

High Temperature Pre-Treatment Induces Favorable Effects of The Low Temperature Treatment to Roots of Vegetables

Yudi Chadirin (Kyushu univ), Kota HIDAKA (KONARC), Yuki SAGO (Kyushu univ), Hiroki KAGAWA (Kyushu univ), Masaharu KITANO (Kyushu univ)

High temperature stress, low temperature stress, root environment, soilless culture, spinach

1. Introduction

The low temperature in root environment causes depression in root water absorption. The depressed water absorption induces water deficit and can trigger the plant adaptive functions such as osmoregulation and antioxidation. These adaptive functions of plants can be expected to produce high quality vegetables that may be enriched in the healthful substances such as sugars and antioxidants. Previous studies showed that high quality vegetable rich in sugar was produced by applying the low temperature stress to roots during a long term in soilless culture, but the plant growth was excessively depressed. In this study, we examined the high temperature pre-treatment to induced favorable effect of the low temperature stress for soilless culture of spinach.

2. Materials and Methods

Spinach plants (*Spinacia oleracea* L. cv. Orai) were grown in the hydroponic cultivation beds in a greenhouse. The nutrient solution based on the A-prescription of Otsuka House (Otsuka Chemical Co., Ltd., Osaka) was circulated from a 60 L tank through the root zone of spinach at a constant temperature of 20°C and an electrical conductivity (EC) of 3 dS m⁻¹. Ten days before harvesting, high temperature pre-treatment was applied for 3 days (30°Cx3/10°C) and 1 day (30°Cx1/10°C) while the other 2 beds were circulated with nutrient solution at a constant temperature 20°C.

The high pre-treatment were followed by the seven days low temperature treatment. The low temperature treatment was applied by circulated nutrient solution at a constant temperature 10°C for three beds. Spinach was harvested after seven days low temperature treatment. Fresh weight, dry weight, brix and concentrations of ascorbic acid (ASA), NO₃⁻ and oxalic acid in the shoot of plants were measured by the standard methods.

3. Result and Discussions

Figure 2 shows time courses of brix and fresh weight with the different root temperature treatments and the respectively temperature. Brix harvested plants was increased to 8% by the 30°Cx3/10°C treatment, which value was significantly higher than that the 20°C treatment. The low temperature treatment (10°C) for a week depressed fresh weight. However, three days high temperature treatment increased 23 % of fresh weight as compared with 1 days high temperature treatment. Furthermore Spinach with the highest ascorbic acid (ASA) and the lowest [NO₃⁻] was produced by 30°C x3/10°C treatment (data was not shown). In fact, ASA in the shoot was enriched by the low temperature treatment and therefore it is considered that the enrichment of ASA was induced to protect the plants from the low temperature-induced oxidative stress. Low temperature stress decreased [NO₃⁻] concentration of spinach in the shoot. Fennell and Markhart (1998) reported that the root hydraulic conductance was decreased by exposing the roots to the low temperature stress. This suggests that decrease in [NO₃⁻] in the shoot under the low temperature treatment was induced by the reductions of water and nutrient uptake thus favorable effect of the low temperature stress.

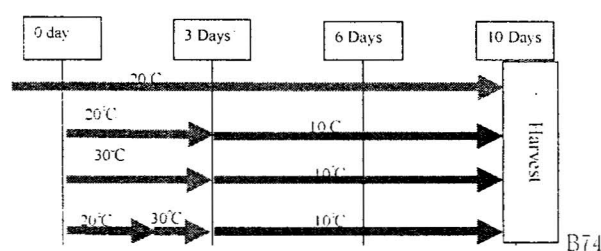


Fig 1. Schematic diagram of the root temperature treatment

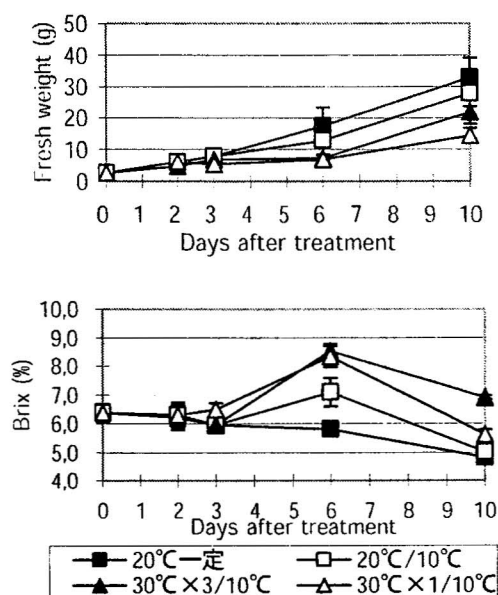


Fig. 2. Time course of fresh weigh and brix of spinach