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Investigating the Leaf, Stem, Seed and Root Extracts of *Chenopodium album* on the Germination and Seedling Development of Maize and Mungbean

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ABSTRACT

Different pot trials under control conditions were carried out to examine the germination, radicle and plumule length of dicot (mungbean) and monocot (maize) seeds as influenced by extracts of different plant parts (seeds, leaves, stem and roots) of *Chenopodium album* L. at glass house, Institute of Agronomy, Faculty of Agricultural Sciences and Technology-Bahauddin Zakariya University, Multan. *C. album* is a dominant weed of winter season in Pakistan and around the globe as well. Various concentration levels including 0.01%, 0.05%, 0.10%, 0.50%, 1% and distilled water (DW) as comparison were set for each of leaf, stem, seeds and roots extracts. Experiments were installed using Completely Randomized Design (CRD) with 4 replications. Data was recorded for germination, radicle length and plumule length of maize and mung bean after 10 days of sowing. Results revealed that all extracts have a varying impact on the germination and seedling development of both test crops, with maximum inhibition of these parameters was recorded with 0.05% solution of stem and root powder extract and 0.01% of seed powder extract and leaves extract. Hence, signifies the importance of this weed and it must be controlled for getting better germination and crop stand of maize and mung bean.

Keywords: Allelopathy; Chenopodium album; leaf, stem, root extracts; seedling development

INTRODUCTION

Allelopathy is a natural ecological process where organisms influence the growth and functions of others, either positively or negatively, through the release of secondary metabolites (Shan et al., 2023). Secondary metabolites are chemicals that do not take part in primary metabolism of plants but may influence the functioning of primary metabolites (Erb and Kliebenstein, 2020). Such type of chemicals, also termed as biochemical/allelochemicals, are produced in almost all plants with their production varies in species to species. Allelochemicals naturally exist in almost all plants species depending upon the environment and area where plants grow. Recent studies have demonstrated that several weed species release allelochemicals, adversely affecting the germination, seedling development, and overall growth of various crops (Saif et al., 2023; Lalbiakdika et al., 2022). Moreover, these allelochemicals can be synthesized in any plant part (Farooq et al., 2011) i.e. leaves root, stem, flower, seed, bud and bark (Weston and Duke, 2003). In Agriculture, the potential impact of such secondary metabolites has been discussed and described in detail (Weston and Duke, 2003).

Chenopodium album L., also known as lamb's quarters, possesses allelopathic characteristics, it's all parts seeds,

stems, leaves and roots, emit bioactive substances that influence the germination and development of nearby plants (Malik and Sidhu, 2024). Research has shown that aqueous extracts derived from the leaves, stems, and roots of C. album can considerably suppress seed germination and hinder seedling growth in crops like maize (*Zea mays* L) and mung bean (*Vigna radiate* L) (Islam et al., 2014). For instance, research indicates that higher concentrations of these extracts lead to a marked reduction in germination rates and root elongation in these species. Similarly, the allelopathic effects on sorghum cultivars have been observed, with leaf extracts causing up to a 43% decrease in germination percentage, while stem and root extracts resulted in 26% and 17% reductions, respectively (Bagheri et al., 2013). In the case of *Brassica juncea* L (mustard), varying concentrations of root, stem, and leaf extracts from C. album have been shown to inhibit seedling growth, with higher extract concentrations leading to more pronounced reductions in root and shoot lengths (Patel and Dabgar, 2014). Furthermore, aqueous extracts of C. album have been found to strongly inhibit germination and radicle growth in wheat and maize, with higher extract concentrations causing significant suppression. Thin-layer chromatography analyses have identified seven phenolic compounds in the shoots of C. album, which are presumed to act as allelochemicals under field conditions (Salam e al., 2014).

Maize (*Zea mays* L) and mung bean (*Vigna radiate* L) are main crops due to their economic significance and agricultural importance in Pakistan. Maize is a staple cereal widely grown for food, feed, and industrial uses, making it crucial to assess potential yield losses due to allelopathy. Whereas, mung bean is a vital legume crop in Pakistan and all over the world. This crop is sensitive to environmental stresses, making it an ideal candidate for studying allelopathic interactions. Understanding of C. album influence on germination and seedling development of these crops can help develop better weed management strategies to enhance productivity.

