

**EFFECT OF ZINC METAL STRESS ON SEED GERMINATION AND SEEDLING BEHAVIOUR OF *VIGNA UNGUICULATA* L.****AMEETA SHARMA\*<sup>1</sup> AND PARMILA <sup>2</sup>***Department of Biotechnology, The IIS University, Jaipur-302020, Rajasthan, India.***ABSTRACT**

The present study focuses on the germination response of different cowpea varieties to metal stress of Zinc and its relationship with the germination. The zinc stress was tested in different concentrations on three varieties of *Vigna unguiculata* viz. V1 (Pahuja), V2 (Rc 19) and V3 (Pusa Komal). Results all together showed that V1 variety was found to be resistant as compared to other two varieties and V2 was found to be relatively less sensitive than V3. Results suggested that all different concentration of metals damagingly influenced % germination and germination parameters like shoot, root, seedling length, fresh and dry weight of all three varieties up to certain extent.

**KEY WORDS:** Cowpea, Seed germination, Morphological parameters, Zinc stress.**\*Corresponding author****AMEETA SHARMA**

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## INTRODUCTION

Extreme echelon of heavy metals contamination in the soil and environment due to speedy industrialization and urbanization has unfavorably affected the agriculture. The outcome of this is adverse affect on seed germination and plant growth, which may modify the concentration of cell bio-molecules and in turn also interfere with the enzyme activity of development and growth metabolism. Heavy metals are quite important for research purpose in terms of toxicological significance to human healthcare, animals and plants.<sup>1</sup> In the last 25 years, throughout the World, cowpea production has increases noticeably whereas in United States production of dry cowpea has declined from little less than one million acres to a few thousand over the same period.<sup>2</sup> A large amount heavy metal salts are water-soluble and get dissolved in wastewater where they cannot be separated easily by physical separation methods.<sup>3</sup> Physico-chemical methods are expensive when heavy metal concentration is quite low, and then are left biological methods viz. bio-sorption or bioaccumulation which is very lucrative in terms of their feasibility and availability.<sup>4</sup> Various pollutants in varied toxicity, concentration and specification target and enter plant via soil and the atmosphere. Usually heavy metals have atomic density more than 4 g/cm<sup>3</sup> and they include chromium, lead, arsenic, cadmium, nickel, zinc, cobalt, iron, silver and the platinum.<sup>5</sup> The toxic effects of these heavy compounds causes harm to plants by changing plant's physiology and metabolism.<sup>6</sup> If heavy metal finds their way inside the plant tissue then as a consequence detoxification tolerance mechanisms for metal sequestration and compartmentalization are activated in different intracellular organelle followed by processes like metal ions trafficking and binding to cell wall, biosynthesis of osmoprotectants like proline, chelation of metal ions and sooner or later if these are ineffective resulting with heavy metal toxicity then initiation of antioxidant defense mechanisms happens.<sup>7,8,14</sup> Hence, keeping this in outlook, present study was undertaken to observe the Zinc metal stress effect on plant *Vigna unguiculata* L. Three easily available, popular and majorly cultivated varieties in Rajasthan were taken viz. Pahuja, Rc 19 and Pusa Komal to find out the seed germination characteristic of cowpea and the following objectives were designed:

1. To find out the tolerance and sensitivity level of cowpea variety to different concentrations of Zinc stress.

2. To study the response of seed and effect on seed germination parameters of cowpea seeds to different concentration of zinc stress. Thus the present work aimed at understanding 2 major areas, (i) Metal tolerance of cowpea varieties as well as, (ii) metal effect on seedling growth by analysing morphological germination parameters (seed germination, shoot length, root length, seedling length, fresh and dry weight).

