Int.J.Curr.Microbiol.App.Sci (2018) *7*(10): 1635-1639

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 10 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.710.185

Impact of Polyamines and Mycorrhiza on Chlorophyll Substance of Maize Grown under Cadmium Toxicity

Prasann Kumar[1, 2*], Purnima[1], Johnson Yumnam[1], Mandala Harshavardhan[1], Panuganti Swaraj Kuamr[1], Nada Jyoti[1], Sunil Kumar[1], Mohit Naik[1] and Lamneivah Misao[1]

[1]*Department of Agronomy, School of Agriculture,* [2]*Division of Research and Development, Lovely Professional University, Jalandhar, Punjab, 144411, India*

**Corresponding author*

Keywords

Maize (*Zea mays* L.), Heavy metals, Chlorophyll

Article Info

Accepted:
12 September 2018
Available Online:
10 October 2018

A B S T R A C T

An average data of chlorophyll a and chlorophyll b were recorded at 30, 60 and 90 days in the wake of sowing of maize in *Rabi* season under cadmium tainted soil. For chlorophyll a, the treatment T17 was found to significantly increase by 0.802%, 17.50% and 5.23% with respect to T12. Similarly, for chlorophyll b, the treatment T17 was found to have significant effect with 10.90%, 7.09% and 8.05% increase with respect to T12.

Introduction

Maize (*Zea mays* L.) is known as spearhead of crops on account of its higher hereditary yield potential among the grains. In India, around 28% of maize produced is utilized for nourishment reason, around 11% as domesticated animals feed, 48% as poultry feed, 12% in wet processing industry (for instance starch and oil generation) and 1% as seed (Abbasi *et al.*, 2015). Heavy metal(s) are across the board toxins of incredible worry as they are non-degradable and along these lines constant. These metals are utilized in different businesses from which effluents are thusly released into the earth. Substantial metals will be metals with a thickness higher than 5 gcm^{-3}. Cadmium is a hazardous substantial metal having thickness 8.642 g cm-^{3} at 200 C.

Cadmium (Cd) is an exceptionally harmful follow component and has been positioned seventh among the main 20 lethal components (Pinto *et al.*, 2004). A polyamine is a natural compound having at least two essential amino gatherings – NH_2 bunch Low-atomic weight direct polyamines perform basic capacities in every single living cell.

Materials and Methods

The present investigation was completed to assess the similarity of polyamines (putrescine) and mycorrhiza in the relief of initiated poisonous impact of cadmium at 30, 60 and 90 DAS of *Rabi* maize. The pot estimate for the trial was in the breadth of 30 cm and 25 cm in stature with limit with regards to 10 kg of soil, having a little gap at the base. Chlorophyll a and chlorophyll b perceptions were recorded at 30, 60 and 90 days subsequent to sowing with the assistance of standard scale and cautious perception. The chlorophyll content in leaves was estimated by the method of Arnon (1949). The chlorophyll extraction was done in 80% acetone. Leaves were washed thoroughly and cut into small discs. 100 mg of such leaves were placed in test tubes containing 25 mL acetone and chlorophyll was extracted. The suspension was centrifuged at 5000 rpm for 5 min and supernatant was used for measuring chlorophyll content. The absorbance was read at 645 nm and 663 nm. 80% acetone served on blank. The Chlorophyll content was estimated by the formula as given below:

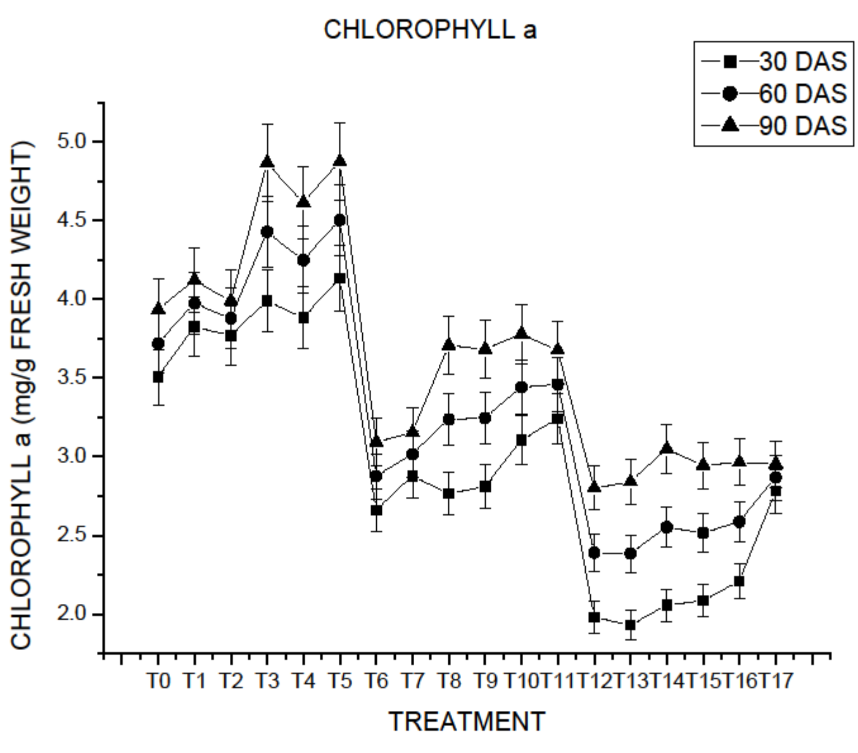
Chlorophyll 'a' Content = $(12.7 \times A663 - 2.69 \times A645) \times \frac{V}{1000 \times W}$

