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Effect of Benzyladenine on Enzyme System During Water Deficit Stress in Maize Seedlings

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Abstract

The effect of benzyladenine on polyethylene glycol-6000 (PEG-6000) induced water deficit stress on peroxidase (POX) and polyphenol oxidase (PPO) superoxide activities of 15 days old seedlings of maize cultivars CM-500 (Resistance) and GYC-9327 (Susceptible) were studied. Cv. CM-500 was characterized by highest enzyme activities. The Cv. GYC-9327 had lowest enzyme activities than that of CM-500.

Keywords: Peroxidase, Polyphenol oxidase, Maize, Zea mays L.

Introduction

Maize (*Zea mays L*.) is the third most important cereal crop after wheat and rice all over the world. Taxonomically, *Zea mays* L. belongs to tribe *Maydeae,* family *Poaceae* and genus *Zea*. It is believed that *Zea* might be derived from old Greek name *Zola* named for food grass. The other *Zea* species, referred to as *teosintes* are largely wild grasses native to Mexico and Central America (Doeblay, 1990). The center of origin for *Zea mays* (2n=20) has been established as the Mesoamerican region, now Mexico and Central America (Watson & Dallwitz, 1992).

Benzyladenine (BA) is the synthetic form of Cytokinins (CKs) known to regulate several aspects of plant height growth and development, including the response of plants to abiotic stress (Haberer and Keiber, 2002). Benzyladenine with seed treatment increases the growth rate and pod yield under moisture stress compared to water soaked seeds (Reddy *et al.,* 2003).Benzyladenine was negatively correlated with ascorbate peroxidase and catalase at vegetative stage.Chlorophyll content and relative water content increase by application of benzyl adenine. BA increased the activity of leaf peroxidase and poly phenol oxidase activity in PEG induced water deficit stress (Dhruve and vakharia, 2008).

Aim of the Study

To study the effect of PEG induced drought stress and benzyladenine on different enzyme activity of maize seedling.

Review of Literature

Drought stress lead to oxidative stress in crop plants due to enhanced generation of reactive oxygen species (ROS) in different cell compartments (Mittler, 2002). Plants have evolved antioxidant defense pathways to protect the cells from oxidative damage during the periods of normal growth as well as under stress conditions. Oxidative damage occurs either due to non induction of coordinated antioxidant defense cascade or their mismanagement (Noctor and Foyer 1998; Moller et al. 2007). Membrane lipid peroxidation or protein oxidation is the simplest criteria of assessing the extent of oxidative stress in the tissue. Efficient antioxidant defense minimizes the level of oxidative stress in the cell (Selote and Khanna-Chopra 2006).

Peroxidase (POX)

Moussa and Abdel-Aziz (2008) studied comparative response of drought tolerant and sensitive maize genotype to water stress. The water stress condition was created by irrigating the pots with polyethylene glycol (PEG) solution of 0.0, -5, -10 and -20 bars and observed on 21 days old seedling. While significantly increased activity of peroxidase observed under water stress.

Deshmukh and Dhumal (2005) investigated that the enzyme activity such as peroxidase was increased under PEG-6000 induced water stress on 15 days old seedling of sorghum (Sorghum bicolor).

Patil et al., (2005) studied the response of pearl millet hybrids under terminal drought condition at 3 different stages, each at 10 days interval (60, 70 and 80 DAS) during kharif season. Drought condition was created by withdrawing irrigation at 50 DAS. Four hybrids showed increased activity of peroxidase (POX) at second and third stage.

Abdelsamad et al., (2007) they found that peroxidase isozyme analysis and revealed differences in the banding profiles under PEG concentration (10% and 20%) with a total of seven bands, whereas three bands occurred in the anodal and four in cathodal direction. In the cathodal direction, the three bands were presented in the four untreated wheat genotypes and in Sakha 93 at 10 % PEG. Band number 3 was commonly disappeared at 10 % PEG in the other three genotypes and also in the four wheat genotypes at 20 % PEG. Among the four anodal direction bands, three bands were consistently appeared in the control and at 10 % PEG in all genotypes. At 20 % PEG, Sakha93 was strongly affected by the absent of all the four anodal bands.

