**Effect of Thiourea on breaking dormancy of potato minitubers**

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*Dormancy breaking of potato minitubers*

Abstract

We investigated the effects of postharvest application of thiourea in various concentrations (0, 10, 20 and 30 g l-1) and with different incubation times (1, 2 and 3 h) on breaking of dormancy and sprouting of potato (*Solanum tuberosum* L., cv. Marfona) minitubers of two ages (freshly harvested and one week after harvest). In comparison with the control minitubers, thiourea treated minitubers showed significantly shorter dormancy, especially when minitubers were treated immediately after harvest. The response to an increase in concentration was stronger in minitubers of one week old than in freshly harvested minitubers, most likely because of impeded the uptake of the thioureasolution after skin set. Irrespective of age of minitubers, a shorter dormancy period was observed with increasing duration of immersion until 2 h, but a further increase was not effective. Advancing breaking of dormancy was associated with removal of apical dominance and therefore applying thiourea also increased the number of sprouts per minituber, especially in freshly harvested minitubers. The number of sprouts had a positive correlation with concentration and incubation time. The length of sprouts increased with an increase in thiourea concentration, especially in freshly harvested minitubers. These results showed that it is possible to design an optimal thiourea treatment by selecting the right combination of minituber age, concentration and duration of incubation.

Keywords: potato minituber, thiourea, dormancy period, sprout

Introduction

The potato is one of the world’s most important food crops and the world’s most important vegetable crop. Potato produces more carbohydrate per unit of surface per year than any other crop except sugarcane (Spooner and Salas, 2006). In conventional systems generally seed potato tubers are utilized for multiplication and production. This method has a number of disadvantages. Some of these are: low rate of multiplication, it is inefficient, it has a high risk of catching various diseases (fungal, viral, and bacterial diseases) and different pests, and it requires intensive control and a high number of field multiplications (Struik & Wiersema, 1999). But recently, the use of minituber for basic seed potato production is common. Minitubers are small seed potato tubers that can be produced year round in glasshouses from in vitro propagated plantlets. The basis of minituber production is to rapidly facilitate the stage between the delivery of virus-free material derived from meristem culture nuclear stock and the production of tubers destined for field planting (Millam and Sharma, 2007). Minitubers are used in breeding programs and in the seed production industry because many tubers can be generated in a small space. Minitubers are often highly dormant, however, and this causes problems when it results in uneven or late emergence.

Dormancy of a potato tuber is defined as the physiological state in which autonomous sprout growth will not occur, even when the tuber is placed under ideal conditions for sprout growth (Reust, 1986). Potato seed tubers should be allowed to pass through their normal period of dormancy and to sprout naturally. However, excessive dormancy might limit seed usage and in such a case inducing sprout growth can be necessary. Rapid and uniform sprouting of the seed (pieces) is then a prerequisite for establishing a healthy crop (Suttle, 2008). Sprouting can be stimulated by applying chemicals (either before or after harvest), by damaging the tubers, and by manipulating the humidity of the air, the air temperature (warm storage, heat shocks, cold shocks) or the composition of the atmosphere of the storage environment (Struik & Wiersema, 1999). However at commercial scale, Rindite (Kim et al., 1999), bromoethane (Coleman, 1984), CS2 (Meijers, 1972), GA3 (Rappaport et al., 1957) and thiourea (Rehman et al., 2001) have been used to break potato tuber dormancy. Exogenous application of thiourea, offers an economical and safety method to break potato minituber dormancy. Hence, in this study we investigate factors influencing the thiourea efficacy in breaking potato minituber dormancy.

Materials and methods

Minitubers from cultivar Marfona (medium to long dormancy) were produced on *in vitro* propagated plantlets by the Pishtaz Tissue Culture Company (Karaj, Iran) in 2008. The *in vitro* propagated plantlets were planted in a seed box, containing a 3:1 (v/v) mixture of peat and perlite, in a greenhouse at a day/night temperature of 20/14oC and a day length of 14 h. Minitubers were hand harvested 120 days after planting.