## MATERIALS AND METHODS

For this metal stress study laboratory experiments were performed on three different varieties of cowpea which were taken from the local distributor. Experimental details are as follows:

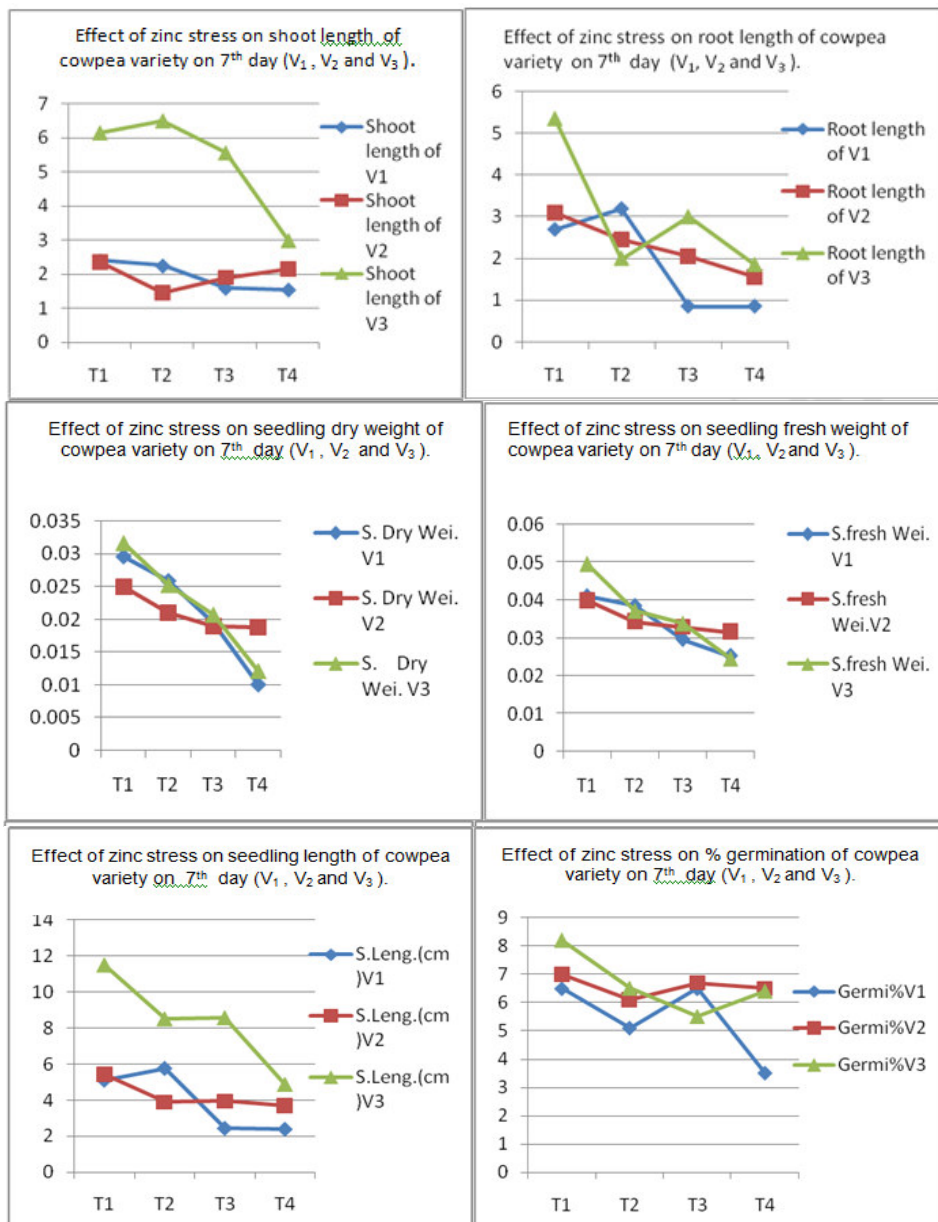
The seed varieties used are as follows:

