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Polyamines and mycorrhiza based mitigation of cadmium induced toxicity for plant height and leaf number in maize

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Abstract
Average data of plant height (cm) and leaf number were recorded at 30, 60 and 90 days after sowing of maize in *Rabi* season under cadmium contaminated soil. The pot experiment was conducted. Putrescine and mycorrhiza were applied as the effective ameliorative agents for cadmium toxicity. The combination of putrescine and mycorrhiza showed the best combination for the mitigation of cadmium induced toxicity in plant height and leaf number plants^{-1}.

Keywords: Agriculture, biotic, cadmium, density, energy, forage

Introduction
Maize (*Zea mays* L.) is known as queen of cereals because of its higher genetic yield potential among the cereals. In India, about 28% of maize produced is used for food purpose, about 11% as livestock feed, 48% as poultry feed, 12% in wet milling industry (for example starch and oil production) and 1% as seed (Abbasi *et al.*, 2015) [1]. Heavy metal(s) are widespread pollutants of great concern as they are non-degradable and thus persistent. These metals are used in various industries from which effluents are consequently discharged into the environment. Heavy metals are metals with a density higher than 5 gcm^{-3}. Cadmium is a dangerous heavy metal having density 8.642 g cm^{-3} at 20 ^{0}C. Cadmium (Cd) is a highly toxic trace element and has been ranked seventh among the top 20 toxic elements (Pinto *et al.*, 2004) [2]. A polyamine is an organic compound having two or more primary amino groups –NH2 group Low-molecular-weight linear polyamines perform essential functions in all living cells.

Materials and Methods
The present study was carried out to evaluate the compatibility of polyamines (putrescine) and mycorrhiza in the mitigation of induced toxic effect of cadmium at 30, 60 and 90 DAS of *Rabi* maize. The pot size for the experiment was in the diameter of 30 cm and 25 cm in height with capacity for 10 kg of soil, having a small hole at the bottom. Morphological observations were recorded at 30, 60 and 90 days after sowing with the help of standard scale and careful observation.

Results and Discussion
Effect of polyamine (putrescine), mycorrhiza and their combination on plant height was studied in maize under the cadmium stress. Data were recorded at 30, 60 and 90 days after sowing (DAS) (Fig.1). It is evident that the average plant height was significantly reduced by 35%, 29% and 25% when exposed to heavy metal stress (T6) as compared to control (T0) at 30, 60 and 90 DAS of interval. Similarly, when plants were exposed to higher dose of heavy metal (T12) then its height was significantly reduced by 73%, 64% and 57% as compared to control (T0) on the dates of proposed interval. Exogenous application of endo mycorrhiza in the soil (T7) showed mitigation effect by increasing the plant height by 13.62%, 7.35% and 3.41% as compared to T6 at 30, 60 and 90 DAS. When treatment, T13 was compared to T12, the plant height increased significantly by12%, 6.7% and 2.66% at proposed DAS. In comparison to T6, the exogenous application of putrescine (T8) showed mitigating effect by increasing plant height by 17.5%, 10.15% and 5.51% on proposed DAS. The average plant

height was significantly enhanced as compared to T6 by 43%, 23% and 6% when treated with higher dose of putrescine (T9) with respect toT8. Similarly, when treatment, T14 was compared with T12, the plant height increased significantly with 22%, 36% and 40% at proposed DAS. The average plant height was significantly enhanced as compared to T12 by 69.25%, 53.73% and 41.84% when treated with higher dose of putrescine (T15) with respect to T14. The combination of putrescine and mycorrhiza showed the best mitigation effect in treatment T10 by increasing plant height by 11.8%, 10.21% and 10.31% with respect to treatment T6 at proposed DAS. When treatment T11 was compared with treatment T6 then significantly plant height increased by 46.02%, 27.84% and 11.52%, respectively. Similar effect was seen in the treatment (T16) with respect to treatment T12. In this treatment (T16), the plant height was found to increase significantly by 38.67%, 43.25% and 44.50%, respectively at proposed DAS. The treatment T17 was found to show better results; significant increase in plant height by 61.505%, 51.27% and 45.197% with respect to T12 was observed. So, the combination of putrescine and mycorrhiza showed the best combination for the mitigation of cadmium toxicity for the plant height. Deng *et al*. (2016) [8] noticed that cadmium (Cd) is a highly toxic trace element that enters the environment mainly from industrial processes and phosphate fertilizers. It can reach high levels in agricultural soils and is easily assimilated by plants. When taken up by plants, it induces various visible symptoms of phytotoxicity e.g. leaf roll, chlorosis, growth reduction in root and shoot, browning of root tips and eventually death. Involvement of PAs in modulating plant physiology and biochemistry to improve growth performance under metal stress (Wang *et al*. 2013). Cadmium toxicity is responsible for reduction of nutrient uptake and water-use efficiency, inhibition of cell division and elongation, damaging photosynthetic pigments, and net photosynthesis which ultimately results in strong inhibition of plant growth (Di-lin *et al*. 2011) [7]. Plant height, root length, and seedling dry weight reduced in Cd-exposed mung bean seedlings in the present study where the root showed higher growth reduction, compared to shoot. However, Spm (Polyamine) application reversed growth inhibition and increased growth in Cd-affected seedlings (compared to Cd stress alone). Involvement of PAs in modulating plant physiology and biochemistry to improve growth performance under metal stress was reported in a previous study (Azizian *et al.* 2011).

