6	125.20	78.2	52.6	70.0	7.80	7.10

SE ±	2.90	2.23	13.6	3.8	3.3	0.45	0.89
CV %	21.4	2.2	21.3	8.9	10.1	10.5	15.4
Probability	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Means bearing a common letter in a column are not significantly different

Mean separation by Duncan’s New Multiple Range Test (DNMRT; $P \geq 0.05$)

Data for the 1994 season as shown in Table 5 indicate significant and positive correlations between marketable yield with bulb size (diameter) and bulb weight. Average bulb weight and bulb size were also significantly and positively correlated with each other, agreeing with the findings of Mulungu *et al* (1998). Research findings suggest that improvement strategies for yield should be geared at selecting for or improving bulb weight and bulb size. In as much as these components are positively correlated among themselves, improvement of either of them will reflect improvement of the other and will not sacrifice yield through component compensation (Adams, 1967). In 1996, marketable yield was highly correlated with average bulb weight ($r = 0.95$, $P \leq 0.01$). Other correlations in this trial were not significant.

TABLE 5

Phenotypic correlations among the components of yield in onion (1994 growing season)

Variable *1*	*2*	*3*	*4*	*5*	*6*	*7*	
				Correlation coefficient			
1.Marketable yield	–	-0.13	0.96**	0.73**	0.25	-0.34	0.63**
2. Days to 50% maturity		–	-0.18	-0.38	0.24	0.68**	-0.66**
3. Bulb weight (g/bulb)			–	0.74**	0.29	-0.38	0.66**
4. Bulb size (diameter)				–	0.22	-0.55**	0.78**
5. Bulb height					–	0.20	-0.22
6. No. of scales per bulb						–	-0.88**
7. Scale thickness							–

** = P d•0.01
 * = P d•0.05

Another interesting relationship is that obtained between days to maturity and number of bulb scales formed (Table 5). The findings suggest that onion bulb maturity is attained when sufficient number of scales characteristic of the cultivar has been formed. Short day Alliums in the tropics must acquire adequate leaf growth in order to reach large bulb sizes. These stages precede top fall, when the vegetative phase ends and the entire mass of foliage falls to the ground and begins to dry up while the bulb reaches its final size after bulb maturity (Muro, Gil & Lamsfus, 1991). Thus, forma-tion of a certain number of scales is important before maturity. Varieties producing more scales sacrifice scale thickness as indicated by the significant negative correlation ($r = -0.88$, $P \leq 0.01$) between the two variables. This relationship also reflects the negative correlation obtained between days to maturity and scale thickness ($r = -0.66$, $P \leq 0.01$) because the former was positively correlated with number of scales formed.

Although marketable yield was negatively correlated with the number of scales formed, this relationship was statistically not significant (Table 5). However, bulb size (diameter), a component which directly influences bulb yield, was significantly correlated with the number of scales formed. Thus, for bulb size improvement in onion, selection or improvement should be based on fewer or medium number of scales. Bulb weight and bulb size were both significantly positively correlated with scale thickness.

Descriptive bulb characteristics of the cultivars shown in Table 6 indicate that three red cultivars, namely Red Creole, XPH 6074 and Redbone have strong association with red skin colour and pungency. They were all more pungent than brown or yellowish brown cultivars which were either sweet/mild or moderately pungent. In Tanzania and indeed in many other tropical and sub-tropical countries, red, pungent onions are much more preferred than yellow or white, sweet onions (Mulungu *et al.*, 1998; AVRDC, 1993; Mohamedali, 1994; Singh & Rana, 1994; Kimani & Mbatia, 1993; Vimala *et al.*, 1994).

TABLE 6

Bulb characteristics of six onion cultivars used in the 1996 trial

Character	*Cultivar*					
	Red Creole	*XPH 6074*	*Granex 429*	*Serrana*	*Texas Grano*	*Redbone*
Bulb external	Single, few structure	Single	Single	Single	Single	
Bulb internal structure	Highly double inside	Slight internal doubling	Highly single centred	Highly single centred	Highly single centred	Highly single centred
Shape of bulb	Rhombic	Rhombic	Thick flat	High globe, spindle	Globe	
Uniformity	Very uniform	Moderate	Moderate	Variable	Moderate	
Skin colour	Red	Red	Brown	Yellowish brown	Yellowish brown	Red
Flesh colour	Red white	Red white	White	White	White	
Skin colour intensity	Pale	Pale	Intense	Pale	Medium	
Red flesh colour intensity	Outer rings only	Outer rings only	-	-	-	
Skin thickness	Thin	Thin	Thin	Medium	Thin	
Skin number	1 –2	3 – 5	1 – 2	1 – 2	1 – 2	
Flavour rating	Very pungent	Very pungent	Sweet	Moderately pungent	Sweet	
Damage resistance	Very resistant	Very resistant	Low	Moderate	Moderate	Moderate

