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The Effect of High Temperature on Sprouting and Weight Loss of Two Onion Cultivars

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Abstract: Effects of constant temperatures of 15, 25 and 35°C were investigated on storability of two bulb onions (*Allium cepa* L.) cvs. Yellow Sweet Spanish and Azarshahr for a period of 90 days. In both cultivars, sprouting of onion bulb is inhibited at high storage temperatures in comparison with low storage temperatures. In onion cvs. Yellow Sweet Spanish and Azarshahr sprouting decreased from 40.3 and 22.3% at 15°C to 3.4 and 1.2% at 35°C, respectively. In both cultivars, growth rate of sprout leaves reached a maximum at 25°C and then decreased. Weight loss in both onion cultivars, increased with increasing temperature and time in storage. However, weight loss varied between the onion cultivars. Decay of bulbs is another limitation of onion storage. The data indicate that high temperatures promote decay during storage. The results showed that although high temperatures inhibited bulb sprouting but due to weight loss is not suitable for long-term storage.

Key words: Onion bulb, sprouting, storage, temperature

Introduction

Onion bulb (*Allium cepa* L.) is an important vegetable crop grown extensively in many parts of the world for fresh market use and for processing. Onions are usually held for long periods between harvesting and marketing so as to fulfill the market demand. In Iran the main crop of bulb onions is stored in unrefrigerated stores with ambient air temperature (Ramin, 1999). Bulbs from these stores are used to supply the market from September to April but storage beyond this is limited by the availability of cold night air and by the shallow state of physiological rest of bulbs.

Sprouting is the major factor limiting storage life of onion bulbs (Chope *et al*., 2006). Sprouting occurs when the leaf primordia that are produced in stored onion bulbs develop green leaves, rather than scale leaves, which elongate and eventually protrude from the neck of the bulb (Abdalla and Mann, 1963). The growth rate of the sprout inside the bulb varies according to cultivar and storage temperature (Chope *et al*., 2006). Temperature has a profound effect on the dormancy period and storage life of onion bulbs (Komochi, 1990; Ramin, 1999). In general sprouting is inhibited both by low and by high temperatures and encouraged at intermediate temperatures (Brewster, 1987; Miedema, 1994; Ernst *et al*., 1999). Cultivars respond differentially to temperature. The optimum temperature range for sprouting in dry storage is 10-20°C (Gubb and MacTavish, 2002).

Typically, storing onions at 0 to 2°C and 65% relative humidity will minimize storage losses (Miedema, 1994; Ko *et al*., 2002). In this respect, several investigate techniques to extend control of sprouting, thus improving shelf-life and quality attributes of the bulbs. Recently there has been a great

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Table 1: Characteristics of onion cultivars used in this study

Bulb shape	Bulb color	Origin	Cultivars
Globe	Yellow	Spain	Yellow Sweet Spanish
Thick flat	Red	Iran	Azarshahr

interest in the potential benefits of using high temperature conditions for storage of onions. Miedema (1994) showed that in various of onions, 280 days after the beginning of storage at 30°C, none of the cultivars had attained 50% sprouting. Ramin (1999) reported that, sprouting of onion bulb was inhibited at 25 and 30°C as a result of significant reduction in the relative growth rate of sprout leaves within the bulbs, compared with low-temperature storage at 2°C treatment and onions become nearly dormant.

The objective of this study was to investigate the effects of different temperatures on storability and physiological parameter of stored onion bulbs.