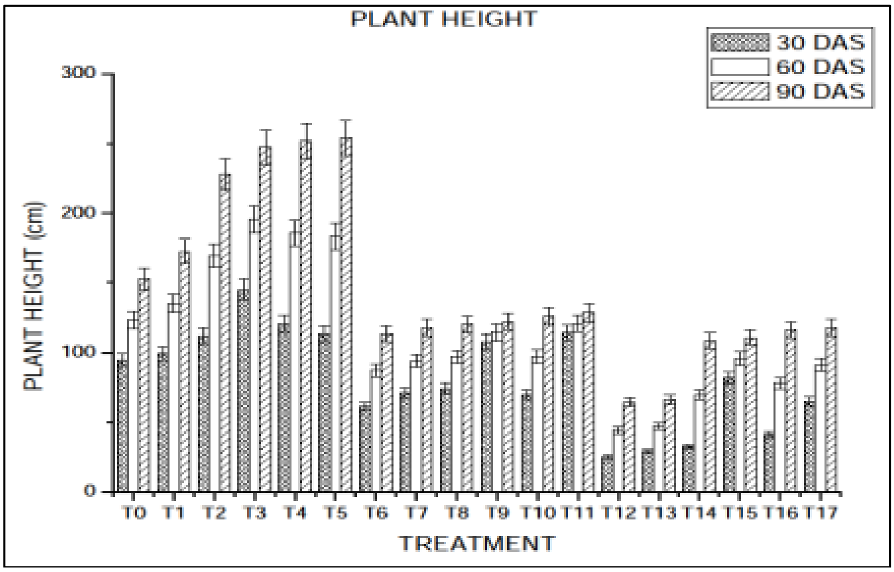

Fig 1: Effect of putrescine and mycorrhiza on Plant height (cm) in maize under cadmium stress condition

where, DAS=Days after sowing. Data are in the form of Mean ± SEM. S=Significance at $P \leq 0.05$ and $P \leq 0.01$, NS= Non Significant at $P \leq 0.05$ and $P \leq 0.01$ using Origin 6.1. T0= Control, T1=Control + Mycorrhiza, T2=Control + 2.5mM Putrescine, T3=Control + 5mM Putrescine, T4= Control + 2.5mM Putrescine + Mycorrhiza, T5=Control + 5mM Putrescine + Mycorrhiza, T6=0.07% $Cd(NO_3)_2$, T7=0.07% $Cd(NO_3)_2$ + Mycorrhiza, T8=0.07% $Cd(NO_3)_2$ + 2.5mM Putrescine, T9=0.07% $Cd(NO_3)_2$ + 5mM Putrescine, T10=0.07% $Cd(NO_3)_2$ + 2.5mM Putrescine + Mycorrhiza, T11=0.07% $Cd(NO_3)_2$ + 5mM Putrescine + Mycorrhiza, T12=0.15% $Cd(NO_3)_2$, T13=0.15% $Cd(NO_3)_2$ + Mycorrhiza, T14=0.15% $Cd(NO_3)_2$ + 2.5mM Putrescine, T15=0.15% $Cd(NO_3)_2$ + 5mM Putrescine, T16=0.15% $Cd(NO_3)_2$ + 2.5mM Putrescine + Mycorrhiza, T17= 0.15% $Cd(NO_3)_2$ + 5mM Putrescine + Mycorrhiza.

