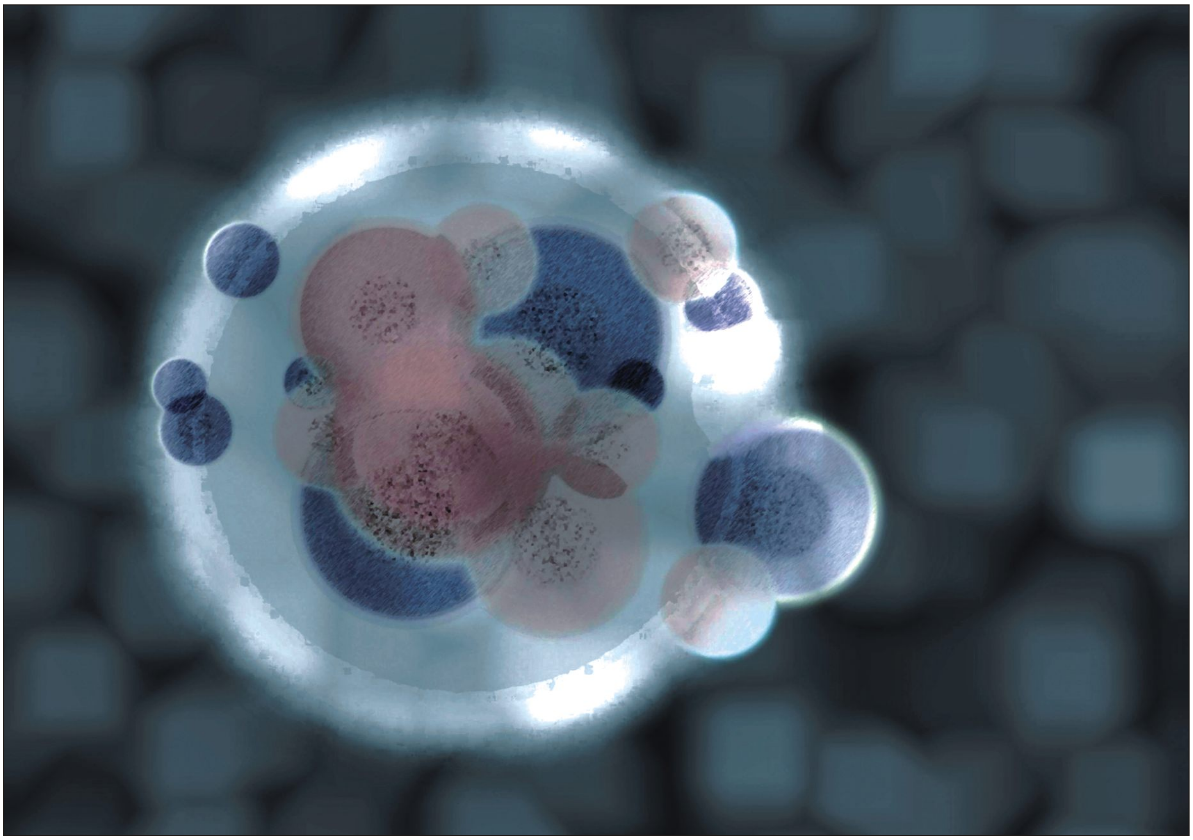

# Journal of Biological Sciences

ISSN 1727-3048

OnLine Journal of Biological Sciences 1 (2): 49-51, 2001


# Effect of Different Levels of Zinc and Phosphorus on Seedling Growth, Chlorophyll and Peroxidase Contents of Rice

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**Abstract:** Water culture experiment was conducted to observe the effects of different levels of Zn and P alone and in combination on the growth ,chlorophyll and peroxidase contents of rice (cv. Shadab).The concentrations for the study were Zn: 0.0, 5.0, 10.0, and 20.0 mg $L^{-1}$, and P 0.0, 20.0, 40.0, 60.0 mg $L^{-1}$. It was observed that the growth of fresh and dry weights of shoot, root and its length were increased in more or less all the treatments as compared to control. Contrary to this the chlorophyll and peroxidase contents were substantially decreased with increasing levels of Zn and P. It was observed that intermediate levels of both Zn and P were seemed to be beneficial for the growth of rice.
**Key words:** P, Zn , Solute, Rice