Based on the reviewed literature on allelopathy and the allelopathic potential of Chenopodium album, laboratory bioassays were designed to evaluate the effects of different concentrations of aqueous extracts from various parts of C. album L. on the germination, radicle and plumule length of maize and mung bean in pot experiments.

MATERIALS AND METHODS

Extract Preparation

Bathu (Chenopodium album L.) plants were collected from fields of Institute. All the parts including seeds, leaves, stems and roots were separated and sun dried for 96 hours. For getting zero moisture, these plants samples were further placed in a hot air oven at 72°C for 24 hours. The dried samples of seeds, leaves, stems, and roots were ground using a Wiley mill until they passed through a 20-mesh screen (Alam and Shaikh, 2007). To get pure extract, 10 grams of powder material was added to 100 mL pure ethanol (1:10) and mixed for 24 hours by placing it on a magnetic stirrer to get a homogenous mixture. This mixture was centrifuged for 15 minutes at 4000 rpm (Model Dynac II Centrifuge, Clay Adams) (Siddique and Ismail, 2013). The supernatant was taken after centrifuge and stored in sealed plastic bottles for further use.

Experimental treatment

1 % solution was prepared by adding 1 mL of desired extract and 99 mL distilled water, this will also act as stock solution. From this solution, further lower concentration solution were prepared by using dilution technique. Experiment was consisted of following treatments, T1= Distilled water (Control), T2= 0.01% of SS, T3= 0.05% of SS, T4= 0.10% of SS, T5= 0.50% of SS and T6= 1% that is the stock solution.

Bioassay details

The germination of monocot and dicot representative in the form of maize (*Zea mays* L.) and mungbean (*Vagina radiata* L.) respectively, was investigated by sowing in petri dishes. A double layer of filter paper (Whatman No 2) was lined in petri dishes and 5 seeds of both crop (maize and mungbean) were placed there in each petri dish. Each petri dish was supplied with pre-defined volume of 5 mL of each extract solution. These petri dishes were kept for ten days in glass house. When required, each petri dish was subsequently irrigated with the same extract solution. After ten days period, germination of both crop seeds was count and seedling development (radicle and plumule length) was calculated for all treatments and means values were recorded.

Statistical Aanalysis

Comprehensive data analysis was performed using Statistix 8.1, following standard procedures. The analysis of variance technique and Tukey test at a 5% probability level was used to compare the differences among

treatment means (Steel et al., 1997).

RESULTS

Results of various parameters, including germination, radicle and plumule length of maize and mungbean are presented in Figures (Figure 1-4). All parameters show a varying response to the applied extract treatments consisted of different concentrations of stem, leaves, seeds and roots of maize and mungbean. In comparison to control level treatments, (DW-T1), all other treatments of seed extract concentrations influence the germination, radicle and plumule length of maize and mungbean (Figure-1). However, germination data showed the impact of C. album seed extract was as prominent as recorded in radicle and plumule length. Whereas, seed extract concentration at 0.01% (T2) recorded maximum reduction of radicle and plumule length among all other treatments in both maize and mungbean seedlings.

Figure representing various concentrations of C. album root powder showed almost similar trend of reducing the germination, radicle and plumule length of maize and mungbean (Grpah-2). Whereas, concentration level at 0.05% (T3) showed maximum inhibition of all aforementioned parameters of maize and mungbean. Mean values presented in Figure-3 showed that all concentrations of stem extract of C. album have a varying impact on germination, radicle and plumule length of maize and mungbean, with maximum inhibition of these parameters was recorded in T3 (0.05% concentration) in both the test species.

Results obtained with leaf extract of C. album were bit different for the recorded parameters of maize and mungbean germination, radicle and plumule length (Figure-4). Germination was not much influenced in both test species. In case of maize, maximum radicle and plumule length was reduced by the application of leaf extract of C. album at 0.1% (T4), while in mungbean maximum inhibition of radicle and plumule length was observed with the application of C. album concentration at 0.01% (T2).

