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Effect of set-size and storage temperature on bolting, bulbing and seed yield in two onion cultivars

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ABSTRACT

The effects of three set-sizes (12.5, 17.5 and 22.5 mm in diameter) and seven storage temperatures (0, 5, 10, 15, 20, 25 and 30 °C) on bolting, bulbing and seed yield in two onion (*Allium cepa* L.) cultivars 'Hygro' and 'Delta' were investigated. The incidence of bolting increased linearly with set-size and curvi-linearly with decreasing storage temperature. Time to inflorescence emergence and floret opening showed a curvi-linear response to storage temperature with the earliest inflorescence emergence and floret opening occurring at 5 °C and the latest at 30 °C for 'Hygro' and at 25 °C for 'Delta'. Seed yield per umbel also showed a curvi-linear response to storage temperature with the lowest seed yield occurring at 30 °C for 'Hygro' and at 25 °C for 'Delta' and the highest seed yield at 5 °C. For a seed crop, storage of large sets (22.5 mm) of these cultivars at 5 °C for 120 days appeared to be optimum with 5–12% higher seed yield per umbel than that of 90 days storage. Bulb yield showed a curvi-linear response to storage temperature with the highest bulb yield occurring at 25 °C and the lowest at 5 °C.

1. Introduction

The conventional method of onion seed production is through bulb onions which have the disadvantage that mother-onion bulb storage results in large losses because a significant proportion of onions kept for seed production purpose is wasted due to poor storage conditions. Moreover, bulbs require more space for storage resulting in a requirement for large storage facilities (sets require 10 times less space than large bulbs). Limited storage facilities may further aggravate the situation. Using onion sets rather than onion bulbs could be an economical way of overcoming this because of less space requirement and longer shelf life. For onion seed production most work has been concentrated on the use of bulbs and a little work appears to have been made to obtain a seed crop using sets (Khokhar et al., 2007b,c; Khokhar, 2008a). The production of onion seed and the onion bulb crop have long been, and will continue to be, a highly specialised industry. Both seed and bulb yield in onion depend on a number of factors, the most important of which are bulb/set-size and temperature during the storage period.

Time of flowering may be influenced by the temperature used for cold storage, and by the date of planting (Atkin and Davis, 1954; Aoba, 1960; Jones and Mann, 1963; Demille and Vest, 1976; Hesse et al., 1979; Currah, 1981; Brewster, 1982a,b; Khokhar, 2008a). Most studies on the effects of storage temperature on inflorescence initiation in onion have shown that the optimum temperature for flowering is in a range between 5 and 13 °C and is greatly reduced or suppressed at temperatures in the range of 15.5–30 °C and low temperature of −3 to 0 °C (Jones, 1927; Heath, 1943a; Aoba, 1960; Lackman and Michelson, 1960; Shishido and Saito, 1977; Brewster, 1987; Khokhar et al., 2007a; Khokhar, 2008b). It has been reported that optimum storage duration for flower initiation of onion cultivars at low temperature (3–11 °C) is in the range of 7–90 days (Bertaud, 1988; De Bon and Rhino, 1988; Khokhar et al., 2007c). Furthermore, inflorescence initiation is favoured by large set/bulb size (Holdsworth, 1945; Aura, 1963; Shishido and Saito, 1977; Khokhar, 2008a). Under low storage temperatures (0–7 °C), bulbing is accelerated while high temperatures (18–30 °C) delay bulbing and ripening (Heath, 1943a; Heath et al., 1947; Heath and Holdsworth, 1948; Aura, 1963; Butt, 1968; Aura, 1968).

The temperature at which onion sets are subjected in storage has a significant influence on bulb yield. Low storage temperature (0 °C) leads to the highest bulb yield but this was reduced as the storage temperature was raised from 0 to 5 °C (Thompson, 1934). In general, high temperature storage (above 20 °C) results in increased total bulb yields while very high temperature (25.5–31 °C) or below 0 °C slightly depressed yield by delaying sprouting after planting the bulbs, thus shortening the period available for growth (Heath, 1943a; Blaauw et al., 1941, 1944; Heath et al., 1947; Aura, 1963). On the other hand, storage of sets at mild temperatures (5–15 °C) usually results in lower marketable yields than do lower and higher storage temperatures (Boswell, 1923; Heath, 1943a; Heath, 1945; Heath et al., 1947; Heath and

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Holdsworth, 1948; Aura, 1963; Khokhar et al., 2007c). Many studies have stated that cold storage (about 0 °C) prevents subsequent flowering and improves bulb yield, but leads to crops maturing earlier than those stored at high temperatures (about 25 °C) (Boswell, 1924; Aura, 1963).

Size of set is closely related to subsequent bulb yield and it has been observed that large sets produce greater yields, especially when these are stored at temperatures which prevent floral initiation during storage (Thompson, 1934; Heath, 1943a; Heath et al., 1947; Khokhar, 2008a). Large sets accelerate the onset of bulbing and consequently onset of maturity (Heath and Holdsworth, 1948).

