日本生物環境工学会
2011 年札幌大会

講演要旨

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講演要旨

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Change in Root Absorptive Function By Application of Temperature Stresses to Root Zone

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Root water absorption, root ion absortion, high temperature stress, low temperature stress, acclimation

1. Introduction

Spinach that exposed to low temperature of 5 °C during 2 weeks before harvest produced high quality in brix, ascorbic acid and [Fe^{2+}] but low in concentration of harmful substances such as [NO_3^-] and oxalic acid. These characteristics of spinach were the result of plant adaptive function because of spinach produced anti oxidant during exposed into low temperature. However the low temperature of 5 °C was too low and the growth was extremely depressed thus produced small spinach and low in fresh weight. For that reason, the temperature of 10 °C was applied to root zone to create low temperature stress in this experiment. In this study, we examined water and ion absorption before and after the high temperature pre-treatment to study its effect to induce favorable effect of the low temperature stress for soilless culture of spinach.

2. Materials and Methods

Spinach (*Spinacia oleracea* L. cv. Orai) plants were grown in cultivation beds of hydroponic system in a greenhouse circulated with nutrient solution based on the a-prescription of Otsuka House at a constant temperature of 20°C and an electrical conductivity (*EC*) of 3 dS m^{-1}. Ten days before harvesting, root temperature treatment was applied for 30°C x 3d/10°C, and 20°C/10°C while control bed was circulated with nutrient solution at a constant temperature of 20°C (Fig 1). From field measurement at a river located in Hisayama, Kasuya-gun, Fukuoka Prefecture, It showed that average daily temperature of water stream below 10 °C during cold to spring season (Fig 2). Hence water stream as natural resources has the possibility for chilling nutrient solution at 10 °C. Ion absorption was measured before and after root temperature stress. Five plants were sampled from respective beds and then transferred into measurement system in growth chamber controlled at an air temperature of 20°C. Fresh weight, dry weight, brix and concentrations of ascorbic acid (ASA), the shoot of plants were measured by the standard methods.

3. Result and Discussions

Figure 3 shows time course of water absorption with the different root temperature treatments and the respectively temperature. The high root temperature activated water uptake through decrease in water viscosity caused increasing mass flow in nutrients uptake (Fig 4). Ions had different respond to the high temperature treatment, however decreased in the same pattern to respond the low temperature stress. The low temperature decreased water absorption and the lowest of water absorption was found in spinach that treated high temperature pre-treatment (30 °C/10 °C) compared to spinach that treated without high temperature pre-treatment (20 °C/10 °C). It`s shown that the high temperature pre-treatment increased temperature difference thus increasing magnitude of temperature stress when low temperature stress was applied. The greater temperature difference occurrence, the root water absorption is more depressed. It affected root ion absorption and resulted favorable effect by decreasing harmful substance such as NO_3^- content and increasing healthful substance such as Brix, and ASA content at harvest (Fig. 5). Thus the high temperature pre-treatment induced favorable effect of low temperature treatment by increasing magnitude of temperature difference. At the end of treatment, root seemed being acclimated to low temperature stress and it is suggested that water and ion absorption was driven by shoot demand. At low temperature of 10 oC treatment, shoot demand is reduced by low relative growth rate.

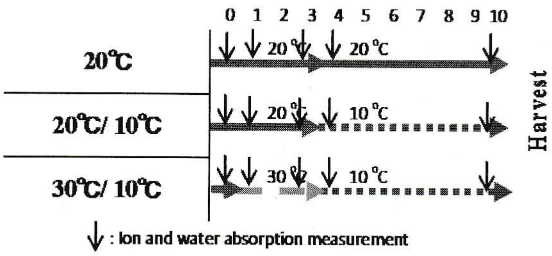

Fig 1. Schematic diagram of the root temperature treatments and water and ion absorption measurement.