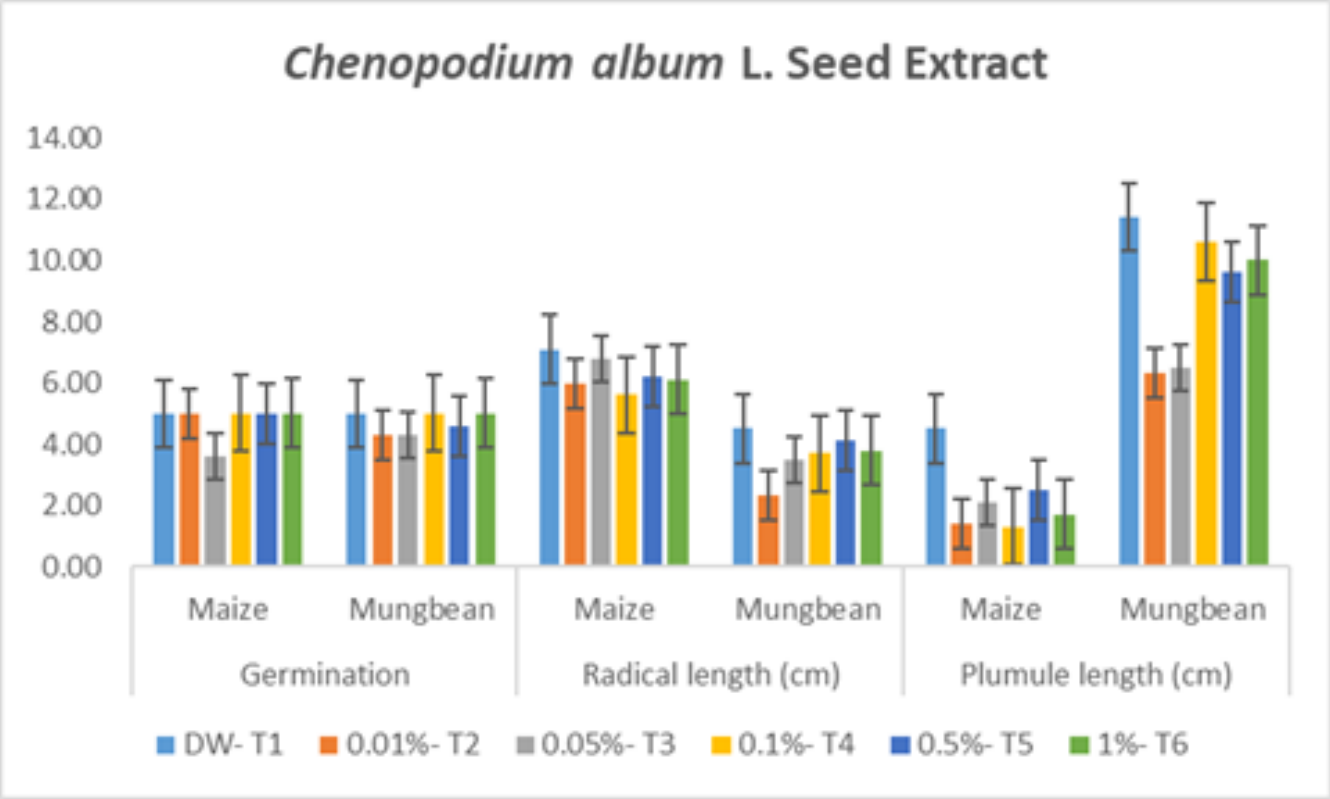

Figure 1.Impact of various concentrations of seed extract of C. album on the germination, radicle and plumule length of maize and mungbean.

