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Effect of spraying TiO_2 nano particles on some of physiological and chemical parameters in maize (*Zea mays* L.)

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Abstract

An experiment was carried out using a factorial on the basis of completely randomized block design. The factor of studied included of TiO_2 Nano particles spraying affected on some physiological and chemical parameters in maize (*Zea mays* L.). The factors were spraying in growth stages (stem elongation and 4 leaves stage) and five levels of Tio2 including: control, Bulk Tio2, 0.01, 0.02, and 0.03 percentage). The characters measured were: Super oxide dismutase (SOD), Catalase (CAT), Glutathione peroxidase (GPX) and Malon dialdehyde (MDA). The results showed that the effect of TiO_2 Nano particles was significant on SOD, CAT, GPX and MDA in $P \leq 0.01$. Mean comparison showed that the highest SOD (1.588 mol/g), CAT (0.206 mol/g), GPX (0.140 mol/g) and MDA (0.140 mol/g) were achieved by Nano particles 0.03% percentage.

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Introduction

Maize is one of the most important cereal crops grown in Iran. Maize or corn (*Zea mays* L) is an annual grass belongs to the family Gramineae. The probable center of origin is the Central American and Mexico region. Maize has a wide range of plasticity to the environmental conditions. It is grown from latitude 58 N to 40 S on a range of 400 – 900 mm rain and temperature of 20- 30^{oC}. Maize is an important cereal food crop, and it ranks in the third position after wheat and rice in the world production of cereals (Poehlman, 1983; Ahmed, 1999). The largest production countries in the world are USA, China, France, India, Canada, Argentina, Spain, Romania and Yugoslavia (EL younis *et al.*, 1987). The total world cultivated area is about 601.66 million hectares. The world productivity according to FAO statistics is about 4.2 tons per hectare. In the Sudan, Maize grown in small scales under rainfed conditions in Kordofan, Darfour, and Southern states, under irrigation in Northern States and under flood irrigation in Kassala State (Ali, 1991). The total cultivated area of maize in the Sudan increased from 80 thousand hectares in 1989/91 to 187 thousand hectares in 1998. Average yield was 632 kg/ hectare (FAO, 1998). The most efficient energy converting life forms on the planet today are photosynthesizing plants. They directly take in the number-one source of energy, solar energy, and convert it into biochemical energy, which they use to carry out life functions. The way in which humans power all aspects of our advanced society, however, is at the other end of the spectrum. We use solar energy, which is stored in the fossilized remains of plant and animal matter deposited many meters underground, which takes millions of years to form - hardly an efficient way of obtaining energy. At the current rate of fossil fuel consumption, we are using up our energy resources faster than physical processes produce them and we are likely to start running out of adequate oil reserves in the near future. Among the three above mentioned crystal structures of TiO_2, anatase owing to its higher photocatalytic activity is commonly used for photocatalysis (Yong *et al.*, 2001). This higher photocatalytic activity is related to its lattice structure. Each Ti atom is coordinated to six oxygen atoms in anatase tetragonal unit cell. Yong *et al* (2001) have reported a significant degree of buckling associated with O-Ti-O bonds in anatase compared to rutile TiO_2. The kinetics of phase transformations in TiO_2 is extensively reviewed by (Zhang and Banfield 1999; Zhang *et al.*, 2000). TiO_2 nanoparticles can be synthesized using various methods such as sulfate process (Howe, 1997), chloride process (Howe, 1997), impregnation (Litter *et al.*, 1994), coprecipitation (Palmisano *et al.*, 1998), hydrothermal method (Wang *et al.*, 1999; Cheng *et al.*, 1995; Wang, *et al.*, 1999), direct oxidation of $TiCl_4$ (Akhtar *et al.*, 1991). Sol-gel method (Wang *et al.*, 1997; De Groot and Fuggle, 1990) is one of the most convenient ways to synthesize various metal oxides due to low cost, ease of fabrication and low processing temperatures. It is widely used to prepare TiO_2 for films, particles or monoliths. In general, the sol gel process involves the transition of a system from a liquid "sol" (mostly colloidal) into a solid "gel" phase. The homogeneity of the gels depends on the solubility of reagents in the solvent, the sequence of addition of reactants, the temperature and the pH. The precursors normally used for the synthesis and doping of nanoparticles are organic alkoxides, acetates or acetylacetonates as well as inorganic salts such as chlorides. Among the classes of solvents, alcohols are largely used but other solvents such as benzene may also be used for some alkoxides. The aim of this study was reduced the damage of drought stress in maize growth by TiO_2 Nano particles.

Materials and methods

This experiment was carried out using a factorial on the basis complete randomized block design with four replications in a year planting (2010-2011) at Islamic Azad University Shahr-e-Qods Branch, Tehran, Iran. The factor of studied included of TiO_2 Nano particles spraying affected on some physiological and chemical parameters in maize (*Zea mays* L.). The factors were spraying in growth stages (stem elongation and 4 leaves stage) and five levels of Tio2 including: control, Bulk Tio2, 0.01, 0.02, and 0.03%). The characters measured were: Super oxide dismutase (SOD), Catalase (CAT), Glutathione peroxidase (GPX) and Malon dialdehyde (MDA).

Statistics analysis

Data were subjected to analysis of variance (ANOVA) using Statistical Analysis System (Spss) computer software at P<0.01.

Results and discussion

SOD (Super oxide dismutase)

The results showed that the effect of TiO_2 Nano particles was significant on SOD in P≤0.01. The highest SOD (1.588 mol/g) was achieved by Nano particles 0.03 percentage and lowest SOD (0.942 mol/g) was achieved by Non Nano particles treatment (Fig. 1).

