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Zinc Phytotoxicity in Black gram (Vigna mungo)

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Abstract : **The objective of the present study is to evaluate morphological responses of black gram seedlings exposed to five different concentrations of soil zinc. Black gram is the most important pulse crop cultivated in Kharif, Rabi and Summer throughout India. Zinc is a heavy metal as well as essential micronutrient needed by plants in small concentrations. Zinc plays important role in black gram crop growth and yield. By the application of recommended dose of zinc fertilizer Black gram crop yield can be increased, but at higher concentrations zinc causes phytotoxicity to the black gram plants. Intensive and indiscriminate use of agrochemicals resulted into excessive accumulation of zinc in agriculture soils. Pot culture experiment was conducted to study the phytotoxic symptoms of zinc metal in black gram crop. In this present work the external visible zinc phytotoxic symptoms on black gram seedlings are recorded at five different concentrations of soil zinc. Zinc phytotoxic symptoms recorded in this study are as follows low plant population due to failure of seed germination, inhibited root growth, brown necrotic spots on the leaves, down ward curling and rolling of leaves, negatively geotropic roots. The information provided by this study can be useful for researchers, black gram cultivating farmers and agriculture scientists.**

IndexTerms **- Black gram, Zinc Phytotoxicity, Negative geotropism, Necrosis, Tip burning, Downward curling**

I. INTRODUCTION

Black gram (Vigna mungo) belongs to family Fabaceae and sub family Faboideae. In India black gram is one of the most important pulse crops grown in Kharif, Rabi and Summer seasons. Generally, it is consumed in the form of Dal. This crop is also used as nutritive fodder as well as green manure crop. The crop is resistant to adverse conditions and improve the soil fertility by fixing atmospheric nitrogen into the soil.

Zinc is a heavy metal and essential necessary micro nutrient needed by black gram in smaller concentrations. Zinc plays important role in crop growth and yield. By the application of recommended dose of zinc fertilizer black gram crop quality and yield can be improved. But at higher concentrations zinc negatively affects the crop growth and development. This condition is called as zinc induced "Phytotoxicity". In black gram. Zinc phytotoxicity is not a common phenomenon, black gram is resistant to higher levels of soil zinc. But in recent times black gram become more prone to Zinc phytotoxicity.

Due to industrialization, urbanization, modern intensive agriculture zinc concentrations in agriculture soils already reached to phytotoxic levels. In this modern era of agriculture for getting higher crop yields excessive usage of agro chemicals like chemical fertilizers and pesticides become common practice. Indiscriminate application of agrochemicals is the main reason behind the accumulation of excessive zinc in soils. Zinc is a heavy metal, at elevated concentrations causes "nutrient soil pollution".

In agriculture soils nutrient pollution became major problem of concern which is responsible for phytotoxicity and yield reduction. Nutrient pollution disturbs the soil ecosystem, increases the soil acidity and also reduces the soil microbial activity which in turn ultimately reduces the productivity of soil. In recent times zinc metal deficiency as well as pollution particularly in agriculture soils emerged as a major agronomic challenge.

There is difficulty in differentiating between visible symptoms of zinc deficiency and zinc phytotoxicity. Identification of zinc phytotoxicity symptoms in black gram, their diagnosis and determination of extent of damage caused to plants, is a great challenge for agriculture scientists. Excessive soil zinc can compete with other plant nutrients like Phosphorous, Iron, Manganese and can cause their deficiencies. Hence there is a pressing need for the evaluation of zinc phytotoxic symptoms in black gram. The objective of the present study is to evaluate morphological responses of black gram seedlings exposed to five different concentrations of soil zinc.

Many researchers are reported about the phytotoxicity of excess soil zinc in black gram crop.

S.B.Kalyanaraman et al (1994) conducted earthen pot experiment with black gram and noticed the excess accumulation of Zn in the plant induced a reduction in the content of some macro (Calcium, Magnesium, Potassium, Sodium) and micro elements (Iron, Manganese, copper) in the plant leaves which indicates the zinc Phytotoxicity.

S.B.Kalyanaraman et al (2008) conducted a glass house earthen pot experiment to study the effect of Zinc on growth of black gram and noticed Zinc phytotoxicity at higher concentrations

Mingda Liu et al (2013) experimented and identified the concentration and spatial distribution of Zinc in agricultural soils on the basis of the integrated Pollution Index (IPI) and Index geo accumulation (Igeo).