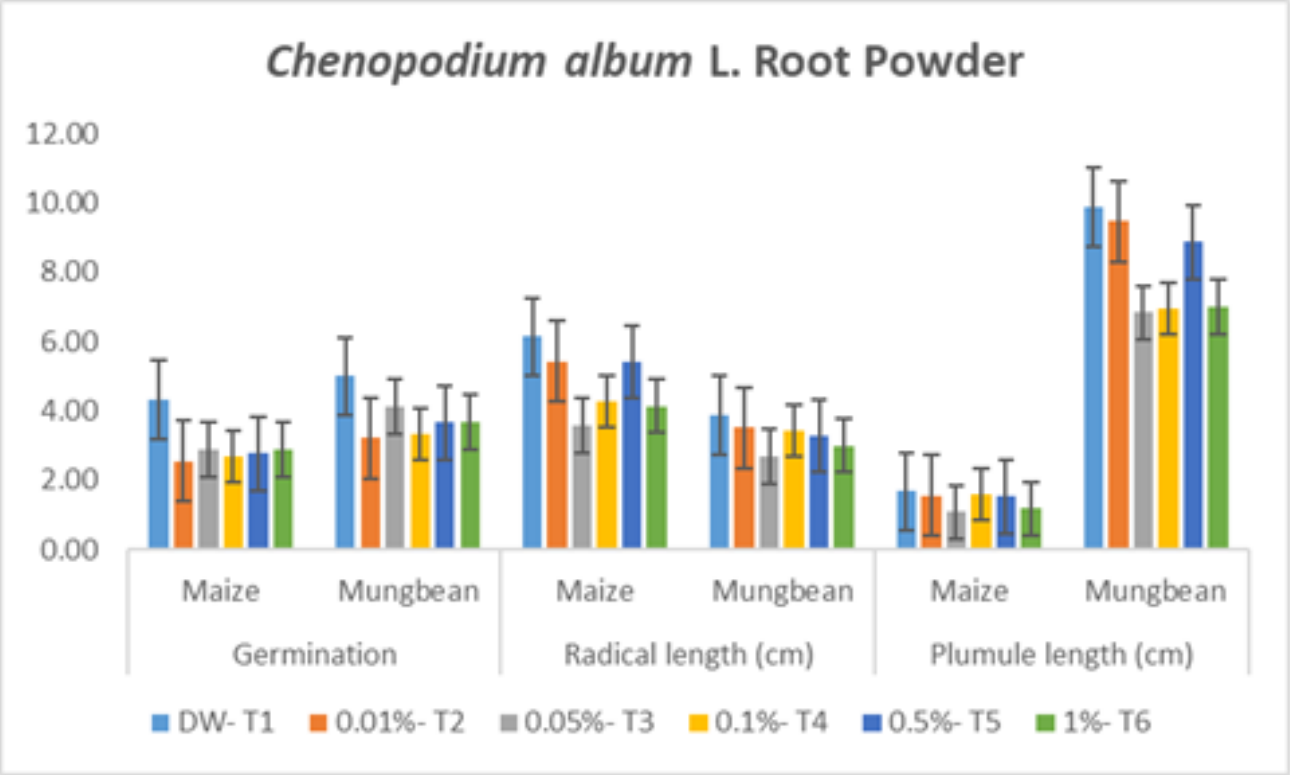

Figure 2. Impact of various concentrations of root powder of C. album on the germination, radicle and plumule length of maize and mungbean.