Materials and Methods

Two onion cultivars, Yellow Sweet Spanish and Azarshahr were used in the experiment. The characteristics of onion cultivars used in this investigation are shown in Table 1. Onion bulbs freshly harvested and dried in the field for two weeks, were obtained from the local market. Bulbs were selected for uniformity and dry aerial parts were removed and any diseased or damaged bulbs discarded prior to storage. Bulbs of 60-70 mm in diameter were used in the study. For each cultivar 72 samples of 15 bulbs were weighted and placed in plastic net bags and kept in growth cabinet at constant temperatures of 15, 25 and 35°C. Relative humidity was controlled at between 65-75%. Sample of 15 bulbs was randomly removed from each temperature treatment and cultivars were dissected for sprouting. Observation on sprouting percentage and elongation, weight loss and decay were made over 90 days at an interval of 15 days, during the course of the experiment. A bulb was considered sprouted when the sprout leaves had emerged from the neck. Weight losses were determined from the change in the weight compared with that at the beginning of the temperature treatments.

The factorial experiment was arranged in a completely randomized design with four replications. MSTAT-C soft ware was used to analyze the data. The lowest significant difference test (LSD) was used to compare the means.

Results

Sprouting

Data shown in Fig. 1 indicate that the changes in sprouting percentage of onion cvs. Yellow Sweet Spanish and Azarshahr in during three months at constant temperatures of 15, 25 and 35°C. Storage temperature had an effect on the sprouting in onions bulb during storage. Sprouting increased with time in all temperature treatment (Fig. 1 and 2). The sprouting varied between the onion cultivars. Yellow Sweet Spanish cultivar had a higher sprouting at any time and temperature treatment during storage, than did cv. Azarshahr. In 'Yellow Sweet Spanish' sprouting were minimum at 35°C, increased at 25°C and were maximum for 15°C (Fig. 1). At the end of storage period (90 days), total sprouting in 'Yellow Sweet Spanish' stored at 15°C was about twelve times as great as at 35°C (40.3 vs. 3.4%) and 1.59 times as great as the 25°C treatment (40.3 vs. 25.3%) (Fig. 1). Similar results were also observed for cv. Azarshahr (Fig. 2).

Growth rate of sprout leaves

The change in growth rate of sprout leaves was also studied. Growth rate varied between the onion cultivars (Fig. 3 and 4). Yellow Sweet Spanish' had the highest growth rate of sprout leaves at all times during storage (Fig. 3). At all temperatures the elongation rate of the leaves increases with

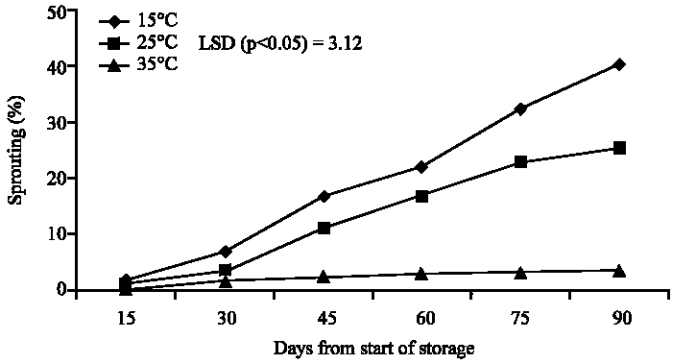

Fig. 1: The effects of temperature on percentage of sprouting in cv. Yellow Sweet Spanish