Monika Tiwari et al (2015) studied the effect of copper, and zinc sulphate on seed germination and growth of Black gram. Both are toxic but copper is more toxic than Zinc.

Murray B Mc Bride et al (2015) worked on aging of toxicity of copper and zinc over 10 years period and found that zinc and copper salts express significant phytotoxicity after 10 years of field aging despite shift of the metals into less labile forms.

Z.Rengel (2015) reviewed about the acidification of the rhizosphere soil increases mobilization of micronutrients like zinc. For zinc 100-fold increase in solubility for each unit of P^H decrease.
D.Montal VO et al (2016) described the fate of Zinc Fertilizer, it is not only depending on the fertilizer composition but also on the interaction of Zinc with the soil and the fertilizer application method.
Sushree Sangita Barik et al (2018) conducted an experiment to study effect of higher concentrates zinc on black gram (Vigna mungo) and suggested that the presence of zinc at higher concentrations resulted in growth inhibition, structural damage of black gram plant.
Srabani Kar et al (2020) studied adverse effect of Zinc on growth and metabolic activities of pulse crops and suggested farmer should adapt foliar application of zinc to take more benefit and avoid soil pollution.
Sachidanand Tripathi et al (2020) Reported about negative environmental implications of excessive fertilizers and pesticide usage.
Prezemyslaw Tkaczyk et al (2020) conducted three years of field study and concluded that high rate fertilisation with ammonium nitrate accelerated the soil acidification process, which was additionally intensified by the application of superphosphate and potassium salt.
G.Jat et al (2021) recommended zinc @ 5kg per hectare along with N P K for getting higher productivity in black gram.
According to past literature zinc phytotoxicity in black gram crop have been less studied in intact plants.

In this present work the external visible zinc phytotoxicity symptoms on black gram seedlings are recorded at five different concentrations of soil zinc.

RESEARCH METHODOLOGY

Pot culture experiment was conducted for observing the morphological symptoms of black gram plant at five different “Soil Zinc” concentrations. Red soil was collected from agriculture field, the collected red soil was sun dried for 3 days. All kinds of crop residues, stubbles, weeds were removed from the soil. Then the soil was grounded for removing large clods and subsequently sieved by stainless steel sieve. This soil is tested for soil zinc concentration and other physiochemical parameters. Black gram seeds and zinc fertilizer (Chelated Zinc EDTA – 12%) purchased from local market. Plastic pots with drainage holes are used in this experiment. Approximately 500 gm of soil is used for each treatment.

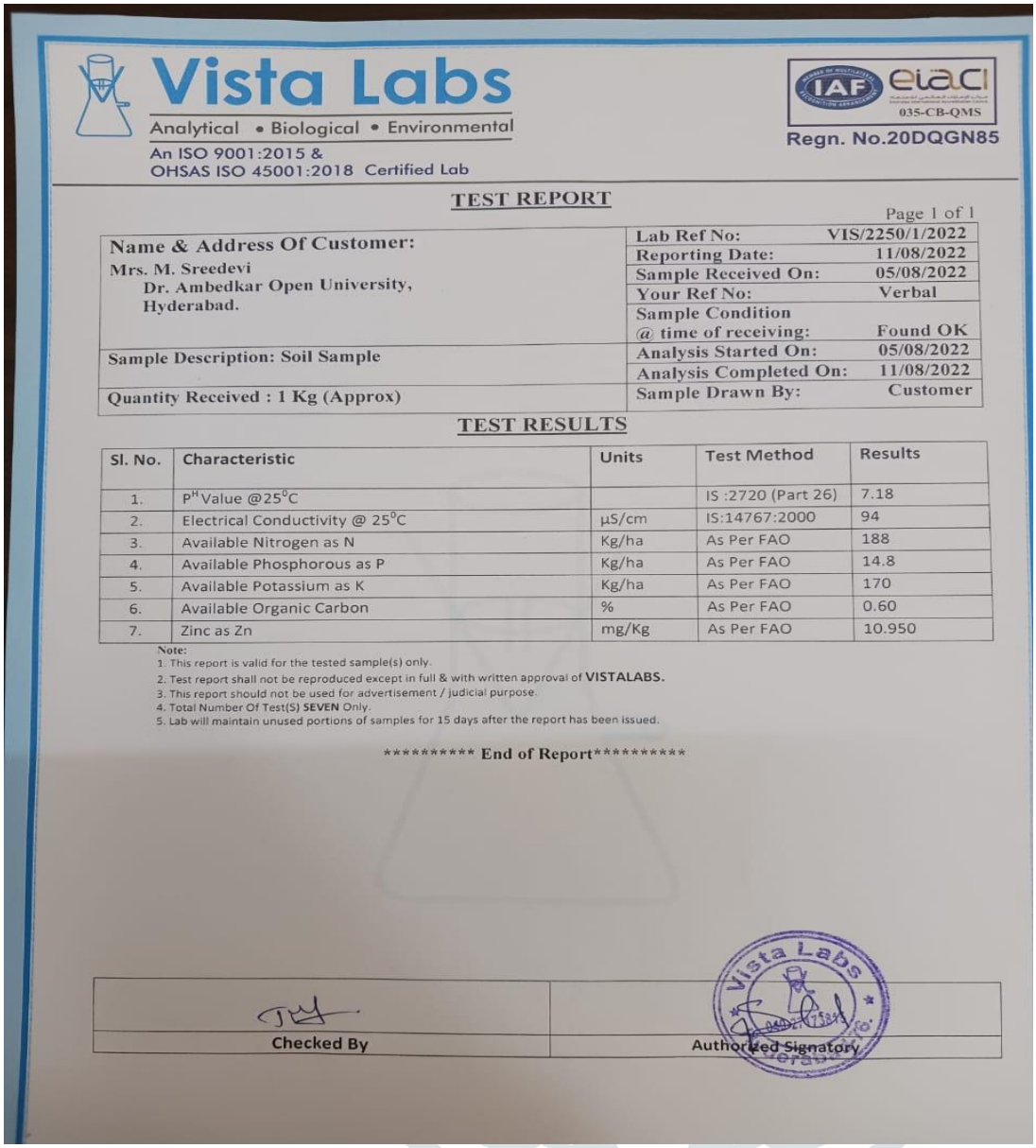
The experiment was conducted by taking five treatments comprising five different concentrations of zinc fertilizer. The treatments were named as A, B, C, D, E. Three replications were taken for each treatment. The chemical fertilizer is thoroughly mixed with soil before sowing of seeds.