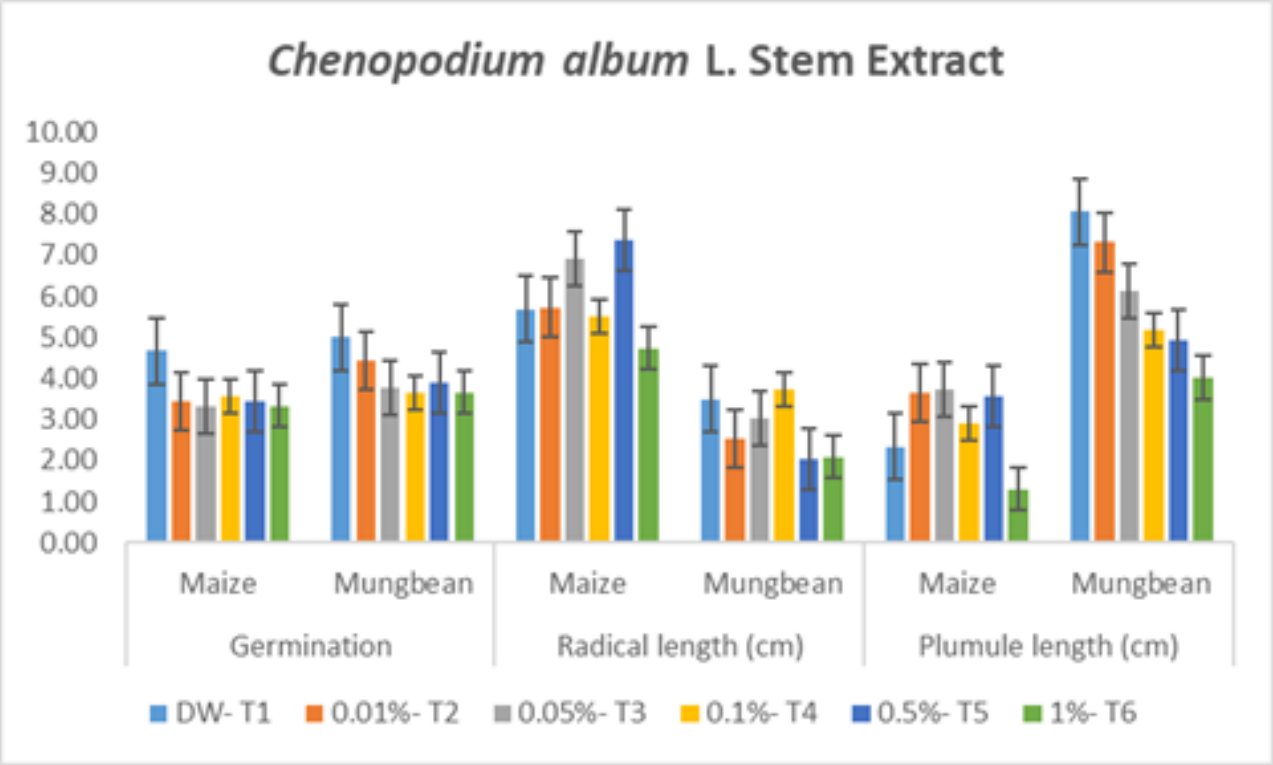

Figure 3. Impact of various concentrations of stem extract of C. album on the germination, radicle and plumule length of maize and mungbean.