## Introduction

Continuous use of phosphoric fertilizers and intensive cultivation of high yield crop varieties have resulted in wide-spread deficiency of Zn and decrease in the growth of many field crops on soils, which are generally calcareous in nature. This may be due to interaction between Zn, P and also in the variability of other growth factors while in others it has been shown either to have no effect (Millikan, 1963) or increased the dry matter production of cereal crops. Zinc uptake by wheat plant was increased with the optimum application of P levels (Grifferty and Barrington, 2000). Different levels of P with micorrhizal maize increased the content of Zn and other elements and accordingly increased the growth of maize (Liu *et al*., 2000). Cakmak and Marschner (1986) observed that phosphorus application induced P-deficiency in cotton and reduced its cotton. Lian *et al*. (1998), used doses of P to detoxify the effect of Zn growth of tea plant. Wide–spread of P-induced Zn deficiencies on many agricultural crops have been reported around the globe and the Zn-P antagonism is well recognized now. When micro-nutrients sources are incorporated in macro-nutrient carriers, the chemical interactions that may occur during formulation, in storage or during the initial dissolution stage in soil caused a wide variety of reaction mechanisms. Considering the importance of Zn and P in the nutrition of plants, an experiment was conducted with variable levels of Zn and P under water culture using rice as a test crop.

## Materials and Methods

Water culture experiment was conducted in greenhouse to study the effects of different levels of zinc and phosphorus alone and in combination on growth and chlorophyll content using rice (cv. Khushboo) as a test crop. Different concentrations of zinc as 0.0, 5.0, 10.0 and 20.0 mg $L^{-1}$ in the form of $ZnSO_4$, $7H_2O$ and P as 0.0, 20.0, 40.0 and 60.0 mg $L^{-1}$ in the form of $KH_2$ $PO_4$ were added to 250 ml capacity plastic glasses containing Hoagland nutrient solution. The composition of nutrient solution was as follows: 4 mM – N, 2.0 mM -K, 1.5 mM -Ca, 1.0 mM -Mg, 0.01 B, 0.1 mM-Mn, 0.001 mM - Cu and 0.002 mM – Mo The concentration of Fe was 5 mg $L^{-1}$ applied as Fe-citrate The initial pH of the solution was 5.6. One week old rice seedlings (cv. Shadab) of uniform height were transferred into plastic glasses at the rate of three seedlings per pot. These glasses were kept overnight in the laboratory to acclimatize the temperature, and then taken out to the greenhouse and randomized and replicated three times. The nutrient solution was stirred occasionally with a glass rod and changed thrice during the experimental periods. After three weeks, the rice plants were harvested and fresh as well as dry weights and shoot and root lengths were recorded. At that time, leaf samples were also taken from each pot and chlorophyll was determined (Lichtenthaler, 1987). Peroxidase content was determined following the method of Kuroda *et al*. (1999). Later on the samples were analyzed for their treatment effects.

## Results and Discussion

Leaf tips burning were noted in some of the treatments such as in no Zn and P treatments (control) , and Zn 5 mg $L^{-1}$ with P 40 mg $L^{-1}$ , and P 60 mg $L^{-1}$. Similarly, yellowish green symptoms were noted in Zn 10 and P 20 mg $L^{-1}$, and P 40 mg $L^{-1}$, and Zn 20 mg $L^{-1}$ with P 60 mg $L^{-1}$. It was observed that fresh and dry weight of shoot and root were generally increased in all the treatments of Zn and P compared to control. The percent increased in growth parameters of shoot (fresh and dry weight) was comparatively higher than the root growth in majority of the Zn and P treatments. Similarly, the shoot and root lengths of rice seedlings were increased considerably, irrespective of treatments compared to control (Table 1). It was revealed from the results that rice plant did produce distinct improvement in the growth parameters, when Zn and P were added alone or in combination in the nutrient solution irrespective of the treatments (Kallsen *et al*., 2000). Similar findings have been reported by Grifferty and Barrington (2000) for other crops. The increase in the growth parameters may be due to the beneficial effects of Zn and P on the growth of rice. When zinc was applied alongwith low P the growth of barley was increased (Genc *et al*., 2000).