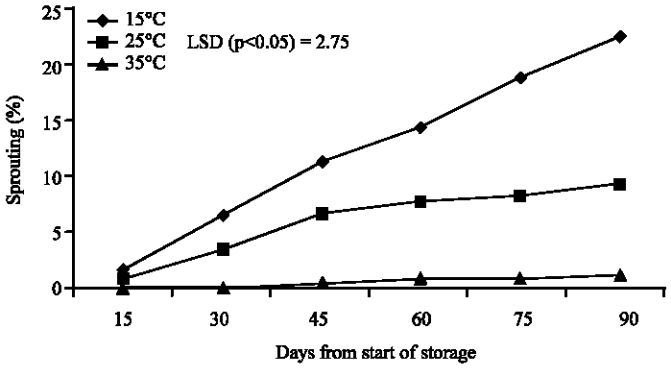

Fig. 2: The effects of temperature on percentage of sprouting in cv. Azarshahr

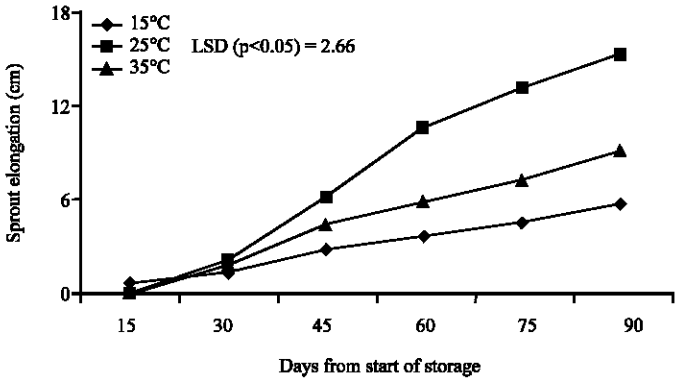

Fig. 3: The effects of temperature on growth rate of sprout leaves in cv. Yellow Sweet Spanish

time. In Yellow Sweet Spanish growth rate of sprout leaves were small at 15°C, increased at higher temperatures. However, at the last of the storage period, Length of sprouted leaves in Yellow Sweet Spanish stored at 25°C was about 1.67 times as great as 35°C (15.4 vs. 9.2 cm) and 2.65 times as great as the 15°C treatment (15.4 vs. 5.8 cm) (Fig. 3). The elongation rate of the leaves in cv. Azarshahr was similar during storage at 15, 25 and 35°C (Fig. 4).

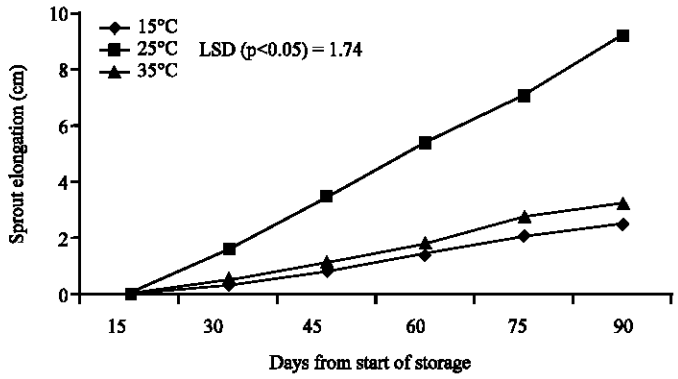

Fig. 4: The effects of temperature on growth rate of sprout leaves in cv. Azarshahr

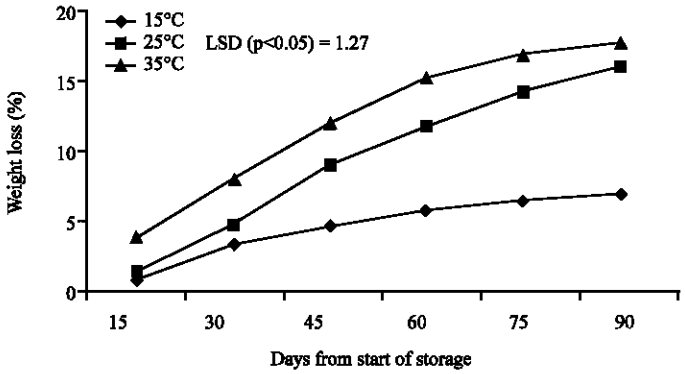

Fig. 5: The effects of temperature on percentage of weight loss in cv. Yellow Sweet Spanish