Treatment A is “control” zinc fertilizer is not added to soil. But the soil zinc concentration is 0.01grams of zinc per kg of soil, in treatment B 5gm of fertilizer is added per kg of soil, in treatment C 10 gm of fertilizer per kg of soil, treatment D 15 gm of fertilizer per kg of soil, treatment E 20 gm of fertilizer per kg of soil added.

The pots were kept under sunlight in an enclosed area. All the treatment pots along with control were arranged in a completely randomized design only little water is given to pots in order to avoid excess drain of fertilizer along with water.

RESULT AND DISCUSSION

Soil Test Report



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Regn. No.20DQGN85

TEST REPORT

Page 1 of 1

Name & Address Of Customer: Mrs. M. Sreedevi, Dr. Ambedkar Open University, Hyderabad.	Lab Ref No: VIS/2250/1/2022
	Reporting Date: 11/08/2022
	Sample Received On: 05/08/2022
	Your Ref No: Verbal
	Sample Condition @ time of receiving: Found OK
Sample Description: Soil Sample	Analysis Started On: 05/08/2022
	Analysis Completed On: 11/08/2022
Quantity Received : 1 Kg (Approx)	Sample Drawn By: Customer

TEST RESULTS

Sl. No.	Characteristic	Units	Test Method	Results
1.	P^H Value @25°C		IS :2720 (Part 26)	7.18
2.	Electrical Conductivity @ 25°C	µS/cm	IS:14767:2000	94
3.	Available Nitrogen as N	Kg/ha	As Per FAO	188
4.	Available Phosphorous as P	Kg/ha	As Per FAO	14.8
5.	Available Potassium as K	Kg/ha	As Per FAO	170
6.	Available Organic Carbon	%	As Per FAO	0.60
7.	Zinc as Zn	mg/Kg	As Per FAO	10.950

Note:
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2. Test report shall not be reproduced except in full & with written approval of VISTALABS.
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Checked By | Authorized Signatory

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PHYTOTOXIC SYMPTOMS OF ZINC IN BLACKGRAM