There is a large body of literature describing the effects of set-size and storage temperature on the growth and development of onion. While in the past bolting has been studied in onions raised from sets, no systematic attempt appears to have been made to obtain a seed crop using sets. These studies are limited in scope, comparing only a small range of storage temperatures and set-sizes. The aim of these studies was to determine the optimum set-size and storage temperature both for seed and bulb production in onion using sets. The information on the factors that control inflorescence initiation and development would not only be useful to promote flowering for breeding work and seed production but also be useful in devising techniques to prevent flowering in bulb crops. Bolting and bulbing of onion plants grown from sets is mainly dependent on set-size and the temperature at which the sets are stored before planting. There is a large body of literature describing the effects of set-size and storage temperature on the growth and development of onion. These studies have often analysed treatments using simple analysis of variance. Furthermore, these studies are limited in scope, comparing only a small range of storage temperatures and set-sizes. The present studies provide quantitative relationships on the effects of set-sizes and storage temperatures on bulb and seed yields aspects. The development of these relationships would provide a considerable insight into the diverse effects of storage temperatures and set-sizes on seed and bulb yields. Growers could use these relationships as a tool to adjust storage temperatures and set-sizes and thus manipulate both seed/bulb crop production.

2. Materials and methods

The experiment was aimed to examine the effects of three set-sizes [12.5 mm (small), 17.5 mm (medium), and 22.5 mm (large) diameter] and seven storage temperatures (0, 5, 10, 15, 20, 25 and 30 °C) and two periods of storage (90 days and 120 days) on bulb and seed yield in two onion cultivars, 'Hygro' and 'Delta'. 'Hygro' and 'Delta' are spring-sown long-day (LD) cultivars. Sets of these cultivars were obtained from MAAS Bv. Kruiningen, The Netherlands, by David O' Conner and Associates, Kirton, Boston, UK. Net bags containing 400 sets from each size were allocated to each treatment. These were stored at different temperatures for two periods of 90 days and 120 days using storage facilities available at Department of Horticulture, Earley Gate and the School of Plant Sciences, University of Reading. During storage, net bags were periodically checked to remove rotten sets if any. Very little work

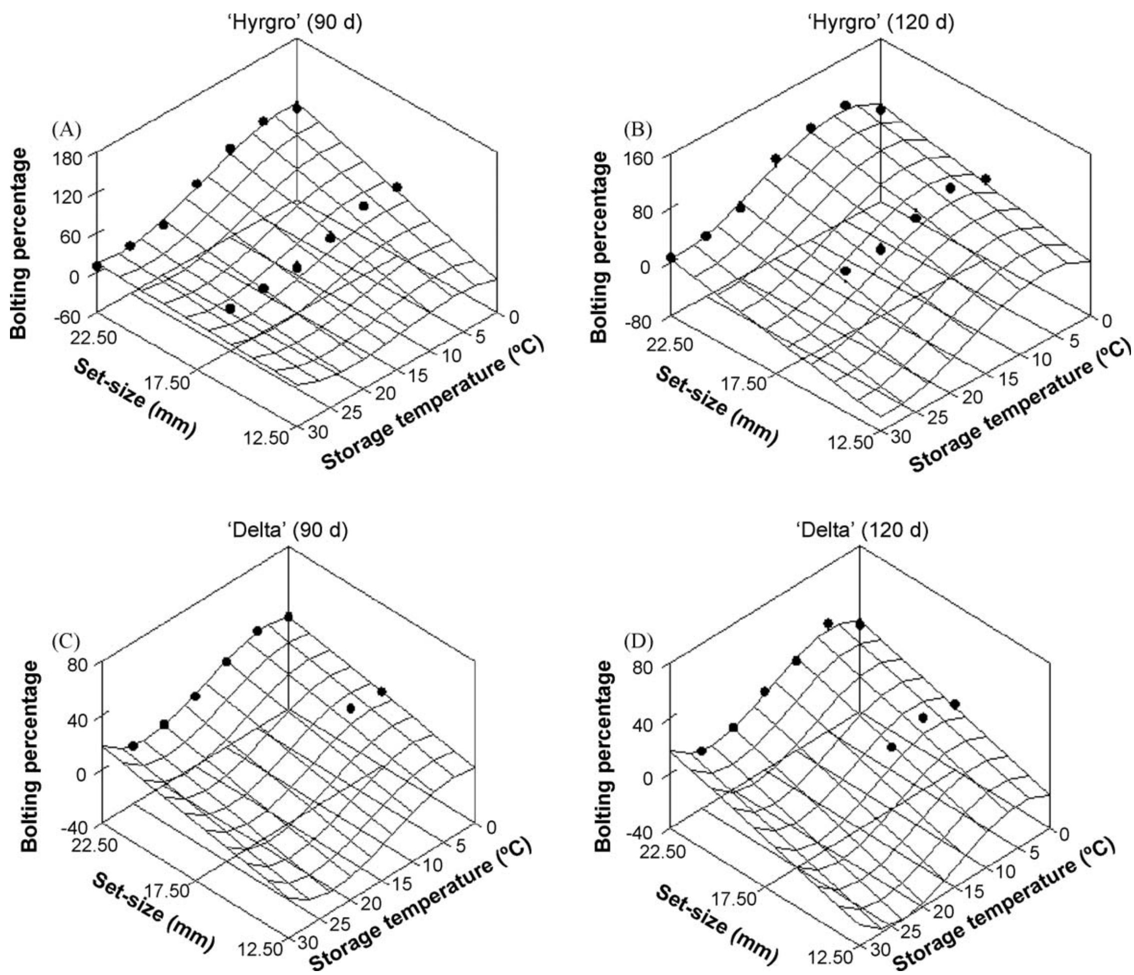

Fig. 1. Effect of set-size and storage temperature on percentage of bolting in two cultivars of onion at storage periods of 90 days and 120 days. The plane was fitted by multiple regression analysis (Panels A–D). r^2 = 0.92–0.99. Blank area in the fitted plane shows no response.