Tuna et al., (2007) studied comparative effects of various salicylic acid derivatives on enzyme activities in salinity stressed maize (zea mays l.) plants. Maize (Zea mays L. cv. DK 684) plants grown in containers under salinity stress were investigated. Salicylic acid was applied by foliar treatments at five days interval. Among the investigated antioxidant enzymes, POX increased with salt treatment but decreased with SA treatments. Application of SA in 2 mM dose considerably increased POX activity and showed different effects of SA on anti-oxidant activity.

Poly Phenol Oxidase (PPO)

Deshmukh and Dhumal (2005) investigated that the enzyme activity such as polyphenol oxidase was increased under PEG-6000 induced water stress on 15 days old seedling of sorghum (Sorghum bicolor).

Tuna et al., (2007) studied the comparative effects of various salicylic acid derivatives on enzyme activities in salinity stressed maize (zea mays l.) plants. Maize (Zea mays L. cv. DK 684) plants grown in containers under salinity stress were investigated. Salicylic acid was applied by foliar treatments at five days interval. Among the investigated antioxidant enzymes, PPO increased with salt treatment but decreased with SA treatments. Application of SA in 2 mM dose considerably increased PPO activity and showed different effects of SA on anti-oxidant activity.

Materials and Methods

Two maize Cvs. CM-500 (Resistance) and GYC-9327 (Susceptible) tolerance and susceptible were raised in pot with three replications. Fifteen days old seedlings were treated with 10, 15 and 20 % PEG-6000 induced water deficit stress. Prior to this induction of stress seeds were treated with 25 ppm benzyladenine for one hour. There were eight treatments (**T_1** – Control, **T_2** - PEG- 6000 (10%) treatment, **T_3** - PEG- 6000 (15%) treatment, **T_4** - PEG-6000 (20%) treatment, **T_5** - Seeds treatment with Benzyladenine (25 ppm) for 1h., **T_6** - Seeds treatment with Benzyladenine (25ppm) + PEG (10%), i.e. T_2+T_5, T_7 - Seeds treatment with Benzyladenine (25 ppm) + PEG (15%), i.e. T_3 + T_5, T_8 -Seeds treatment with Benzyladenine (25 ppm) + PEG (20%), i.e. T_4 + T_5. This eight treatments were divided into two groups First groupT_1 to T_5 to study the effect of PEG stimulated water stress and second group treatments T_5 to T_8 observed the effect of benzyladenine under PEG induced water deficit stress. The seedlings were analysed for activity of enzymes i.e. Peroxidase and Poly phenol oxidase.

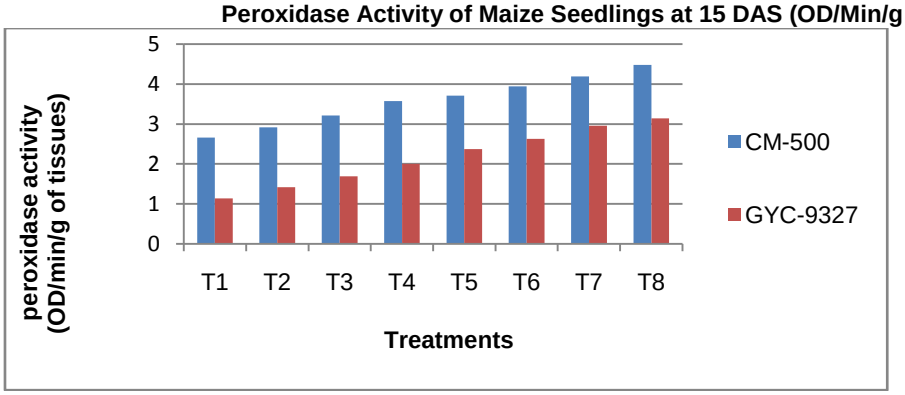
Result & Discussion

Peroxidase activity was expressed in O.D/min/g of tissues.The peroxidase (POX) activity was significantly increased during drought stress in resistant and susceptible genotype as compared to control condition.Resistant genotype (CM-500) exhibit higher and lower POX activity in treatment T_8 (4.48) and T_1 (2.66), respectively, while susceptible genotype showed the highest and the lowest POX activity in treatment T_8 (3.14) and T_1 (1.14). Drought stress treatments (T_2, T_3 and T_4) were significantly increased POX activity in both the resistant and susceptible genotypes as compare to control.