Under certain treatments, yellowish green colour of leaf was also observed, where the growth medium was high in available P, and perhaps interaction involving Zn, P, and Fe leads to poor utilization of Zn by plants (Viets,1966) which caused leaf tip burning and yelloish green leaf colour. However, such deficiency symptom did not effect the growth of rice crop. Mortvedt and Giordano (1969) attributed through his findings that the decreased agronomic effectiveness of Zn and N reactions happened due to formation of complex compound of Zn and N in the growth medium. It has also been reported that Zn and P form complexes reducing the solubility of Zn and P in the growth medium (Young, 1969). Such reactions perhaps alter the chemical and physical forms of the plant

Table 1: Effect of different levels of Zn and P on the seedlings growth, chlorophyll and peroxidase activity rice

| Zn and P Treatments (mg $L^{-1}$) | Fresh weight shoot (g) | Dry weight Shoot (g) | Fresh weight root (g) | Dry weight root (g) | Shoot length (cm) | Root length (cm) fresh wt. | Cholorophyl (mg $g^{-1}$) | Peroxidase (µ mole $gm^{-1}$) fresh wt. $min^{-1}$ |
|---|---|---|---|---|---|---|---|---|
| Zn 0 Po (To) | 0.1210 | 0.0614 | 0.1025 | 0.0227 | 16.00 | 6.30 | 1.043 | 21.70 |
| | (0.0) | ±0.00(0.0) | ±0.113(0.0) | ±0.000(0.0) | ±0.00(0.0) | ±0.00(0.0) | (0.0) | (0.0) |
| Zn 0 $P_{20}$ ($T_1$) | 0.2975 | 0.0755 | 0.1671 | 0.0336 | 18.00 | 8.87 | 0.988 | 18.88 |
| | ±0.241 | ±0.073 | ±0.134 | ±0.022 | ±9.165 | ±6.345 | (-5.27) | (-12.99) |
| | (+145.86)* | (+22.96) | (+63.02) | (+48.01) | (+12.5) | (+40.79) | | |
| Zn 0 $P_{40}$ ($T_2$) | 0.862 | 0.1135 | 0.7003 | 0.0103 | 34.00 | 14.00 | 1.222 | 22.41 |
| | ±0.00 | ±0.000 | ±0.000 | ±0.000 | ±0.000 | ±0.00 | (+17.16) | (+3.27) |
| | (+612.47) | (+84.85) | (+583.21) | (-54.62) | (+112.5) | (+122.22) | | |
| Zn 0 $P_{60}$ ($T_3$) | 0.4109 | 0.891 | 0.2659 | 0.0247 | 20.33 | 7.43 1.107 | | 14.17 |
| | ±0.268 | ±0.042 | ±0.175 | ±0.023 | ±2.517 | ±2.503 | ±(6.13) | (+34.70) |
| | (+239.58) | (+45.11) | (+159.41) | (+8.8) | (+27.06) | (+17.93) | | |
| Zn 5 Po ($T_4$) | 0.2908 | 0.0887 | 0.1719 | 0.0273 | 20.50 | 10.50 | 0.649 | 14.27 |
| | ±0.157 | ±0.038 | ±0.114 | ±0.009 | ±0.707 | ±0.707 | (-37.77) | (-34.23) |
| | (+140.33) | (+44.46) | (+6.70) | (+20.26) | (+28.12) | (+66.66) | | |
| Zn 5 $P_{20}$ ($T_5$) | 0.2892 | 0.0878 | 0.2301 | 0.0181 | 18.50 | 9.00 | 0.560 | 22.85 |
| | ±0.018 | ±0.015 | ±0.040 | ±0.003 | ±0.707 | ±2.828 | (-46.30) | (+5.29) |
| | (+139.00) | (+42.99) | (+124.48) | (+20.26) | (+15.62) | (+42.85) | | |
| Zn 0 $P_{40}$ ($T_6$) | 0.2795 | 0.0682 | 0.2062 | 0.0183 | 18.43 | 9.00 | 0.758 | 13.78 |
| | ±0.0888 | ±0.009 | ±0.060 | ±0.0061 | ±1.692 | ±2.646 | (-27.32) | (-36.49) |
| | (+130.99) | (+11.07) | (+101.17) | (-19.38) | (+15.18) | (+42.85) | | |
| Zn 0 $P_{60}$ ($T_7$) | 0.0745 | 0.0504 | 0.1203 | 0.0102 | 18.33 | 10.33 | 0.710 | 13.73 |
| | ±0.0211 | ±0.002 | ±0.017 | ±0.002 | ±5.859 | ±7.767 | (-31.92) | (-36.72) |