Chlorophyll 'b' content = $(22.9 \times A645 - 4.68 \times A663) \times \frac{V}{1000 \times W}$

Results and Discussion

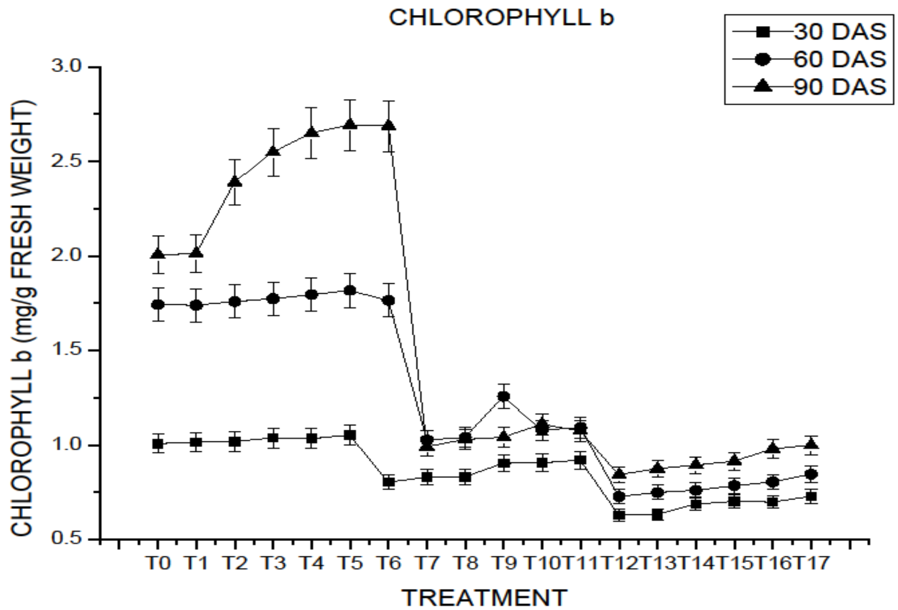
Data were recorded at 30, 60 and 90 days after sowing (DAS) (Fig.1). Chlorophyll a content was significantly reduced by 33.70%, 30.91% and 28.53% when exposed to heavy metal stress (T6) as compared to control (T0) on dates of 30, 60 and 90 DAS of interval. Similarly, when plants were exposed to higher dose of heavy metal (T12) its chlorophyll a content was significantly reduced by 60.65%, 48.71% and 38.51% as compared to control (T0) on the dates of proposed interval. Exogenous application of endomycorrhiza in the soil (T7) showed the mitigation effect by increasing the chlorophyll a content by 0.22%, 5.12% and 2.03% as compared to T6 on the proposed dates of interval. Similarly, when treatment T13 was compared to T12 the chlorophyll a content increased significantly by 1.0%, 6.35% and 1.35%. In comparison to T6, the exogenous application of putrescine (T8) showed the mitigation of chlorophyll a content by 0.108%, 13.22% and 20.85%. The average chlorophyll a content was significantly enhanced as compared to T6 by 0.152%, 13.55% and 19.97% when treated with higher dose of putrescine (T9) with respect to T8. Similarly, when treatment T14 was compared with T12 the chlorophyll a content increased significantly by 0.076%, 5.93% and 8.42% on proposed dates of interval. The average chlorophyll a content was significantly enhanced as compared to T12 with 0.106%, 4.615% and 4.95% when 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 chlorophyll a content in treatment T10 with 0.446%, 20.73% and 23.30% increase with respect to treatment T6 on proposed dates of interval. When treatment T11 was compared with treatment T6 then significantly chlorophyll a content was increased by 0.584%, 21.35% and 19.7%, respectively. Similar effect was seen in the treatment (T16) with respect to treatment T12. In this treatment the chlorophyll a content was found to increase significantly by the 0.228%, 7.17% and 5.57%, respectively. The treatment T17 was found to significantly increase 0.802%, 17.50% and 5.23% with respect to T12. So, the combination of putrescine and mycorrhiza showed the best combination for the mitigation of cadmium toxicity for the chlorophyll a content. Plants exposed to Cd can show many symptoms such as chlorosis, leaf roll, and necrosis (Benavides *et al.,* 2005). Chlorosis, leaf roll and stunting are the main and most easily observed toxic symptoms in the presence of excessive amounts of heavy metals. Toxicity may result from the binding of metals to sulphydryl groups in proteins leading to disruption of structure, inhibition of activity and deficiency of essential elements. Chlorophyll contents in mung bean leaf declined with increasing Cd concentrations which is similar with previous studies (Doganlar and Atmaca, 2011). Cadmium-induced reduction in chl content and chlorosis might be due to the reduction of Fe in leaves and to the negative effects of Cd on chl metabolism (Cabala *et al.,* 2011). Degradation of chl due to high activity of chlorophyll-degrading enzyme and/or the inhibition of its biosynthesis by Cd were proposed to reduce photosynthesis and growth in previous studies (De Andeade and Da Silveria, 2008). However, chl content increased after Spmpretreatment, compared to Cd stress only. According to scientist, PAs entering the intact chloroplast protect the photosynthetic apparatus from stress effects. Polyamines stabilize molecular complexes in thylakoid membranes structural constituent of chl and protected chl under osmotic stress (Fig. 1).