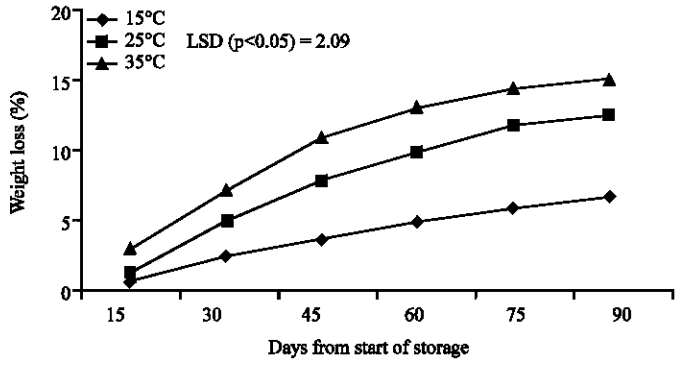

Fig. 6: The effects of temperature on percentage of weight loss in cv. Azarshahr

Weight loss

Weight loss varied between the onion cultivars. The loss of weight increased with temperature. Yellow Sweet Spanish had a higher weight loss at any time and temperature treatment during storage, than did cv, Azarshahr. At the end of storage period, the lowest total weight loss (7.2%) was found

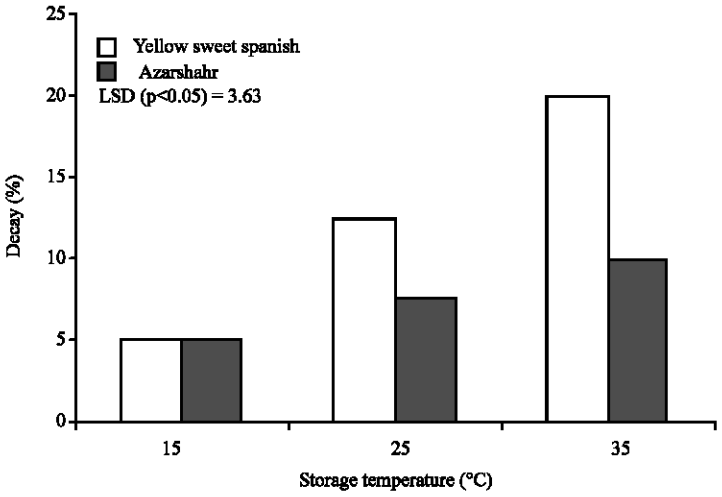

Fig. 7: The effects of temperature on percentage of decay in onions cvs. Yellow Sweet Spanish and Azarshahr during three months storing period

in 15 storage treatment. Weight loss for onions stored at 35 and 25°C were 2.5 and 2.3 times great than for those stored at 15°C, respectively (Fig. 5). Similar results were observed for cv. Azarshahr (Fig. 6).

Decay

Results obtained here showed that high temperature promotes decay during storage. 'Yellow Sweet Spanish' showed a significantly higher percentage of decay than cv. Azarshahr at 25 and 35°C storage temperatures (Fig. 7).

Discussion

Results of this study indicated that the bulb sprouted was significantly reduced by high temperature storage. The highest temperature (35°C) strongly inhibited sprouting and the onions remained dormant when stored continuously at this temperature. Inhibition of sprouting at high storage temperature seems to be a general phenomenon in onion which has been reported for several cultivars (Miedema, 1994). Abdalla and Mann (1963) reported that the visible sprouting of stored bulb is most rapid at temperatures between 10 and 20°C and is delayed by lower temperatures or increases in temperature over the rang 20-30°C. Temperature of 30°C has been shown to delay sprouting in many cultivars of onion from divers regions of origin (Stow, 1975). Ward (1976) also studied sprouting in bulbs stored at constant temperatures of 2, 7.5, 15 and 25°C and found that sprouting increased from 2 to 15°C but was less at 25°C. High temperature may impose a state of inactivity or induce thermodormancy in bulbs as proposed by Miedema and Kamminga (1994) and Ramin (1999). Miedema and Kamminga (1994) reported that the cytokinin levels of bulbs are lower at 30 than at 5 and 15°C. Low metabolic activity of bulbs may be true for onion stored at high temperature. Tanaka *et al*. (1985) used continuous measurements of respiration rate to examine the relationship between dormancy and temperature. The respiration rate at high temperature declined soon after the beginning of storage, compare with that at 15°C. They concluded that the decline in respiration rate at high temperature was resulted from dormancy condition.

