

# Dihydrozeatin, a Powerful Chemical for Promoting Shoot Growth of Rice (*Oryza sativa* L., cv. Tai-keng 3) Seedlings

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## ABSTRACT

Effects of dihydrozeatin (DHZ), dissolved in Hoagland solutions at various concentrations ( $10^{-9}$  to  $10^{-17}$  M), on rice seedling shoot and root growth of a Taiwan cultivar (cv. Tai-keng 3) were investigated. The results showed that Hoagland solutions containing DHZ at  $10^{-9}$  to  $10^{-15}$  M all were effective in promoting shoot growth, but none of DHZ solutions enhanced root growth. These results indicate that DHZ molecules dissolved in Hoagland solution are efficient, rapid and stable in promoting Tai-Keng 3 rice seedling shoot growth. In addition, DHZ solution at  $10^{-15}$  M was found to be the lowest effective concentration in the literatures of cytokinin-promoting growth so far. The method used here can be considered as a practical one for cultivating and improving rice seedling growth.

**Key words:** dihydrozeatin, Hoagland solution, rice seedling, shoot growth, a Taiwan rice cultivar (cv. Tai-keng 3).

## Introduction

Rice is one of major crops in the world. Techniques for improving its production are of a considerable concern for human beings from an early history. So far tissue culture has been used as a method for producing mass rice seedlings. But an application of individual chemical for improving rice seedling growth has not yet been efficiently found. Triacontanol (TRIA),  $\text{CH}_3\text{CH}_2(\text{CH}_2)_{27}\text{CH}_2\text{OH}$ , was shown to increase rice seedling growth at nanomolar concentration<sup>(3)</sup>. Ries<sup>(3)</sup> also found that spraying with TRIA rapidly elicited a second messenger (L(+) adenosine) in the roots of rice seedlings and L(+) adenosine at nanomolar concentrations caused plants to respond in a manner similar to TRIA. In this report, dihydrozeatin, a type of cytokinin, was found to be more powerful than TRIA and L(+) adenosine in the promotion of rice seedling shoot growth of a Taiwan cultivar (cv. Tai-keng 3) when applied to germinating rice seedlings with Hoagland nutrient solutions.

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## Materials and Methods

A rice cultivar (*Oryza sativa* L. cv. Tai-Keng 3) was used as the experimental material. Seeds were kindly provided by Taichung District Agricultural Improvement Station, Changhua. Dihydrozeatin (DHZ) and other general chemicals were purchased from Sigma and Wako Pure Chemical Industries Ltd., respectively. Experiments were carried out between July 27 and Aug. 16, 1995.

Rice seeds were surface-sterilized with 70% ethanol for 10 min, rinsed with distilled water a few times, immersed in fresh distilled water and placed under white fluorescent lamps ( $19.0 \mu \text{mol m}^{-2} \text{s}^{-1}$ ) for germination. Distilled water was daily replaced. The temperature in the growth space was regulated at  $25^\circ\text{C}$ . Germinated rice seedlings (5-day-old) were transferred to culture solutions which include Hoagland solution [ $\text{Ca}(\text{NO}_3)_2$ ,  $5.0 \times 10^{-3} \text{ mol L}^{-1}$ ;  $\text{KNO}_3$ ,  $5.0 \times 10^{-3} \text{ mol L}^{-1}$ ;  $\text{MgSO}_4$ ,  $2.0 \times 10^{-3} \text{ mol L}^{-1}$ ;  $\text{KH}_2\text{PO}_4$ ,  $1.0 \times 10^{-3} \text{ mol L}^{-1}$ ; Fe- EDTA,  $1.18 \times 10^{-5} \text{ mol L}^{-1}$  and micronutrient solution consisting of  $\text{H}_3\text{BO}_3$ ,  $4.6 \times 10^{-5} \text{ mol L}^{-1}$ ;  $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$ ,  $9.14 \times 10^{-6} \text{ mol L}^{-1}$ ;  $\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$ ,  $7.65 \times 10^{-7} \text{ mol L}^{-1}$ ;  $\text{CuSO}_4$ ,  $7.0 \times 10^{-7} \text{ mol L}^{-1}$  and  $\text{H}_2\text{MoO}_4$ ,  $1.24 \times 10^{-7} \text{ mol L}^{-1}$ ; pH 5.0] and Hoagland solutions to which DHZ was added to provide concentrations of  $10^{-9}$  to  $10^{-17}$  M. Each tested solution (pH 5.0) was contained in plastic trays (diameter, 11.5 cm; depth, 3.5 cm) with two filter papers each (Advantec, Toyo; No.1; diameter, 90 mm). Each tested solution included four replicates with seven seedlings each.