| | (-38.43) | (-17.91) | (+17.36) | (-55.06) | (+14.56) | (+63.96) | | |
| Zn 10 Po ($T_8$) | 0.3750 | 0.0613 | 0.3957 | 0.0298 | 21.00 | 11.50 | 0.590 | 10.64 |
| | ±0.042 | ±0.016 | ±0.162 | ±0.014 | ±0.000 | ±0.707 | (-43.43) | (-50.96) |
| | (+209.91) | (-0.0016) | (+286.04) | (+31.27) | (+31.25) | (+82.53) | | |
| Zn 10 $P_{20}$ ($T_9$) | 0.2920 | 0.0665 | 0.2816 | 0.0298 | 29.00 | 14.00 | 0.904 | 15.26 |
| | ±0.00 | ±0.000 | ±0.000 | ±0.000 | ±0.000 | ±0.00 | (-13.32) | (-29.87) |
| | (+141.41) | (+8.30) | (+74.73) | (31.27) | (81.25) | (122.22) | | |
| Zn 10 $P_{40}$ ($T_{10}$) | 0.4288 | 0.0881 | 0.2823 | 0.0287 | 19.00 | 11.00 | 1.031 | 16.58 |
| | ±0.00 | ±0.000 | ±0.000 | ±0.000 | ±0.000 | ±0.00 | (-1.15) | (-23.59) |
| | (+254.38) | (+43.48) | (+175.41) | (26.43) | (+18.75) | (+74.60) | | |
| Zn 10 $P_{60}$ ($T_{11}$) | 0.2804 | 0.0540 | 0.2604 | 0.0028 | 7.00 | 4.00 | 0.311 | 25.85 |
| | ±0.00 | ±0.000 | ±0.000 | ±0.000 | ±0.000 | ±0.00 | (-70.18) | (+19.12) |
| | (+131.75) | (-12.50) | (+54.04) | (-87.66) | (-56.25) | (-36.50) | | |
| Zn 20 Po ($T_{12}$) | 0.1894 | 0.0461 | 0.1244 | 0.0133 | 11.50 | 9.00 | 0.372 | 13.90 |
| | ±0.052 | ±0.002 | ±0.019 | ±0.004 | ±2.471 | ±4.243 | (-64.33) | (-32.94) |
| | (+56.52) | (-24.91) | (+21.36) | (-41.40) | (-28.12) | (+42.85) | | |
| Zn 20 $P_{20}$ ($T_{13}$) | 0.4198 | 0.0972 | 0.6332 | 0.0262 | 20.33 | 12.33 | 0.561 | 14.54 |
| | ±0.140 | ±0.024 | ±0.088 | ±0.006 | ±2.08 | ±3.215 | (-46.21) | (-32.99) |
| | (+246.94) | (+58.30) | (+517.75) | (-15.41) | (+27.06) | (+96.03) | | |
| Zn 20 $P_{40}$($T_{14}$) | 0.411 | 0.0949 | 0.2571 | 0.0292 | 18.67 | 12.35 | 0.276 | 15.20 |
| | ±0.0172 | ±0.028 | ±0.109 | ±0.0120 | ±4.041 | ±3.24 | (-37.53) | (-29.95) |
| | (+239.66) | (+54.56) | (+150.82) | (+28.63) | (+16.68) | (+96.03) | | |
| Zn 20 $P_{60}$ ($T_{15}$) | 0.3009 | 0.2445 | 0.2122 | 0.179 | 19.00 | 11.00 | 0.421 | 13.85 |
| | ±0.00 | ±0.000 | ±0.000 | ±0.000 | ±0.000 | ±0.00 | (-59.63) | (-36.17) |
| | (+148.67) | (+298.20) | (107.002) | (-21.14) | (+18.75) | (+74.60) | | |

*The values in the parentheses are percent increase (+) or decrease (-) over control

nutrients present in the medium which lead to the yellowish green colour of the plant leaf.

It was also observed that both chlorophyll and peroxidase contents substantially decreased in almost all treatments of zinc and phosphorus when applied alone or in combination in the nutrient solution (Table 1). Literature reveals that certain enzymes in combination with Zn and P are possibly involved in the degradation of chlorophyll and peroxidase activities in the growth medium. However, in some treatments, a slight increase in chlorophyll content was observed in 0 Zn and 40 P mg $L^{-1}$, where 17 % increase was observed compared to control. It was concluded from the experiment that applications of Zn and P at lower levels in nutrient culture solution found to have beneficial effects on increasing the growth parameters of rice plant.

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