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CHARACTERISTICS AND STORAGE PERFORMANCE OF EIGHT ONION CULTIVARS

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Abstract

Eight short-day onion cultivars were grown for storability assessment under natural ventilation. The bulbs of the various cultivars had different colours, skin thickness and flavours. They differed in shape and shape uniformity. Physiological weight loss at the end of the 6 months of storage in all the cultivars ranged 35 - 90 per cent. Rots and sprouts were generally low in the red onion bulbs. Sprouting became pronounced when the mean monthly night temperatures fell to 22 °C. All the red bulbs *viz.* Bawku Red, HA-226 and Red Creole showed good storage performance. Belem-IPA-9 with a yellow-brown skin colour also showed good storage performance. Gladalan, Galil, Gladiator and HA-95 exhibited poor storage performance.

Résumé

ABBEY, L., DANQUAH, A-O, KANTON, R. A. L. & OLYMPIO, S. N.: *Caractéristiques et résultats de stockage de huit variétés d'oignon.* Huit variétés d'oignon de court-jour étaient cultivées pour l'évaluation de capacité de stockage sous la ventilation naturelle. Les bulbes de différentes variétés avaient des différentes couleurs, épaisseurs de pelure er saveurs. Ils différaient en forme et en uniformité de forme. La perte de poids physiologique à la fin de six mois de stockage dans tous les variétés variait de 35% et 90%. Pourritures et germes étaient dans l'ensemble faibles dans les bulbes d'oignon rouge. Le germe devenait plus marqué lorsque les températures mensuelles moyennes de nuit tombaient à 22 °C. Tous les bulbes rouges c.-à-d., Bawku Red, HA- 226 et Red Créole montraient de bon résultat de stockage. Belem-IPA-9 avec une couleur de pelure jaune-brune aussi montrait un bon résultat de stockage. Gladalan, Galil, Gladiator et HA- 95 produisaient des pauvres résultats de stockage.

Introduction

In Ghana, the most popular onion (*Allium cepa* L.) cultivar is Bawku Red. Exotic cultivars which are also grown include Early Texas Grano and Red Creole. In 1995, shallots and onion production in the country was 29,000 tonnes covering an area of 1,970 ha (Vordzorgbe, 1997). Generally, onion supply in Ghana does not meet national demand due to the small acreage of production, low yields and seasonal production. As a result, dry onion bulbs are imported annually, thus nullifying its contribution to national earning.

Major factors that affect onion bulbs in storage include time of harvest, type of cultivar, pests and diseases, and atmospheric composition such as oxygen, carbon dioxide, temperature and relative humidity (Kader, 1992; Thompson, 1992; Brewster, 1994; Brice *et al.*, 1997). The adverse effects of these factos could be minimized by the presence of effective protective barrier comprising the outer leaf scales and good management practices during storage (Ladeinde & Hicks, 1988; Brice *et al.*, 1997). Several experiments have shown that dormant onion bulbs have remarkably low rates of

respiration, which increase with time and temperature (Kader, 1992; Thompson, 1992; Brewster, 1994; Brice *et. al.*, 1997). Brewster (1994) explained that bulb storage at warm temperatures, i.e. 25 - 30 °C reduces cytokinin activity that would otherwise increase the activities of gibberellin and auxin as sprouting progresses.

The objective of this study was to evaluate the storage performance of short-day onion cultivars under natural ventilation in a semi-deciduous forest region.

Experiemental

The study was conducted at Crops Research Institute, Kwadaso-Kumasi from March 1997 to February 1998. The location is on latitute 6° 40' N, longitude 1° 40' W and altitude 255 m above sea-level. The plants were grown in a sandy loam (at a depth of 0-20 mm, *p*H = 5.0, total %N = 0.08, K (p.p.m.) = 64.4, P (p.p.m.) = 74.4, %C = 0.90 and % organic matter = 1.55). The average daily temperature and relative humidity for the location are 27.2 °C and 76.1 per cent, respectively. Onion cultivars used for the trials were Belem-IPA-9 (Brazil), Galil [hybrid] (Israel), Gladalan Brown (Australia), Gladiator (Australia), HA-95 [hybrid] (Israel), Red Creole (USA), HA-226 [Hybrid] (Israel) and Bawku Red (Ghana). Seeds were sown on heat-sterilized seed-bed and were transplanted after 5 weeks. The plants were largely rainfed (i.e 634.3 mm rainfall), but were hand-irrigated as and when needed. Recommended agronomic practices were adopted (Sinnadurai, 1992).

Cured onion bulbs from the field were bagged in nets. Each cultivar of between 65 and 162 bulbs was replicated three times and completely randomized by hanging the bagged-bulbs on wooden bars 1-m above the floor of the store. The bulbs were thus subjected to natural ventilation. These were periodically re-randomized to avoid spatial variation within the store. Crib was used for storage. This was made from 1-cm spaced splitted bamboo structure (3.0 × 2.0 × 2.5) m^3 roofed with corrugated iron sheets. The crib is 30 cm high above ground level placed in partial shade provided by the canopies of *Glyricidia* and *Leucaena* spp.