Germinated rice seedlings in each culture tray were grown under white fluorescent lamps ( $19.0 \mu \text{mol m}^{-2} \text{s}^{-1}$ ) for 18 days at  $25^\circ\text{C}$ . The tested solution in each tray was maintained at a sufficient level for seedlings to absorb enough nutrients during the experimental period. At the final stage of harvest, the seedlings from each tray were washed with water (mainly for roots) and blot-dried with paper towels. Seed was cut off from each seedling. Then, shoots were separated from roots and each portion was dried in an oven (at  $70^\circ\text{C}$ ; 24 h). Dried shoots and roots of each tray were weighed to provide a unit of dry mass ( $\text{mg plant}^{-1}$ ), separately. The results of each measured parameter were finally analyzed by Duncan's multiple range test at the 5% level.

## Results and Discussion

Two separate experiments were carried out for these treatments of dihydrozeatin (DHZ) solutions; one was from  $10^{-9}$  M to  $10^{-12}$  M, while the other, from  $10^{-13}$  M to  $10^{-17}$  M. The results in Fig 1 showed that DHZ solutions from  $10^{-9}$  to  $10^{-15}$  M all stimulated an increase in rice seedling shoot growth of Tai-keng 3 in terms of dry mass, but none of DHZ solutions stimulated root growth. These results indicate that DHZ dissolved in Hoagland solutions are efficient, rapid and stable in promoting young rice seedling shoot growth, which is the site of photosynthesis. DHZ solution at  $10^{-15}$  M was found to be the lowest effective concentration in cytokinins related to growth literatures so far. Solutions of TRIA and L(+) adenosine at  $10^{-9}$  to  $10^{-10}$  M were

reported to be active in promoting rice seedling growth<sup>(3,4)</sup>. In tobacco callus growth, zeatin added to Murashige and Skoog medium at  $1.7 \times 10^{-10}$  M was the lowest effective concentration<sup>(1)</sup>. Letham<sup>(2)</sup> also found that zeatin dissolved in M2 growth medium promoting carrot root callus growth was at  $5 \times 10^{-11}$  M.

Although the reasons for DHZ actions on enhancing shoot growth have not yet been fully investigated, the main purpose of this paper is to show that DHZ is so powerful on this case. This is a magnificent and unprecedented matter. Tai-Keng 3 seedling shoots in DHZ treatments were usually longer than the control (unpublished data). Hopefully, the method used here will be considered as a practical one for cultivating and improving rice seedling growth in the near future.