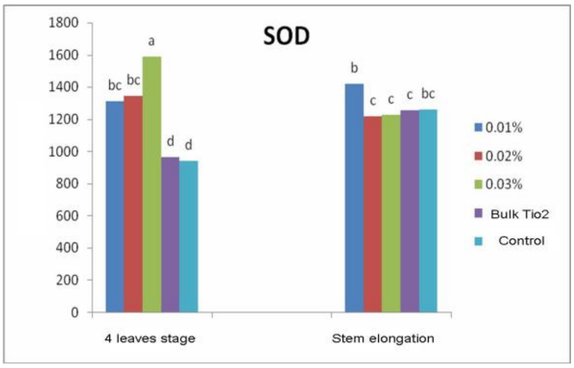

Fig.1. Effect of Nano particles TiO_2 spraying on SOD in maize.

CAT (Catalase)

The results showed that the effect of TiO_2 Nano particles was significant on CAT in P≤0.01. The highest CAT (0.206 mol/g) was achieved by Nano particles 0.03percentage and lowest CAT (0.142 mol/g) was achieved by Non-Nano particles treatment (Fig. 2).

GPX (Glutathione peroxidase)

The results showed that the effect of TiO_2 Nano particles was significant on GPX in P≤0.01. The highest GPX (0.140 mol/g) was achieved by Nano particles 0.03 percentage and lowest GPX (0.090 mol/g) was achieved by Non-Nano particles treatment (Fig. 3).

MDA (Malon dialdehyde)

The results showed that the effect of TiO_2 Nano particles was significant on MAD in P≤0.01. The highest MAD (0.140 mol/g) was achieved by Nano particles 0.03% percentage and lowest MAD (0.090 mol/g) was achieved by Non-Nano particles treatment (Fig. 4).

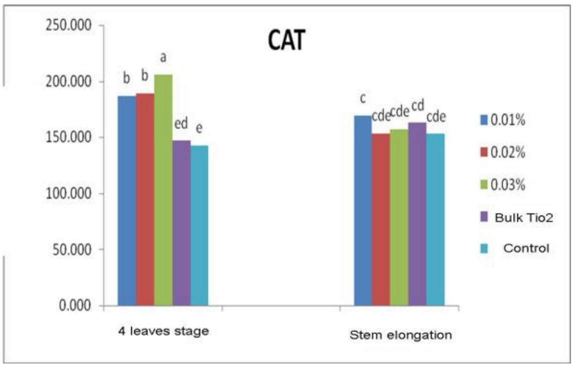

Fig. 2. Effect of Nano particles TiO_2 spraying on CAT in maize.

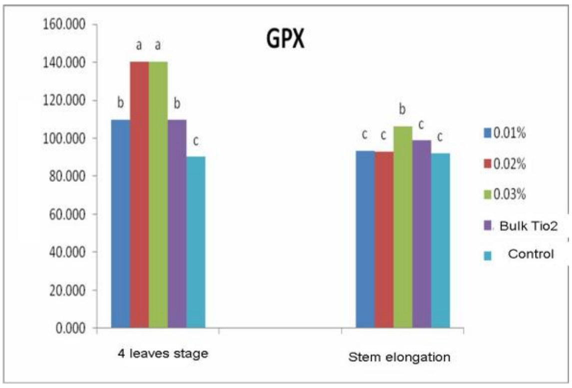

Fig. 3. Effect of Nano particles TiO_2 spraying on GPX in maize.

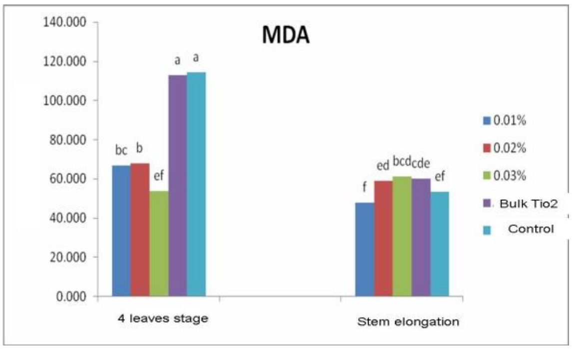

Fig. 4 Effect of Nano particles TiO_2 spraying on MDA in maize.

One of the most recent nanomaterials that has been attracted a great attention due to its unique properties is titanium dioxide. TiO_2 powders possess interesting optical, dielectrical, and catalytical properties, which results in industrial applications such as pigments, fillers, catalyst supports, and photocatalysts (Barbe *et al.*, 1997; Ahmed and Attia, 1995; Ferroni *et al.*, 1996; Rekoske and Barteau, 1997; Atta *et al.*, 1992). Control of the size, shape, and structure of the colloidal precursor is an important factor in determining the properties of the final material. Titania powders have been obtained either directly from titanium-bearing minerals or by precipitation from solutions of titanium salts or alcoxides (Barringer and Bowen, 1985). However, these powders have generally lacked the properties of uniform size, equated shape, and unagglomerated state desired for quantitative studies of colloidal phenomena (Barringer and Bowen, 1985). Among them are the sol-gel, hydrothermal and peptization methods, with advantage of low reaction temperature (Ayllon *et al.*, 1992; Chen *et al.*, 2003; Yang *et al.*, 2001; Kim and Hahn, 2001; Ding and liu, 2004; Dhage *et al.*, 2004). It has been demonstrated that the initial nanostructure of titania precursors prepared by hydrolyzing titanium alcoxide strongly affects the crystallization behavior and characteristics of the final powder (Zeng *et al*, 1998). The peptization process has the same advantage of flexibility as the solgel method, in which the reaction can be carried out at a molecular level by heating the solution or using peptization agent (Zeng *et al*, 1998; Bischoff and Anderson, 1995).

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