1. V<sub>1</sub>-Pahuja
2. V<sub>2</sub>-Rc19
3. V<sub>3</sub>-Pusa Komal

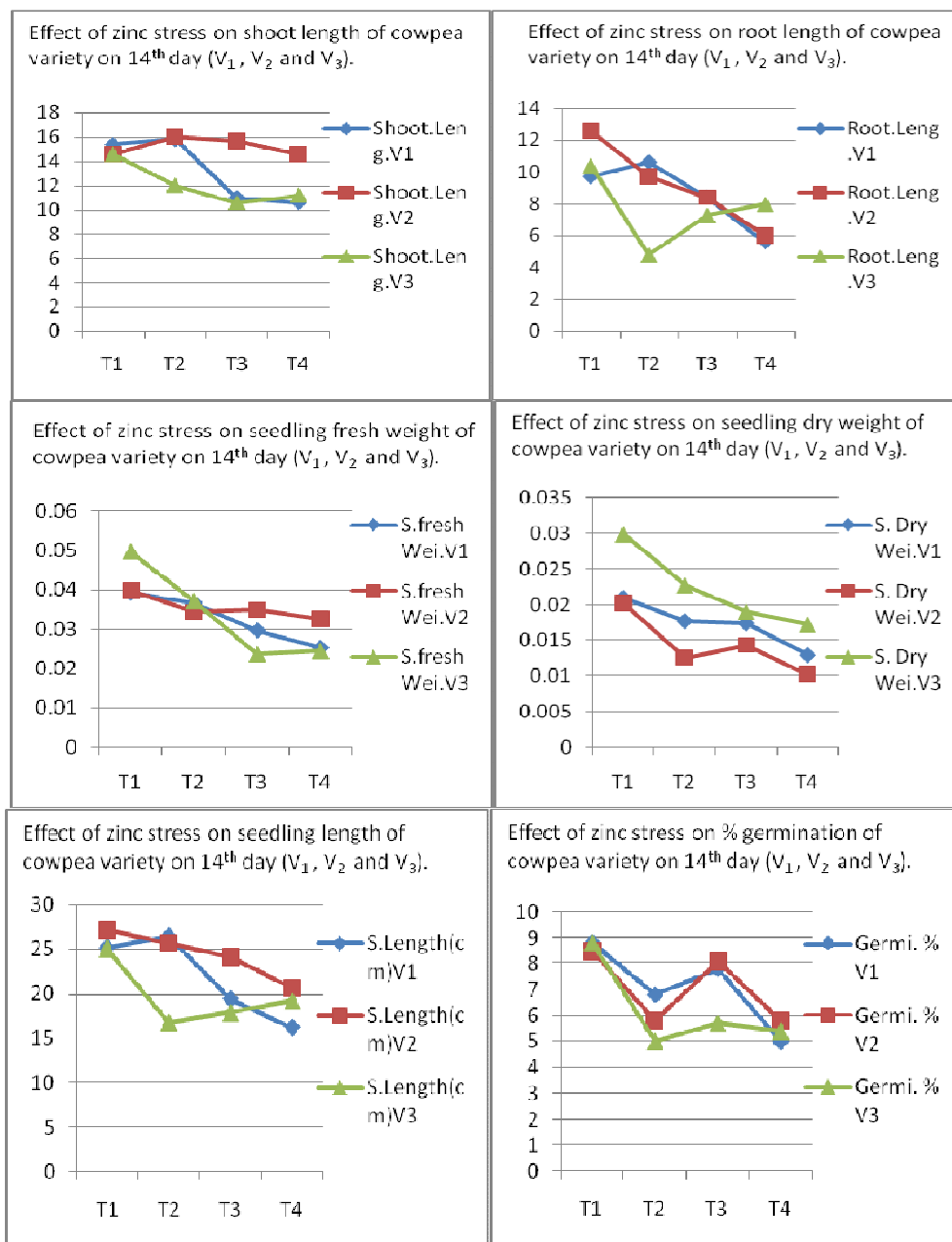
The concentrations of metal (Zinc) stress taken for treatments T in the study were:

1. T<sub>1</sub>- 0 ppm ZnSO<sub>4</sub> solution (Control)
2. T<sub>2</sub> - 100 ppm ZnSO<sub>4</sub> solution
3. T<sub>3</sub> - 300 ppm ZnSO<sub>4</sub> solution
4. T<sub>4</sub> - 600 ppm ZnSO<sub>4</sub> solution

Various morphological germination characteristics were studied to identify the seed quality of three *Vigna unguiculata* L. varieties and their growth under zinc stress conditions. On the basis of these observations on various germination and morphological parameters it was determined that which variety had the tendency to with stand high metal stress with better germination. All experiments were carried out for 7 to 14 days at 28±2°C in alternate light and dark period of 8 and 16 hr respectively under light intensity of 120µmolm<sup>-2</sup>s<sup>-1</sup>. Six replicates of the treatments in CRD with factorial concept were studied. Seeds were placed on moist filter paper in petri dish. Initially just on the next day, first count of germination was taken then after six and fourteen days, length, wet and dry weight of root, shoot and seedling were measured. Observations were recorded accordingly for various seed germination parameters for which normal seedlings were selected from each treatment. The shoot and root length were measured from the base of primary leaf to base of hypocotyle and from the tip of primary root to base of hypocotyle respectively and mean of length was expressed in centimetres. For taking dry weight, the seedlings were kept in butter paper pockets in an oven and then in desiccators for cooling.