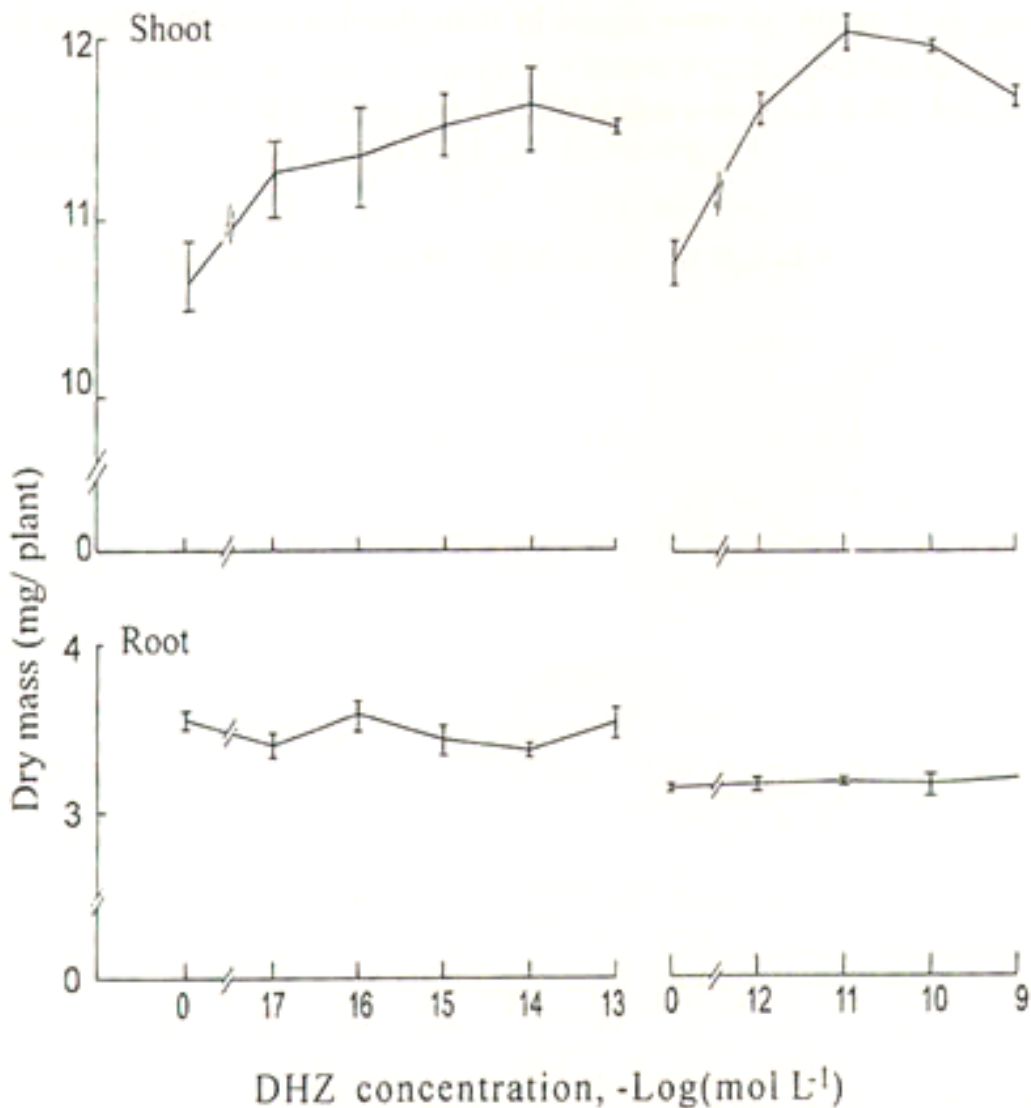


Fig. 1. Effects of dihydrozeatin (DHZ), dissolved in Hoagland solutions at various concentrations on 18-day-old rice seedling shoot and root growth of a Taiwan cultivar (cr. Tai-keng 3). Each value is the mean of four replicates ( $p=0.05$ ). Two experiments were involved in this figure.

## References

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# "Dihydrozeatin"一種誘導栽培稻(台梗3號)幼苗生長的強促進劑

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## 摘 要

本題研究的目的主要是在探討dihydrozeatin (DHZ)溶入Hoagland溶液內( $10^{-9}$ 至 $10^{-17}$  M)對台梗3號幼苗的shoot及根生長有何不同的影響力。結果顯示此DHZ溶液在 $10^{-9}$ 至 $10^{-15}$  M之間皆能有效地促進幼苗shoots之生長而沒任一DHZ溶液對根的生長有助益。由這些結果可知DHZ分子溶入Hoagland溶液內對稻苗shoots之生長是極有幫助的、快速的且穩定的。除此之外，DHZ溶液在 $10^{-15}$  M仍屬有效濃度，此低濃度是目前在cytokinins影響植物生長的文獻內最低者。本篇內之研究方法可做為栽培水稻幼苗生長的實用參考。

關鍵字：benzyladenine、溶液、水稻(台梗3號)、幼苗生長。

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