The data on leaf number ($Plant^{-1}$) were recorded at 30, 60 and 90 days after sowing (DAS) (Fig.2.) Average leaf number ($plant^{-1}$) was significantly reduced by 16%, 28% and 25.67% when exposed to cadmium stress (T6) as compared to control (T0) on dates of 30, 60 and 90 DAS of interval. Similarly, when plants were exposed to higher dose of heavy metal (T12) then its leaf number ($plant^{-1}$) was significantly reduced by 33%, 44% and 51.35% as compared to control (T0) on the dates of proposed interval. Exogenous application of endomycorrhiza in the soil (T7) showed mitigation effect by increasing leaf number by 8.0%, 6.25% and 1.81% as compared to T6 on the dates of 30, 60 and 90 DAS of interval. Similarly when treatment T13 was compared to T12 the average leaf number ($plant^{-1}$) increased significantly by 20%, 12% and 1.81% on proposed date of intervals. In comparison to T6, the exogenous application of putrescine (T8) showed mitigation of average leaf number ($plant^{-1}$) by 10.0%, 6.25% and 1.81% on proposed dates of interval. The average leaf number ($plant^{-1}$) was not significantly enhanced as compared to T6 with 1.81%, 10% and 1.8% when treated with higher dose of putrescine (T9) with respect to T8. Similarly when treatment T14 was compared with T12 the average leaf number ($plant^{-1}$) not increase significantly. The average leaf number ($plant^{-1}$) was not significantly enhanced as compared to T12 when it treated with higher dose of putrescine (T15) with respect to T14. The combination of putrescine and mycorrhiza showed the best mitigation effect by increasing the average leaf number (plant^{-1}) in treatment T10 with 10.0%, 9.35% and 1.818% with respect to treatment T6 on proposed date of interval. When treatment T11 was compared with treatment T6 then significant average leaf number (plant^{-1}) did not increased. Similar effect was seen in the treatment (T16) with respect to treatment T12. In this treatment the average leaf number (plant^{-1}) was found increased significantly by the 20.0%, 4.0% and 3.63%, respectively. The treatment T17 was found significant with 20%, 10.0% and 1.81% with respect to T12. So, the combination of putrescine and mycorrhiza showed the best combination for the mitigation of cadmium toxicity for the average leaf number (plant^{-1}). Courbot *et al*. (2004) [5] studied that the higher concentration of Cd was responsible for the complete inhibition of germination and growth was also decreased as concentration of heavy metals was increased as compared to control plants; minimum morphological growth occurred in the plants in which Pb concentration was 8g/kg soil and for Cd, it was 2.5g/kg soil when compared with control plants. Cheng *et al*. (2006) [6] reported that Cd in the nutrient solution produced growth inhibition in lettuce plants, the growth of lettuce shoots was significantly reduced after 14 days when compared to the control. Exogenous Spermine restored GR activity under Cu^{2+} and Cd^{2+} stress in sunflower leaf disks (Da-lin *et al*. 2011) [7].

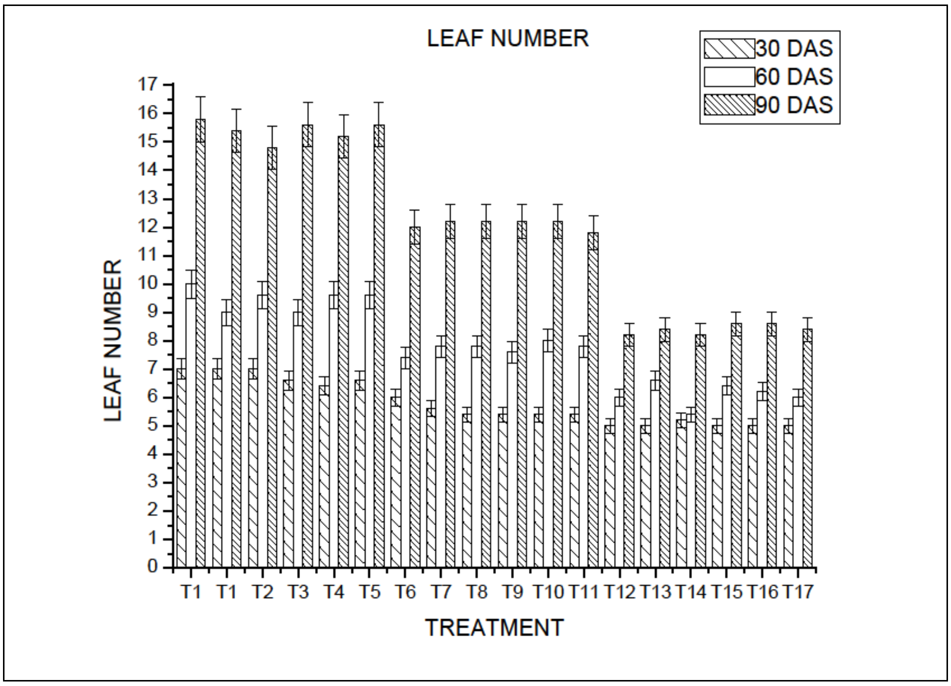

Fig 2: Effect of putrescine and mycorrhiza on Leaf number (plant-1) in maize under cadmium stress condition