Records were collected on bulb shape and shape variation (NRI recommended scheme), skin and flesh colour (visual observation), skin thickness (using a pair of callipers) and flavour rating (i.e. taste and smell were rated by 20 randomly selected women and men). Data were also collected on weight loss, percentage sprouting and percentage rots. ATP digital apparatus was used to record daily temperature and relative humidity of the store.

Results and discussion

Qualitative characters of onion bulbs

The eight onion cultivars evaluated at harvest showed different degree of internal and external qualities of bulb (Table 1). Apart from Belem-IPA-9, Gladiator and Red Creole cultivars which had moderately uniform bulb shapes, all the bulbs were very uniform, a quality requirement for marketable bulbs. Colour and flavour of the bulbs varied (Table 1). Belem-IPA-9, Galil [H] and Gladalan Brown cultivars produced sweet light yellowish-brown onion bulbs. Although the red skin bulbs showed supremacy in pungency, HA-95 [H] with yellowish-brown skin was also very pungent. This is an indication that light skin bulbs do not necessarily mean poor flavour. Compared with the other cultivars, the local onion, Bawku Red, was found to be moderately pungent with medium (about 0.3 mm) outer skin thickness. However, compiled results of extensive evaluation trials carried out in Asia, South America and Africa by Currah, Green & Orchard (1997) showed differences in cultivar characteristic attributes. These may be attributed to differences in weather conditions and the growing environment, such as soil properties and stress as observed in shallots by Abbey & Fordham (1998), Brewster (1994) and Warid & Loaiza (1996).

Storage performance under natural ventilation

Deterioration of onion bulbs in storage is largely influenced by biological and environmental fac-

TABLE 1
Qualitative characters of nine onion cultivars elevated under rainfwed condition

Cultivar	*Bulb shape*	*Shape variation*	*Colour of bulb*		*Skin thickness*	*Flavour*
			Skin	*Fresh*		
Belem-IPA-9	High globe	Mod. uniform	Y/B	G/W	Medium	Sweet
Galil [H]	Ovate	Very uniform	Y/B	W	Thin	Sweet
Gladalan Brown	Ovate	Very uniform	Y/B	G/W	Thin	Sweet
Gladiator [H]	Ovate	Mod. uniform	Y/B	G/W	Thin	Mod. pungent
HA-95 [H]	Ovate	Very uniform	YB	W	Medium	Very pungent
Red Creole	Flat globe	Mod. uniform	R	R/W	Medium	Very pungent
HA-226 H	Thick flat	Very uniform	R	W	Medium	Very pungent
Bawku Red	Thick flat	Very uniform	R	R/W	Medium	Mod. pungent

NB: Mod. = moderate; Y=yellow; W=white; R=red; G=green

tors. Onion bulbs are living tissues which continuously undergo several metabolic processes, and, therefore, quantity and quality losses between harvest and consumption due to these processes may adversely affect bulb features (Kader, 1992). As a result, the conomic value of the crop could be affected. Among the onion cultivars evaluated, HA-95[H] showed the highest weight loss of 28 per cent within the first month whilst Bawku Red recorded the least, i.e. 9 per cent (Fig. 1). The general trend, however, was

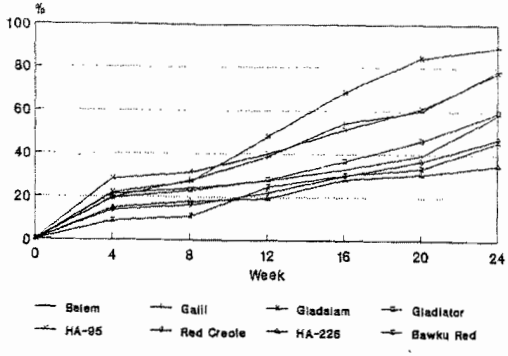

Fig. 1. Mean cumulative physiological weight loss (%) of eight onion cultivars

high rate of physiological weight loss within the first 4 weeks, possibly by transpiration through the dermal system, and the neck and stem regions, before completely sealing to reduce rate of moisture loss at storage. These have been elucidated by Brewster (1994) and Kader (1992). The process of maintaining respiration could also explain the cause of physiological weight loss in stored products (Brewster, 1994; Kader, 1992). Brewster & Rabinowitch (1997) indicated that during onion storage, weight lost through evaporation of water is about 80 per cent, and about 20 per cent through respiration. The differences in water loss resulting in differences in physiological weight loss could possibly be attributed to 1) differences in skin permeability, 2) differences in time of complete sealing of the neck, and 3) differences in cell structure and bulk density (dry matter). These are influenced by the growing environment and genotype (Naito, Yamagudhi & Yokoo, 1981).