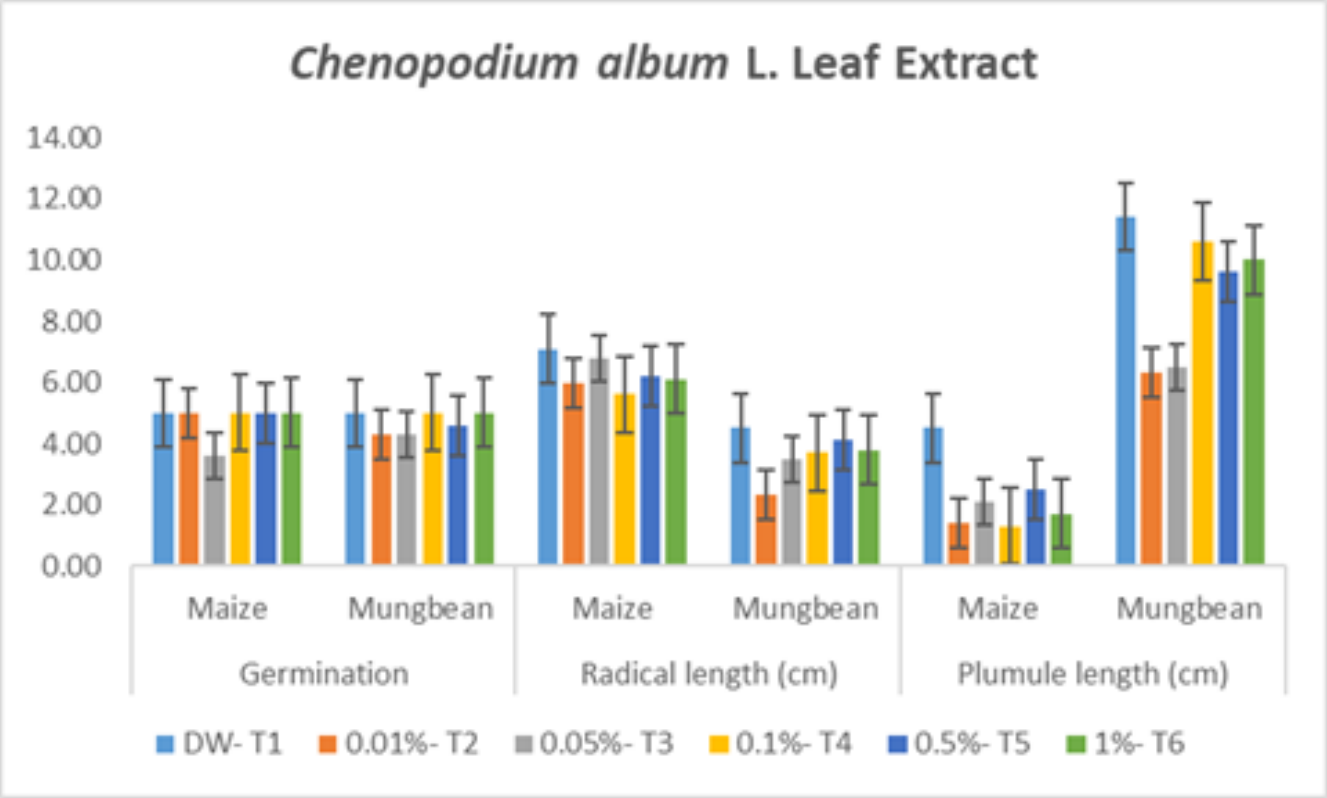

Figure 4. Impact of various concentrations of leaves extract of C. album on the germination, radicle and plumule length of maize and mungbean.

DISCUSSION

Chenopodium album L. is found in about 40 crops species of 47 countries around the globe (Holm et al., 1977). Seed germination and seedling growth showed different response to all treatments. Response of radicle and plumule growth of maize and mungbean was different to alike concentration levels. Allelochemicals mediated potential of *C. album* is well documented. Furthermore, Reinhardt et al., (1994) documented growth inhibition in various crop species due to incorporation of residual material of *C. album* L. in soil. Seeds of mungbean were germinated after one day while maize germination was delayed as compared to mungbean. Difference response of the allelopathy was observed toward radicle and plumule growth. Various allelochemicals reported in *C. album* are momilactone, phenolics, brassinosteroids, jasmonates, alkaloids, hydroxamic acids and amino acids (Kruse et al., 2000). The direct action of secondary metabolites involves various physiological and biological changes that influence plant growth and metabolism (Rizvi et al., 1992). Allelochemicals are the plant secondary compounds which are released to the surroundings by the process of decomposition of the residues, vitalization or as exudates (Khalaj et al., 2013).

The present study shows that all the plant parts of *C. album* L. possess allelopathic activity, however, this allelopathic action is concentration dependent, as recorded in different parameters of maize and mungbean. Furthermore, Majeed et al., (2012) also reported this allelopathic activity of *C. album* due to the compounds present in the leaves, like phenolics and alkaloid.

Inhibitory action against the seedling development of maize and mungbean was recorded incorporated as well as residual soil of C. album (Farooq et al., 2023). Malik et al., (1994) also studied this phenomenon using extract of *C. album* and observed inhibition of germination and growth in radish and wheat, further they also isolated 7 phenolics with chlorogenic acid as a major toxic material (Mallik et al., 1994).

By reducing the mitochondrial respiration ATP production may also decrease due to phenolic

compound. It could be due to some physiological effects which can reduce the growth (Rezaie and Yarnia, 2009)

It has been assumed that once in soil environment, allelopathic compounds come in contact with roots of test plants for water, cell division, minerals, physiological function, and cell division and it may alter its absorption capacity (Majeed et al., 2012). In our study, all the extracts from different parts of *C. album* show inhibitory actions for all the parameters like germination, radicle and plumule length of both test species, i.e. maize and mungbean. Because allelochemicals action is concentration dependent and treatments included in experiment are also very low concentrations that's why inhibitory action is not very prominent.

Alam and Sheikh, 2007 use root extract of *Chenopodium murale* L. on seedling growth and seedling germination of Rice and founded that due to direct contact with extract of allelochemicals the growth of root become more stunted than shoot growth (Alam and Shaikh, 2007). Previous research shows that allelopathy has more effect on seeding growth and this effect may lead to increase the weeds competition and environmental factor. Allelopathy reduces the growth of radicle and shoots (Rezaie and Yarnia, 2009.

CONCLUSION

From these controlled condition pot trials it can concluded that all the parts of C. album including stem, leaves, seeds and roots have some allelopathic compounds that shows inhibitory actions against germination, radicle and plumule length of maize and mungbean. Specifically, maximum inhibition of radicle and plumule length was recorded at 0.05 % of stem extract and root powder extract while seed powder shows maximum inhibition with 0.01% concentration. Data regarding leaves extract show maximum inhibition of radicle and plumule length of maize with 0.1% solution while in mungbean, it was recorded with 0.01% solution.

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