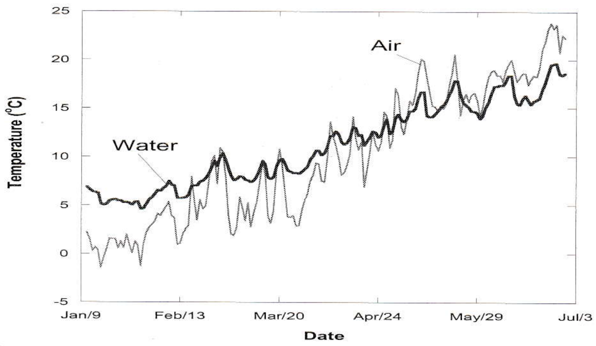

Fig 2. Daily average of water stream and air temperature in Hisayama, Kasuya-gun Fukuoka Prefecture.

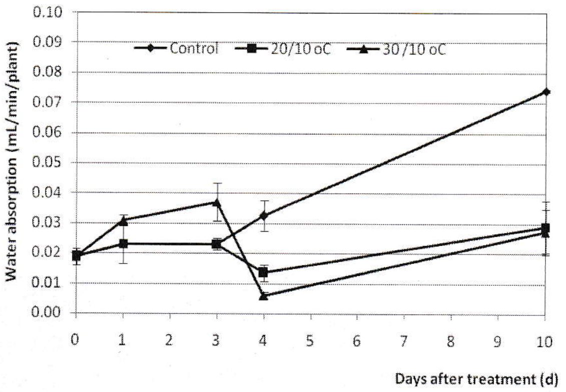

Fig 3. Water absorption by spinach roots during high and low temperature stresses treatment to the root.

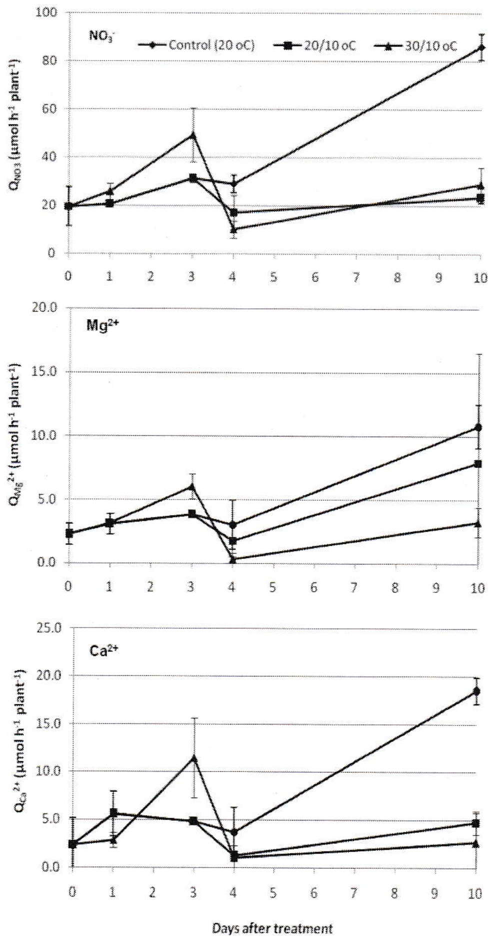

Fig 4. Rate NO_3^-, Mg^{2+} and Ca^{2+} (Q_{NO3}^-, Q_{Mg}^{2+}, Q_{Ca}^{2+}) by root of spinach during temperature stresses to the root.

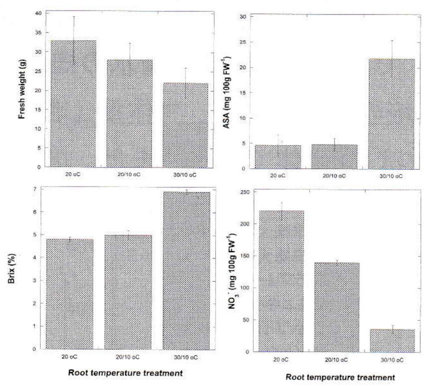

Fig 5. Effect of root temperature treatment on fresh weight, Brix, ASA and NO_3^- content of harvested spinach.