**Figure 1**  
*Effect of Zn stress on Cowpea varieties V<sub>1</sub>, V<sub>2</sub> and V<sub>3</sub> on 7<sup>th</sup> day of germination.*



**Figure 2**  
Effect of Zn stress on Cowpea varieties V<sub>1</sub>, V<sub>2</sub> and V<sub>3</sub> on 14<sup>th</sup> day of germination.

## RESULTS AND DISCUSSION

The achieved results showed that as the concentration of the metal stress increased, most of the germination parameters of the seed decreased. It was inferred from the observations that at minimum applied metal stress the germination rate was not so poor but as the level of stress increased then the values for various growth parameters decreased. Similar results were reported earlier in studies related to zinc stress on other plants.<sup>9</sup> Germination parameters were observed at 6-14 days interval and it was found that there were variations in the response of all three varieties of cowpea to varied metal stress concentration. It was reported earlier that the effects of metal stress like all other stresses depend on the seed germination development stage at which the stress is applied.<sup>10</sup> It was observed that as the Zn concentration increased the germination percentage of cowpea decreases from S<sub>2</sub>V<sub>1</sub> to S<sub>4</sub>V<sub>1</sub> treatments.

Highest germination were obtained in S<sub>1</sub>V<sub>1</sub> (control) and least was noticed in S<sub>4</sub>V<sub>1</sub>. It was also observed that as the salt Zn concentration increased, the germination percentage of cowpea decreased from S<sub>2</sub>V<sub>1</sub> to S<sub>4</sub>V<sub>1</sub>. At six days interval there was a gradual decrease in shoot, root, and seedling length, fresh and dry weight of variety V<sub>3</sub> seedlings with the increase in the concentration of metal stress. Although, there were variations in the response of other two varieties viz. V<sub>1</sub> and V<sub>2</sub> to increased concentration of metal salt. Related results were reported previously also.<sup>11,15</sup> It was seen out of three varieties under study; at six day interval better germination parameters were obtained in variety V<sub>3</sub>, whereas at fourteen days interval variety V<sub>2</sub> was found to be more tolerant to metal stress. Variety V<sub>1</sub> was observed as most sensitive to Zinc stress in its germination response. In roots, Zn toxicity is apparent as a reduction in the growth of the main root, fewer and shorter lateral roots and a yellowing of roots.<sup>12</sup> The data pertaining to seed quality parameters of cowpea

(variety  $V_1$ ,  $V_2$  and  $V_3$ ) as influenced by different concentrations of Zinc stress are presented in the Figure 1 and 2. Subjecting the cowpea to different salt stress was found to be detrimental to seed germination parameters in this study. The results showed wide variation in the responses of the five parameters in three different varieties of cowpea in terms of germination components. Similarly studies have been done with various plant growth hormones on *Vigna radiata*, earlier.<sup>13</sup> Salt stress negatively impacted on important seedling parameters in all the varieties tested. Taken together, these results suggest that Pahuja variety could withstand Zinc metal stress whereas, Rc 19 is relatively sensitive and Pusa Komal was found least tolerant to Zinc metal stress.

## CONCLUSION

The present study focused on the germination responses of different cowpea varieties to metal salt stress and in particular, the relationship between germination and metal stress conditions. It was expected that findings from the study could enable the identification of traits that could be useful in breeding bean varieties under metal stress conditions. The effects of metal stress like all other stresses depend on the seed germination development stage at which the

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stress is applied, the degree and the duration of the stress. In this study, seed germination was subjected to three different concentrations of Zinc metal salts for 7-14 days. Seeds were treated with different metal stress concentrations. The results showed wide variation in the responses of all the parameters in three different varieties of cowpea in terms of germination components. Salt stress negatively impacted on important seedling parameters in all the varieties tested. Specifically, our results suggest that only a minute concentration of metal salt can affect the morphological germination parameters of *Vigna unguiculata* L. Such kind of studies can be a great help to further and extended research. This can also help in improving plant crop varieties and enhanced productivity.

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## CONFLICT OF INTEREST

We wish to confirm that there are no known conflicts of interest associated with this publication.

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