Bulb yield (marketable) and yield variables for the 1996 trial are shown in Table 7. Yields were generally low with the highest yield of 13.3 t/ha for Granex 429 significantly exceeding all other cultivars including the control. All other cultivars were not significantly ($P \leq 0.05$) different from each other in yield. Granex 429 had high yield partly because of its high bulb weight. Redbone was earliest to mature, reaching 50% bulb maturity at 94 days. Red Creole had comparatively high degree of thick necks (13.4%). Thick neckedness delays maturity and unharvested thick-necked plants prolong management activities, may often be abandoned, and, if harvested, they are not of marketable quality. All these are sources of economic loss.

TABLE 7

Bulb yield and some yield variables of six onion cultivars used in the 1996 trial

Cultivar	*Yield t/ha*	*Bulb size g/bulb*	*Days to 50% bulb maturity*	*Percent thick necks*
Red Creole	4.2	50.7	149.3	13.4
XPH 6074	6.9	54.9	143.3	4.8
Granex 429	13.3	108.7	131.7	1.8
Serrana	3.4	51.7	128.3	0.8
Texas Grano 438	6.7	61.8	146.7	3.9
Redbone	5.5	50.7	93.7	2.3
Mean	6.7	63.1	132.2	5.4
CV %	39.5	24.2	12.5	50.8
$LSD_{0.05}$	4.8	27.8	30.1	5.0

In 1996, all except two cultivars had more than 50% weight loss after 20 weeks (almost 5 months) in storage (Table 8). Granex 429, Redbone and Texas Grano 438 had the most severe weight losses. Two exceptional cultivars, Serrana and XPH 6074, had long storability, retaining more than 50% of their weight after 5 months of storage. AVRDC (1998) recognizes this as a long storage quality. The two varieties retained good storability (more than 50% marketable weight) even beyond 24 weeks (about 6 months) which is an excellent long storage characteristic (Table 8). Up to 30 weeks (7 months) in storage the two varieties still retained about 49% (nearly 50%) of their initial weight and are obviously much better than the control, Red Creole, which had 58.8% bulb weight loss after 20 weeks (5 months) of storage. Texas Grano 438 and Redbone showed comparatively poor storability with more than 50% weight loss after only 14 weeks of storage. High yielding characteristic in Granex 429 was associated with higher rates of bulb weight loss in storage. The lowest yielding cultivar Serrana was among the two cultivars with long keeping quality in storage. Breeders should combine high yield with long storage if we are to develop profitable onion cultivars for farmers and consumers.

TABLE 8

Percent weight loss of six onion bulbs after various storage periods in the 1996 trial

Cultivar	*Percent weight loss*				
	10 wk	*14 wk*	*20 wk*	*24 wk*	*30 wk*
Red Creole	15.0	27.4	58.4	69.8	86.3
XPH 6074	12.4	16.3	25.0	33.7	51.5
Granex 429	31.7	45.2	78.0	83.0	100.0
Serrana	23.6	25.2	32.5	37.9	51.0
Texas Grano 438	45.5	55.7	74.5	80.6	91.4
Redbone	36.2	70.0	85.5	92.2	99.0
Mean	27.4	40.0	59.0	66.2	79.9
SD	3.4	4.3	4.8	4.7	4.5

Rotting, sprouting and respiration are known to be the main causes of storage losses in onions (Brice *et al.*, 1997; Warid Guerero & Loaiza, 1996; Brewster, 1994). Proportionate weight loss shows that rotting was the major cause of loss for Texas Grano 438, Redbone and Granex 429 (Table 9), while respiration (plus evaporation) was the major cause of loss in all the other cultivars at 30 weeks of storage.