TREATMENT -A

CONTROL

TREATMENT-B

5 Grams of Zinc fertilizer

TREATMENT-C

10 Grams of Zinc fertilizer

TREATMENT-D

15 Grams of Zinc fertilizer

TREATMENT-E

20 Grams of Zinc fertilizer

Inhibited growth of Seedlings

TREATMENT-E

Initial Phyto toxicity symptoms

TREATMENT – B

Inhibited Root Growth

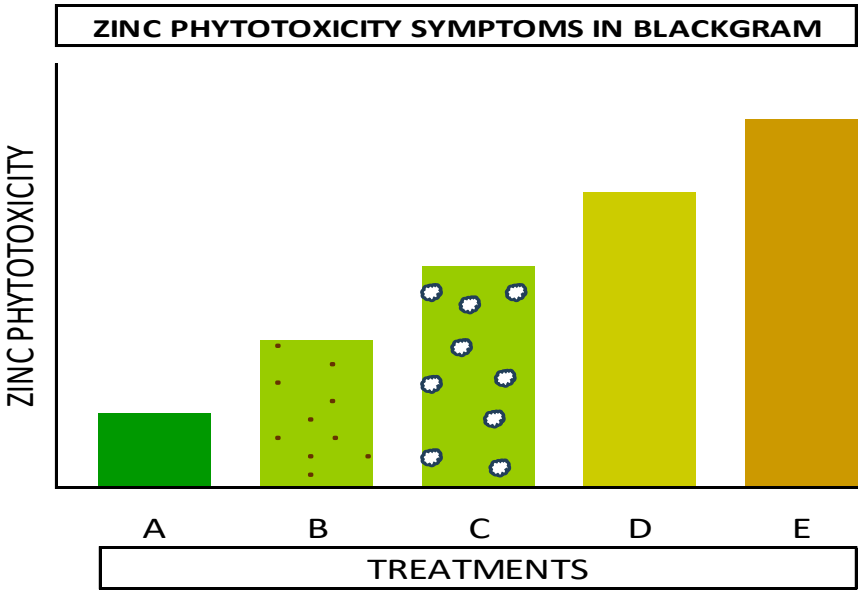
TREATMENT-C

Negatively geotropic Roots

TREATMENT-D

ZINC PHYTOTOXICITY IN BLACKGRAM

S.No.	Treatment	Soil Zinc Concentration (Grams)	Zinc Phytotoxicity
1	A	0.01	Absent
2	B	5.00	Less
3	C	10.00	High
4	D	15.00	Very High
5	E	20.00	Extreme



Symptoms are recorded 20 days after sowing. In the present study zinc phytotoxic symptoms are clearly visible in all treatments except Control (Treatment A). In Treatment B small rusty brown necrotic spots observed on the leaves. Necrosis is caused by premature death of cells. Downward curling of young leaves is evident. In Treatment C inhibited root growth, scorching of leaves, rolling and curling of leaves, death of leaves observed. In Treatment D plant growth is totally affected except one single seedling all plants are died. This is due to ***negatively geotropic*** root development. Inhibited root growth, very poor development of lateral roots, plant root system not able to tolerate high concentrations of soil zinc and exhibited negative geotropism. In negative geotropism the roots grow upward, against the gravitational pull, above the soil surface. In this case plants are not able to establish themselves in soil and gets dried up and die. Because of this reason only single seedling remained with the tip burning symptom on leaf. In Treatment E plant population drastically reduced due to failure of seed germination, even though seeds are germinated, plants are not able to survive, dried up and died. After 10 days of sowing further growth is not observed in the seedlings, total plant population is vanished.

The phytotoxic symptoms of zinc may vary with soil type, soil PH, soil zinc concentrations and other parameters. Black gram crop genotypes and verities are differ greatly in their tolerance to high zinc concentrations.

The present symptoms exhibited by crop plants at soil PH 7.18 (slightly alkaline) and the initial zinc concentration in soil taken for study is 0.01 grams per kg of soil.

CONCLUSION

Hence soil must be tested before sowing of seeds for zinc concentration. Appropriate studies are needed to optimize the zinc fertilizer application dosage. Instead of soil application, need based spraying of Zinc fertilisers on crop can be more useful. Judicious application of agricultural chemicals is one of the most important key factors for getting qualitative crop produce as well as achieving sustainable agriculture production. Soil health can be protected by avoiding excessive usage of chemicals. The information provided by this study can be useful for researchers, black gram growing farmers and agricultural scientists.