However, 25 ppm BA + 20 % PEG treatment (T_8) showed significantly higher POX activity in both resistant and susceptible genotypes as compared to control and stress conditions (fig.1).

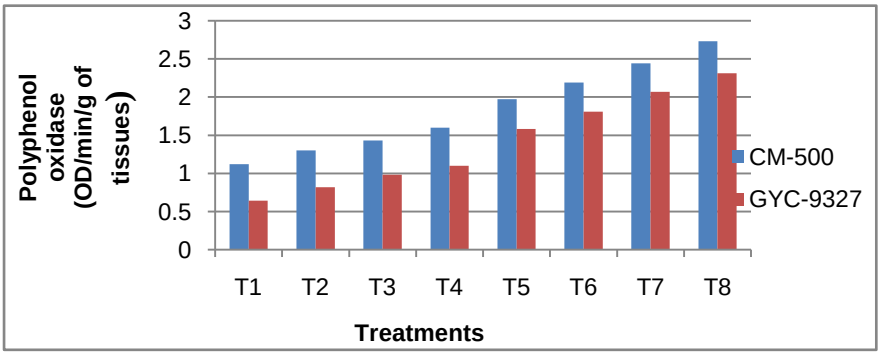
The due to combined effect of BA and PEG induced drought stress conditions (T_6, T_7 and T_8) were significantly increased POX activity in both genotypes as compared to drought stress conditions Dhruve et al., (2009) suggested that application of BA increased the activity of peroxidase in stressed plant. This could be indicative of an increased production of ROS and hence build up of a protective mechanism

Fig 1
Peroxidase Activity of Maize Seedlings at 15 DAS (OD/Min/g of Tissues)



T_1=control,
T_2= 10 % PEG,
T_3= 15 % PEG,
T_4= 20 % PEG,
T_5= BA soaked seed,
T_6=BA + 10 % PEG,
T_7=BA + 15 % PEG,
T_8 = BA +20 % PEG

Fig 2
Poly Phenol Oxidase Activity of Maize Seedlings at 15 DAS (OD/Min/G of Tissues)



T_1=control,
T_2= 10 % PEG,
T_3= 15 % PEG,
T_4= 20 % PEG,
T_5= BA soaked seed,
T_6=BA + 10 % PEG,
T_7=BA + 15 % PEG,
T_8 = BA +20 % PEG

Polyphenoloxidase (PPO)

Poly phenol oxidase (PPO) activity was significantly increased during drought stress in resistant and susceptible genotypes as compared to control condition. Resistant genotype (CM-500) exhibit higher and lower PPO activity in treatment T_8 (2.73) and in T_1 control (1.12), respectively, while susceptible genotype showed the highest and the lowest PPO activity in treatment T_8 (2.31) and in T_1 (0.64), respectively. Drought stress treatments (T_2, T_3 and T_4) were significantly increased PPO activitin both resistance and susceptible genotypes as compared to control (fig 2).

The due to combined effect of BA and PEG induced drought stress conditions (T_6, T_7 and T_8) was PPO activity significantly increased in both the genotypes as compared to drought stress conditions.

These results suggested that increase in PPO activity was observed in both genotypes under drought stress conditions but increased was more in resistant genotype than susceptible genotype. Dhruve et al., (2009) showed significantly higher PPO activity in BA soaked seeds as compared to control. The combined effect of BA and PEG induced drought stress the higher PPO activity.

Conclusion

Enzyme activity

Two different antioxidant enzymes at 15 DAS stage were under taken for biochemical changes in resistance and susceptible genotypes during drought stress. Peroxidase and Polyphenol oxidase activities showed significant differences and provide useful information of biochemical changes in maize seedling during drought. During PEG induced drought stress, POX and PPO activity were significantly increased in resistance and susceptible genotypes. However, BA treatment gave maximum activity in both genotypes. The combine PEG induced drought stress and benzyladenine also increased POX and PPO activity during drought stress in resistance and susceptible genotype. The BA had found better performance in resistance and susceptible genotype during drought stress condition.

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