Evaluating the Germination of Primed Onion Seeds by Oxygen Uptake Measurements

Sheldon C. Furutani
College of Agriculture, University of Hawaii at Hilo, Hilo, Hawaii 96720-4091.

Bernard Zandstra and Hugh C. Price
Department of Horticulture, Michigan State University, East Lansing, Michigan 48823.

ABSTRACT

Onion seeds were primed in sodium chloride or mannitol solution for 0, 2, 4, and 6 days at 10°C and assayed for germination and respiration rates. Germination and respiration rate of seeds increased with increased duration of priming. This report suggests the use of respiration rate measurements after 2 hours of imbibition as an alternative means for assessing germination performance.

INTRODUCTION

Assays based on speed of germination are widely used to evaluate the effect of seed priming (Furutani et al. 1986). These assays are lengthy since germination is often monitored over several days. This study describes a method to assess the germination of primed onion seeds by measuring \( O_2 \) uptake during seed imbibition.

MATERIALS AND METHODS

Onion (Allium cepa L. cv Clima) seeds were primed by placing 2 g seed into aerated glass columns with 1.5 MPa CaCl\(_2\)14O\(_2\) (mannitol) at 10°C for 2, 4, or 6 days as described by Furutani et al. (1986). Primed seeds were removed from the columns, rinsed 3 times with 300 ml distilled water (dH\(_2\)O), and dried for 24 hrs at 22°C and 40% RH. Time to 50% germination (Orchard 1977) and percent germination was obtained by incubating the 2, 4 and 6 day primed seeds in petri dishes fitted with Whatman No. 2 filter paper and 8 ml dH\(_2\)O at 10°C. Nonprimed seeds were used as controls. Germination (radical visible) was counted daily for 28 days. Each treatment consisted of 4 replicates (50 seeds/replicate) arranged in a randomized complete block design.

Oxygen uptake of imbibing seeds was measured with a differential respirometer (General Medical Engineering Co.). Nonprimed and 2 and 6 day primed seeds (1.5 g) were placed into the outer well of a single-side-arm respirometer flask, 0.2 ml 20% KOH (w/w) was pipetted into the center well fitted with a cork constructed from Whatmann No. 2 filter paper. Two ml dH\(_2\)O was pipetted into the side arm and the flask equilibrated for 1 hr to 10°C in a water bath. The dH\(_2\)O in the side arm was then combined with the seeds and \( O_2 \) uptake was measured every 1 hr for 5 hrs (Umbriet et al. 1964). Oxygen uptake measurements were corrected to standard temperature and pressure (STP) by the following equation (Umbriet et al. 1964):

\[
O_2 = \frac{(Pb - 3 - Pw)}{(t + 273)} (760)
\]

\( O_2 = \) volume of oxygen at STP.
\( t = \) water bath temperature in degrees Kelvin.
\( Pb = \) barometric pressure of the atmosphere in mm Hg.
\( Pw = \) water vapor pressure of water bath in mm Hg.

Uptake was expressed as ul \( O_2 \) utilized hr\(^{-1}\) g\(^{-1}\) oven dried seed. Each treatment was replicated 3 times and the experiment was conducted twice. Imbibition rate for nonprimed and 2 and 6 day primed seeds was measured by imbining 10 g seed in 200 ml dH\(_2\)O at 10°C. Seeds were sampled at hourly intervals for 8 hrs by removing 1 g seed from the imbining solution, blotted dry with paper towel, weighed and oven dried at 100°C for 16 hrs then reweighed to determine moisture content (Year book of agriculture, 1961). The experiment was conducted twice using 4 replicates per treatment.

RESULTS AND DISCUSSION

Time to 50% germination decreased after priming and was inversely correlated with priming duration (Figure 1). Percent germination of seeds for all treatments ranged from 89.7 to 92.5% and differences were not significant by F test (5% level). The increased speed of onion seed germination after priming is in agreement with other reports (Furutani et al. 1986; Heydecker et al. 1973).

Oxygen uptake was greater for 2 and 6 day primed seeds compared to nonprimed controls (Figure 2). Greater \( O_2 \) uptake after 2 and 3 hrs imbibition was observed when the priming duration was increased from 2 to 6 days. Although the priming treatment led to increased \( O_2 \) uptake, imbibition rates were not significantly different for primed and nonprimed seeds (not shown). The relationship between \( O_2 \) uptake at 2 hr after the start of imbibition and time for 50% germination for nonprimed, 2, and 6 day primed
Fig. 1 The effect of priming on days to 50% germination. Onion seeds were primed at 10°C in 1.1 MPa mannitol.

Fig. 2 Oxygen uptake of nonprimed, 2 and 6 day primed onion seeds during imbibition at 10°C.

Fig. 3 Relationship between O₂ uptake of onion seeds and days to 50% germination. Germination and O₂ uptake measurements were conducted on nonprimed, 2 and 6 day primed seeds.

Seeds is shown in Figure 3. Imbibition after 2 hr was selected since the greatest differences in O₂ uptake among priming treatments were observed at this time. Decreased germination time was associated with higher O₂ uptake rates during seed imbibition. Thus, measurement of O₂ uptake could provide an alternative to germination tests for onion seeds for assessing the germination performance. The greatest advantage of this method is the speed (2 hours vs several days) in which germination performance can be assessed.

REFERENCES