where, DAS=Days after sowing. Data are in the form of Mean ± SEM. S=Significance at $P \leq 0.05$ and $P \leq 0.01$, NS= Non Significant at $P \leq 0.05$ and $P \leq 0.01$ using Origin 6.1. T0= Control, T1=Control + Mycorrhiza, T2=Control + 2.5mM Putrescine, T3=Control + 5mM Putrescine, T4= Control + 2.5mM Putrescine + Mycorrhiza, T5=Control + 5mM Putrescine + Mycorrhiza, T6=0.07% $Cd(NO_3)_2$, T7=0.07% $Cd(NO_3)_2$ + Mycorrhiza, T8=0.07% $Cd(NO_3)_2$ + 2.5mM Putrescine, T9=0.07% $Cd(NO_3)_2$ + 5mM Putrescine, T10=0.07% $Cd(NO_3)_2$ + 2.5mM Putrescine + Mycorrhiza, T11=0.07% $Cd(NO_3)_2$ + 5mM Putrescine + Mycorrhiza, T12=0.15% $Cd(NO_3)_2$, T13=0.15% $Cd(NO_3)_2$ + Mycorrhiza, T14=0.15% $Cd(NO_3)_2$ + 2.5mM Putrescine, T15=0.15% $Cd(NO_3)_2$ + 5mM Putrescine, T16=0.15% $Cd(NO_3)_2$ + 2.5mM Putrescine + Mycorrhiza, T17= 0.15% $Cd(NO_3)_2$ + 5mM Putrescine + Mycorrhiza.

Conclusion

The decrease in internodal length was noticed in both the higher doses of heavy metal treatments (0.07% Cd $(NO_3)_2$) and (0.15% $Cd(NO_3)_2$) and the significant increase was noticed in the treatment of putrescine and mycorrhiza. The decrease in number of nodes was also noticed in both the higher doses of heavy metal treatment (0.07% Cd $(NO_3)_2$) and (0.15% $Cd(NO_3)_2$) and the significant increase in the treatment of putrescine and mycorrhiza in combination was recorded.

References

1. Abbasi GH, Akhtar J, Malik W, Ali S, Chen ZH, Zhang G. Morpho-physiological and micrographic characterization of maize hybrids under NaCl and Cd stress. Plant growth Regulation. 2015; 75(1):115.
2. Pinto AP, Mota AM, Devarennes A, Pinto FC. Influence of organic matter on the uptake of cadmium, Zinc, copper and iron by sorghum plants. Science of Total Environment. 2004; 326:239-247.
3. Auda MA, Zinada IA, Ali EES. Accumulation of heavy metals in crop plants from Gaza Strip, Palestine and study of the physiological parameters of spinach plants. Journal of the Association of Arab Universities for Basic and Applied Sciences. 2011; 10(1):21-27.
4. Azizian A, Amin S, Maftoun M, Emam Y, Noshadi M. Response of corn to cadmium and drought stress and its potential use for phytoremediation. Journal of Agricultural Science and Technology. 2013; 15(2):303-310.
5. Courbot M, Diez L, Ruotolo R, Chalot M, Leroy P. Cadmium-responsive thiols in the ectomycorrhizal fungus *Paxillus involutus*. Applied and Environmental Microbiology. 2004; 70(12):7413-7417.

6. Cheng WD, Zhang GP, Yao HG, Wu W, Xu M. Genotypic and environmental variation in cadmium, chromium, arsenic, nickel, and lead concentrations in rice grains. Journal of Zhejiang University-Science. 2006; **7**(7):565-571.
7. Da-lin L, Kai-qi H, Jing-jing M, Wei-wei Q, Xiu-ping W, Shu-pan Z. Effects of cadmium on the growth and physiological characteristics of sorghum plants. African Journal of Biotechnology. 2011; 10(70):15770-15776.
8. Deng B, Yang K, Zhang Y, Li Z. Can heavy metal pollution defend seed germination against heat stress? Effect of heavy metals (Cu^{2+}, Cd^{2+} and Hg^{2+}) on maize seed germination under high temperature. Environmental Pollution. 2016; 216:46-52.