In this study weight loss increased with temperature. Increase in weight loss due to high temperature in this study is in agreement with the findings of Ramin (1999). He reported that the weight loss of onion bulbs cvs. Texas Early Grano and Dorcheh were 10% in 65-75% relative humidity at 2°C over 270 days or 0.035% per day, whereas losses in bulb weight for cvs. Texas Early Grano and Dorcheh were 0.16 and 0.116 % per day for the 25°C and 0.285 and 0.196% per day for 30°C for nine months of storage, respectively, under 65-75% relative humidity. Weight loss at high temperatures might be controlled by increasing relative humidity, but relative humidity of 65-75% is reported to be the most sui for storing onions at any temperature (Ramin, 1999).

Present results show that high temperature promotes decay during storage. This result was in agreement with those of Ramin (1999) who pointed out that the numbers of infected onions increased with duration of storage, cultivar and temperature.

References

Abdalla, A.A. and L.K. Mann, 1963. Bud development in the onion (*Allium cepa* L.) and the effect of storage temperature on bulb rest. Hilgardia, 35: 85-112.

Brewster, J.L., 1987. The effect of temperature on the rate of sprout growth and development within stored onion bulbs. Ann. Applied Biol., 111: 463-467.

Chope, G.A., L.A. Terry and P.J. White, 2006. Effect of controlled atmosphere storage on abscisic acid concentration and other biochemical attributes of onion bulbs. Postharvest Biol. Technol., 39: 233-242.

Ernst, M.K., G. Bufler, M. Roske, M. Ritzkowski, C. Metzger and H.P. Liebig, 1999. Cultivar and temperature effects on starch in the primary thickening meristem of onion bulbs. J. Hortic. Sci. Biotechnol., 74: 588-593.

Gubb, I. and H.S. MacTavish, 2002. Onion Pre- and Postharvest Considerations. In: Allium Crop Science: Recent Advances. Rabinowitch, H.D. and L. Currah (Eds.). CABI Publishing, Wallingford, UK, pp: 233-266.

Ko, S.S., W.N. Chang, J.F. Wang, S.J. Cherng and S. Shanmugasundaram, 2002. Storage variability among short-day onion cultivars under high temperature and high relative humidity and its relationship with disease incidence and bulb characteristics. J. Am. Soc. Hortic. Sci., 127: 848-854.

Komochi, S., 1990. Bulb Dormancy and Storage. In: Onions and Allied Crops, I. Botany, Physiology and Genetics. Rabinowitch, H.D. and J.C. Brewster (Eds.). CRC Press, Boca Ratan, Florida, USA, pp: 89-111.

Miedema, P., 1994. Bulb dormancy in onion. I. The effect of temperature and cultivar on sprouting and rooting. J. Hortic. Sci., 69: 29-39.

Miedema, P. and G.C. Kamminga, 1994. Bulb dormancy in onion. II. The role of cytokinine in high-temperature imposed sprout inhibition. J. Hortic. Sci., 69: 41-45.

Ramin, A.A., 1999. Storage potential of bulb onions (*Allium cepa* L.) under high temperatures. J. Hortic. Sci. Biotechnol., 74: 181-186.

Stow, J.R., 1975. Resistance of 20 cultivars of onion (*Allium cepa* L.) to rotting and sprouting during high temperature storage. Exp. Agric., 11: 201-207.

Tanaka, M., K. Chee and S. Komochi, 1985. Studies on the storage of autumn harvested onion bulbs. I. Influence of storage temperature and humidity on the sprouting during storage. Research Bulletin Hokkaido. Nat. Agric. Exp. Station, 141: 1.

Ward, C.M., 1976. The influence of temperature on weight loss from stored bulb due to desiccation, respiration and sprouting. Ann. Applied. Biol., 83: 149-155.