Fig.1 Effect of putrescine and mycorrhiza on Chlorophyll “a” content (mg g^{-1} FW) in maize under cadmium stress condition



Where, DAS=Days after sowing. Data are in the form of Mean ± SEM. S=Significance at P≤0.05 and P≤0.01, NS= Non-Significant at P≤0.05 and P≤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.

Fig.2 Effect of putrescine and mycorrhiza on germination chlorophyll "b" content (mg g^{-1} FW) in maize under cadmium stress condition



Where, DAS=Days after sowing. Data are in the form of Mean ± SEM. S=Significance at P≤0.05 and P≤0.01, NS= Non-Significant at P≤0.05 and P≤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.

Chlorophyll b content was significantly reduced by 22.13%, 58.86% and 67.97% when exposed to heavy metal stress (T6) as compared to control (T0) on dates of 30, 60 and 90 DAS of interval (Fig. 2). Similarly, when plant was exposed to higher dose of heavy metal (T12) then its chlorophyll b content was significantly reduced by 41.22%, 61.09% and 60.07% as compared to control (T0) on the dates of proposed interval. Exogenous application of endomycorrhiza in the soil (T7) showed mitigation effect by increasing the chlorophyll b content by 2.72%, 15.75% and 15.65% as compared to T6 on the proposed dates of interval. Similarly, when treatment T13 was compared to T12 the chlorophyll b content was found to increase significantly by 0.21%, 1.32% and 1.60% on proposed dates of interval. In comparison to T6, the exogenous application of putrescine (T8) showed mitigation of chlorophyll b content with 2.94%, 16.59% and 17.66% increase on proposed dates of interval. The average chlorophyll b content was significantly enhanced as compared to T6 by10.79%, 29.58% and 18.23% when treated with higher dose of putrescine (T9) with respect to T8. Similarly, when treatment T14 was compared with T12 the chlorophyll b content increased significantly by 6.32%, 2.04% and 2.63% on proposed dates of interval. The average chlorophyll b content was significantly enhanced as compared to T12 by 7.96%, 3.48% and 3.66% when 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 chlorophyll b content in treatment T10 by 11.12%, 18.88% and 21.79% with respect to treatment T6 on proposed dates of interval. When treatment T11 was compared with treatment T6 then chlorophyll b content increased significantly by 12.64%, 19.78% and 19.98% respectively. Similar effect was seen in the treatment (T16) with respect to treatment T12. In this treatment, the chlorophyll b content was increased by the 7.63%, 4.63% and 7.07% respectively. The treatment T17 was found to have significant effect with 10.90%, 7.09% and 8.05% increase with respect to T12. So, the combination of putrescine and mycorrhiza showed the best combination for the mitigation of cadmium toxicity for the chlorophyll b content. Sandalio *et al.,* (2001) reported that the chloroplasts, the major component of photosynthetic organ, are highly sensitive to damage exposed to Cd toxicity. Curbot *et al.,* (2004) observed that the two wheat varieties to which Cd and Pb were applied, total chlorophyll decreased. Cho and Kim (2003) noticed that cadmium has a great mobility in soil as compared with other metals, and easily taken up by roots and is translocated to different plant parts. Singh *et al.,* (2003) showed that both growth and photo synthetic pigments affected by the presence of heavy metals.

The decrease in chlorophyll a and b content were 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.

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How to cite this article:

Prasann Kumar, Purnima, Johnson Yumnam, Mandala Harshavardhan, Panuganti Swaraj Kuamr, Nada Jyoti, Sunil Kumar, Mohit Naik and Lamneivah Misao. 2018. Impact of Polyamines and Mycorrhiza on Chlorophyll Substance of Maize Grown under Cadmium Toxicity. *Int.J.Curr.Microbiol.App.Sci.* 7(10): 1635-1639.
doi: https://doi.org/10.20546/ijcmas.2018.710.185