 Three replications of 10 minitubers (average weight of about 1.5 g) were immersed whole in deionised water (control) or in a thiourea (Merck, Germany) solution with a concentration of 10, 20 or 30 g/L. Minitubers were immersed for 1, 2 or 3 h. Moreover we used minitubers of two different ages: zero (i.e. freshly harvested) or one week after harvest. Following treatments, minitubers were air dried and then placed in the dark at 25±0.3ºC and 85±5% RH.

Minitubers were considered sprouted when a tuber had at least one sprout of at least 2 mm long. The development of sprouts of the minitubers was recorded at two-day intervals until all minitubers had sprouted. The dormant period was assessed as number of days from treatment to sprouting, and was considered to have ended when 80% of the minitubers had at least one sprout of at least 2 mm long. After the end of dormancy, the average number of sprouts present per minituber and the sprout length were assessed.

In a parallel experiment to examine the effect of incubation time on thiourea uptake, whole minitubers (immediately and one week after harvest) were immersed in 20 g l-1 thiourea and the mean weight increase of minitubers was recorded after 1, 2 or 3 h. There were six replicates of ten minitubers each.

 The experimental design was a factorial randomized design and data were subjected to analysis of variance (ANOVA). Date were presented as mean ± SE.

Results and discussion

*Dormancy period*

The percentage of sprouting was lower for one week old minitubers than for freshly harvested minitubers, at least after thioureatreatment. The general effect of the thiourea treatments on dormancy breaking of potato minitubers was clearly present throughout the whole experiment (Figure. 1). However, the effect of thiourea varied with age of the minitubers and with the concentration of the active ingredient. Treatment of freshly harvested minitubers with thiourea was more effective than treatment of minitubers one week after harvest. Skinning and feathering of newly dug, immature minitubers are common and the wounds caused by separating minitubers from the stolons are still not cured. In addition, immediately after harvest minitubers have a thin skin. These factors may have facilitated the entry of the chemical. In freshly harvested minitubers, in 1 and 2 h incubation times dormancy period decreased with an increase in thiourea concentration, but in 3 h incubation time, 20 g/L thiourea was more effective than 30 g/L. In contrast, in minitubers of one week after harvest, dormancy was significantly shorter when thiourea concentration increased.

 Irrespective of age of minitubers, a shorter dormancy period was observed with increasing duration of immersion until 2 h, but a further increase was not effective (Figure. 1).

{Fig 1}

 *Number of sprouts per minituber*

Irrespective of thiourea duration and concentration, freshly harvested minitubers treated with thiourea showed significantly more sprouts per minituber than those treated one week after harvest (figure 2). There were significance differences among the different concentrations and durations in their effect on the number of sprouts per minituber. However, these effects varied with age of the minitubers. In freshly harvested minitubers, number of sprout increased with an increase in incubation time except in 30 g/L that minitubers were treated with thiourea for 2 h had lower number of sprout per minituber than those treated for 3 h. in contrast in one week old minitubers, a lower number of sprout per minituber was observed with increasing duration of until 2 h, but a further increase was not effective. There were a marked difference between the thiourea treatment and the control, which had only one sprout per minituber.

{Fig 2}

*Sprout length*

The length of the sprouts increased with an increase in the thiourea concentration and this effect was most expressed in freshly harvested minitubers (Figure. 3). The best fit for the relationship between thiourea concentration and sprout length was obtained with a polynomial model both for 0 and 1 week old minitubers.

{Fig 3}

*Uptake of solutions*

Thioureauptake in freshly harvested minitubers may be greater since uptake of the solutions in freshly harvested minitubers was higher than in minitubers of one week after harvest (Figure. 4).

{Fig 4}

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**FIG. 1** Sprouting of potato minitubers in response to treatment with various concentrations and incubation time of thiourea on the day of harvest and one week after harvest. Vertical bars indicate the standard error for each treatment at each time of measurement.

**FIG. 2** number of sprouts per minituber in response to treatment with various concentrations and incubation time of thiourea on the day of harvest and one week after harvest. Vertical bars indicate the standard error for each treatment at each time of measurement.

**FIG. 3** The effect of thiourea concentration on sprout length of potato minitubers.

**FIG. 4** Effect of duration of incubation on water uptake in whole freshly harvested minitubers (FH) and in whole, one week old minitubers (WH). Vertical bars indicate the standard deviation for each treatment at each time of measurement.