During the trial, the mean monthly atmospheric temperature and relative humidity for the first month was 25 °C and 85 per cent, respectively, and 23 °C and 90 per cent in the store. These

translated into 2.8 KPa and 2.5 KPa water vapour pressure (WVP) on a psychometric chart, respec tively. Thompson (1992) explained that the rate of moisture loss from fresh produce is mainly controlled by WVP difference between the intercellular spaces of plant material and the surrounding air. This difference could be the major factor which contributed to the high losses in weights (Fig. 1) within the first 4 weeks of storage. There was relatively consistent rate of physiological weight loss (PWL) after the 4th week until week 20, after which the rate began to increase in all the cultivars except Gladalan Brown and HA-226 [H]. Fig. 1 depicts a sigmoidal weight loss curve in Gladalan Brown. This indicates a reduced PWL rate from week 20 in contrast to the behaviour of the other cultivars. The initial low and consistent PWL rate could be due to environmental response. The higher PWL rates at different levels after the 12th week could be ascribed to environmental × genotypic response.

The highest percentage rots (Fig. 2) was recorded by Gladalan Brown and Galil [H], followed

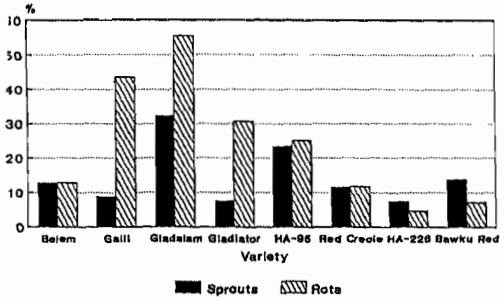

Fig. 2. Percentage sprouts and rots of onions after 6 months of storage

by Gladiator and HA-95[H] cultivars in descending order. Fenwick & Hanley (1990) found that different bulb skin colour contain different amounts of phenolic substances and flavonols, some of which inhibited fungal disease development. The results seem to confirm this finding although phenols were not measured. These cultivars also exhibited poor storage performance due to the high percentage rot. The red onion bulbs used in this study, *viz.* Bawku Red, HA-226 [H] and Red Creole had comparatively lower rot disease problems during storage. Consequently, they showed good storage performance. As observed by Madisa (1994) in a similar trial in Botswana, onion bulb rot was observed earlier (from the 2nd month in storage,i.e. October) than sprouting (observed from the 4th month in storage, i.e. December).

The trial also revealed short dormancy periods in Gladalan Brown and HA-95 [H] (Fig. 2). Cool nights, i.e. 22 °C from December resulted in pronounced sprouting in all the cultivars. This compares favourably with studies by Brewster (1994) which indicated that the rate of sprouting was slower at 5 °C and 30 °C than at intermediate temperatures. Gladalan had the highest percentage sprouting (over 30%), followed by HA-95, Bawku Red, Belem and Red Creole in descending order. Sprouting was low (below 10%) in Galil, Gladiator and HA-266. Magruder *et al.* (1941) observed that ranking onion cultivars based on dormancy duration remains similar when they are grown in a wide range of soils and climates, and stored in a variety of conditions. It is, nevertheless, obvious that dormancy, although is greatly determined by genotype, can be modified by the environment and biotic factors. Deterioration, as measured by the rate of rotting, sprouting and moisture loss, showed a linear increase throughout the 24 weeks in storage (Fig. 3). General deterioration in the storage quality of onion bulbs could be controlled by selection of cultivars with good skin quality, long period of dormacy during storage and good storage technique.

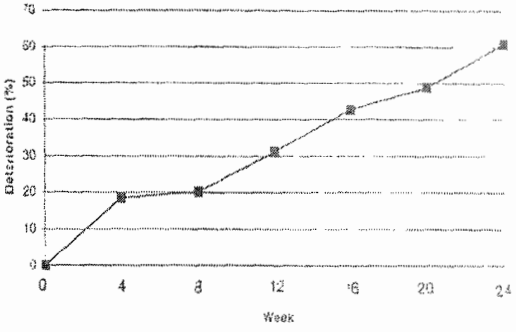

Fig. 3. Time rate of determination (%) in storage

Conclusion

Significant differences in yield and storage potentials among short-day onion cultivars have been found in many international collaborative trials (Currah, Green & Orchard, 1997). Under the conditions of this experiment, Bawku Red cultivar had the most uniform bulb size within the marketable range, and stored well. HA-226 and Red Creole are the other alternatives to the local Bawku Red cultivar. Belem-IPA-9 and Gladiator could be grown for use as salads by virtue of their colour, mild flavour and keeping quality. Studies on appropriate storage technology to improve storage condition will be laudable. The high quality and storage potential of some of the onion cultivars grown under rainfed condition indicate the possibility for all-year round bulb production of selected cultivars. This will reduce foreign exchange expenditure on dry bulb importation to Ghana.

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