TABLE 9

Percent weight loss of six onion cultivars due to rotting after various storage periods (1996 trial)

Cultivar	*Percent weight loss*				
	10 wk	*14 wk*	*20 wk*	*24 wk*	*30 wk*
Red Creole	2.5	2.5	26.1	27.6	30.6
XPH 6074	2.6	3.8	6.6	13.2	17.2
Granex 429	8.5	14.7	38.7	38.7	45.5
Serrana	0	0	8.5	11.9	16.9
Texas Grano 438	23.3	31.6	42.1	46.8	54.4
Redbone	14.8	34.9	48.1	50.5	52.3
Mean	8.6	14.6	28.3	31.4	34.7
SD	2.9	3.7	4.0	3.9	4.2

The results showed that Texas Grano 438 and Redbone were especially susceptible to rotting with 31.6% and 34.9% weight loss, respectively, after only 14 weeks of storage. Serrana and XPH 6074 had relatively low rotting rates and should be considered as sources of genes for improvement of keeping quality. Genetic variability for resistance to rotting should be increased in the materials available for use by breeders. More investigation is, however, required to determine specific pathogens responsible for rotting during storage.

Sprouting was not a major cause of storage loss for the first 5 months of storage (Table 10). Serrana and Texas Grano 438 did not show any appreciable amount of sprouting even after the experimental storage period of 30 weeks. Red Creole was earliest to sprout and it had the highest percentage sprouting after 30 weeks of storage (Table 10). These results suggest that sprouting is not a serious problem in the first 5 months of storage at the prevalent trial temperatures (24.8–26.7 ^{o}C). Many investigators have found that dormancy in onion bulbs at ambient conditions is best maintained at 25 ^{o}C (Brewser, 1994) or 25–30 ^{o}C (Brice *et al.*; 1997).

TABLE 10

Percent weight loss of onion bulbs due to sprouting after various storage periods (1996 trial)

Cultivar	*Percent weight loss*				
	10 wk	*14 wk*	*20 wk*	*24 wk*	*30 wk*
Red Creole	1.3	1.3	2.8	10.4	20.9

XPH 6074	0	0	1.7	1.7	14.7
Granex 429	0	3.2	6.6	10.6	14.7
Serrana	0	0	0	0	2.0
Texas Grano 438	0	0	1.6	3.1	5.1
Redbone	0	6.9	7.8	10.8	10.8
Mean	0.2	1.9	3.4	6.1	11.8
SD	0.7	1.6	1.7	2.1	2.6

Onion bulbs are living organs, and, because they are vegetative, they contain an appreciable amount of water in their succulent tissue. In their dormant state the living cells have a slow rate of respiration. Because it is difficult to separate water loss through respiration and evaporation from outer bulb tissues, respiration and evaporation are usually considered together. Table 11 presents weight loss of the onion bulbs due to respiration and evaporation. On the average, almost as much weight is lost through respiration and evaporation as through rotting. By 30 weeks of storage all cultivars had lost nearly the same weight through respiration/evaporation except XPH 6074 whose weight loss was relatively low. Granex 429 and Texas Grano 438 were especially fast deteriorating through respiration/evaporation processes. It is difficult to tell whether more loss occurs due to respiration or evaporation.

TABLE 11

Respiratory and evaporation weight loss of onion bulbs during various storage periods (1996 trial)

Cultivar	*Percent weight loss*				
	10 wk	*14 wk*	*20 wk*	*24 wk*	*30 wk*
Red Creole	11.2	14.7	29.5	31.8	34.8
XPH 6074	9.8	12.5	16.7	18.8	19.6
Granex 429	23.2	27.3	32.7	33.7	36.9
Serrana	18.2	20.0	24.0	26.0	32.1
Texas Grano 438	22.2	24.1	30.8	30.7	32.0
Redbone	18.6	28.2	29.6	30.9	31.0
Mean	17.2	21.1	27.2	28.2	31.1
SD	2.2	2.4	2.3	2.2	2.3

Conclusion

Results of these trials show that Granex 429 was comparatively a very good yielding variety in both trials. However, it has poor storability and it is not as pungent as the red cultivars. Serrana and XPH 6074, on the other hand, have comparatively very good storability. As far as storability is concerned, rotting seems to be the major cause of loss as respiration/evaporation is not necessarily associated with loss of bulb tissue. It is also important to recommend more investiga-tions on factors associated with long storage characteristics for improvement purposes. Serrana and XPH 6074 look promising as good sources of genes to incorporate good storage traits in other genetic backgrounds. However, their inherently low yielding characteristics necessitate the use of high yielding genotypes in the improvement programme.

Acknowlegement

The authors are grateful to the Franco-Tanzania Horticulture Development Project (FTHDP) for financially supporting this investigation.

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