REFERENCES

- Ayyapam M, Bakiyaraj.R Mhakavi T and Suresh kanth (2018), Accumulation of Zinc and its effect on growth, bio chemical of Blackgram (Vigna mungo L), JETIR, volume 5, issue 10.
- D.Montalvo, MC Langhin (2016), Zinc Fertilizers an over view, advances in agronomy
- Fatna Zaakour, Mariame kholaiq, Aya khouchlaa, Ikram Ei Mjiri, Abdelmejid Rahimi, Najib Saber (2022), Journal of Ecological Engineering-23 (5), 1-15
- Fiona H.M> Tang, Manfred Lenzen, Federico Maggi (2021), Risk of Pesticide pollution at the global scale, Nature Geoscience (14), 206-210
- G.Jat, S.K.Sharma, R.H Meeno, D.Jain, R.Choudary, R.S.Choudary, S.K.Yadav, (2021) Amelioration of Zinc deficiency in blackgram (Vigna mungo L.) through soil applied Zinc in Typic Haplustepts soil of Rajasthan, Journal Environmental biology Vol 42 (6), PP 1554-1559
- Jelle Metens and Erik Suolders (2012), Heavy metals in soils, part of the Environmental pollution book series (EPOL, Volume 22), PP 465-493
- Murray B MC Bride, Meifang Cai (2015), Copper and Zinc aging in soils for a decade: changes in metal extractability and phytotoxicity, Environmental Chemistry 13 (1), 160-167
- Monica Tiwari, M.Kumar, Rekha Yadav, U.Jain (2015), Impact of heavy metals (Copper and Zinc) on seed germination and seedling growth in Vigna mungo L. Hepper Var Azad (KU-96-3) Life Sciences leaflets 65, 55 to 65.
- M Dhandapani, S Chitra, M Sangeetha, S Geetanjali, A Shanmugam, K Nelson (2023) Source-Sink alterations in Rice fallow Adaptive Blackgram variety ADTS for enhancement of yield and quality of see, International Journal of Environmental and climate change 13 (6), 194, 202
- Mingda Liu, Yie Li, Weizhang, Yaojing Wang (2013) International symposium on Environmental Sciences and Technology, Assessment and spatial distribution of Zinc pollution in agricultural Soils of Chaoyoung, China, Procedia Environmental Sciences 18-283-289.

- Martin Inseng, Matthias Wiggenhauser, Michael muller, Armin Keller, Emmanuel Frossard Wol F gang wilcke, and Moritz Bigalke (2019), The fate of Zinc in agricultural soils: A stable Isotope Approach to Anthropogenic impact Soil formation and soil plant cycling, Environment Science and Technology 53 (8).
- Natasha N, Shahid M, Bibi J, Iqbal J, Khalid S, Murtaza B, Bakhat HF, Farooq ABU, Amjad M, Hammad HM, Niazi NK, Arshad M (2022) Zinc in Soil-Plant-Human system: A data analysis review Sci Total Environ, PMID: 34871690, DOI 10 1016/J. sci tot env.2021. 152024.
- Przemyslaw T Kaczyk, Agnieszka Mocek-plociniak, Monika Skowronska, Wieslaw Bednarek, Sebastian Kvsmeirz and Elzbieta Zawierucho (2020), The mineral Fertilizer dependent chemical parameters of soil acidification under field conditions, sustainability, Vol 12 Issue 17.
- S.B. Kalyanaraman, P Sivagurunathan (1994), Effect of Zinc on some important macro and micro elements in Blackgram leaves, communicates in soil science and plant analysis 25 (13-14), 2247-2259
- S.B.Kalyanaraman, P Sivagurunathan (2008), Effect of Cadmium, Copper and Zinc on the growth of Blackgram, Journal of Plant Nutrition 16 (10): 2029-2042.
- Srabani Kar Ravindra Prasad (2020), Adverse Effects of Chromium, Cadmium and Zinc on the growth and metabolic activities of pulse crops and their key management strategies: A Review, International Journal of current microbiology and applied sciences, Vol 9.
- Sachidanand Tripathi, Pratap Srivastava, Raj kumari, S.Devi, Rahul Bhandouria (2020), Chapter 2- Influence of synthetic fertilizers and pesticides on soil health and soil microbiology, agro chemical deterioration, treatment and remediation, Pages 25-54.

- Sushree Sangita Barik, Dr Rasmita Padhy (2018), Morphologial analysis of black gram (Vigna mungo L) with zinc stress, The Pharma Innovation Journal 7 (7): 465-469
- Xingyuan Li, Yongzhang Zhou, Jingru Zhang (2021), Status and associated human health risk of Zinc accumulation in agricultural soils across China, process safety and Environmental protection, Vol 146, Pages 867-876.
- Z.Rengel (2015) Availability of Mn, Zn & Fe in the rhizosphere, Journal of Soil science and plant nutrition.