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プレス発表資料

令和５年７月５日

A recently published review article focuses on the physiological responses of the wild grass *Holcus lanatus* L to potentially toxic elements found in soil.

A review article authored by Dr. Ismail Rahman, an associate professor at IER, and his team explores the ecological aspects of the wild grass *Holcus lanatus*. The journal paper focuses explicitly on the plant's responses and mechanisms of tolerance towards potentially toxic elements (PTEs), such as arsenic (As), lead (Pb), cadmium (Cd), and zinc (Zn). Furthermore, the article presents insights into the plant's capacity for tolerance and exclusion of PTEs through related mechanisms, highlighting its potential as a cost-effective ecological alternative for the remediation of polluted land sites.

The global problem of potentially toxic elements (PTEs) infiltrating the environment is a major environmental concern. Industrialization, urbanization, and modern agricultural practices contribute to anthropogenic PTEs in the environment, which can endanger human and animal health through dietary exposure. A possible way to reuse PTE-contaminated land is shared in the journal publication.

✧ The ecology of the wild grass *H. lanatus* is discussed.

The review article discusses the characteristics and global distribution of *Holcus lanatus*, also known as Yorkshire fog or velvet grass. This adaptable plant thrives in a variety of terrestrial habitats and soil conditions. It is a prolific seed producer able to colonize bare soil efficiently while maintaining a significant presence in the soil seed bank. *H. lanatus* is commonly used as fodder and forage. The plant provides a valuable food source for butterflies in its natural habitat. Furthermore, because of its dense surface roots, *H. lanatus* can act as an ecosystem engineer, assisting in the reclamation of eroded, degraded, and denuded lands.

✧ The responses of *H. lanatus* to the PTEs have been compiled.

The review article compiled existing literature on the responses of *H. lanatus* to potentially toxic elements (PTEs), such as arsenic (As), lead (Pb), cadmium (Cd), and zinc (Zn). The tolerance of *H. lanatus* phenotypes to pentavalent arsenic in soil with phosphorus fertilization is depicted in **Figure 1**. It has been observed that phosphorus fertilization increases the growth of the *H. lanatus* tolerant phenotype and reduces the plant's absorption of pentavalent arsenic from the soil. **Figure 2** shows the cadmium tolerance of *H. lanatus*, which indicates that the root-to-shoot translocation in the plant parts decreased further as the cadmium concentration in the roots increased.

✧ The mechanisms of tolerance to PTEs in *H. lanatus* have been discussed.

The review article delves into the mechanisms employed by *H. lanatus* to achieve tolerance to PTEs. One strategy involves reducing the rate of PTE uptake by the plant. For instance, *H. lanatus* demonstrates As-tolerance by suppressing the transport systems responsible for phosphorus/arsenate (P/As^{V}), thereby potentially lowering the rate of As uptake compared to non-adapted plants. In the case of high Cd-concentrations in the soil, *H. lanatus* copes by limiting the distribution of Cd in sensitive tissues, binding Cd to the cell wall, actively excreting it, and compartmentalizing it within vacuoles, thereby restricting its entry and root-to-shoot translocation.

Tolerance to PTEs in transgenic plants was enhanced by increasing the synthesis of PTE-binding peptides, such as phytochelatins (PCs) and glutathione (GSH). In *H. lanatus*, observed antagonistic and synergistic effects among PTEs, such as Cd, lead (Pb), and zinc (Zn), lead to a decreased translocation of these PTEs from the roots to the shoots.

Arbuscular mycorrhizal fungi (AMF), associated with *H. lanatus*, play a direct or indirect role in helping the species survive and adapt to edaphic stresses, including PTEs such as As, Cd, Pb, and Zn contamination. The presence of AMF may aid in alleviating the toxicity of PTEs to the host plant, such as H. lanatus, by creating a barrier to uptake.

✧ **Introduction of a potential plant for cultivation on contaminated land or a source PTE-tolerant gene**

The presence of PTEs in soil threatens crop productivity and quality. Furthermore, PTEs can enter the food chain via soil-crop transfer, posing human health risks. However, some plant species, such as the wild grass *H. lanatus*, have shown tolerance or exclusion mechanisms to PTEs. This makes it a viable candidate for cultivation in metal-contaminated areas, ensuring a supply of PTE-free animal fodder. Furthermore, the grass growing in these contaminated areas could be a source of genes that confer PTE tolerance. Cultivating agricultural products safely in PTE-contaminated soils is now possible by transferring these functional genes with exclusion characteristics into crop tissues.

【掲載誌・論文】

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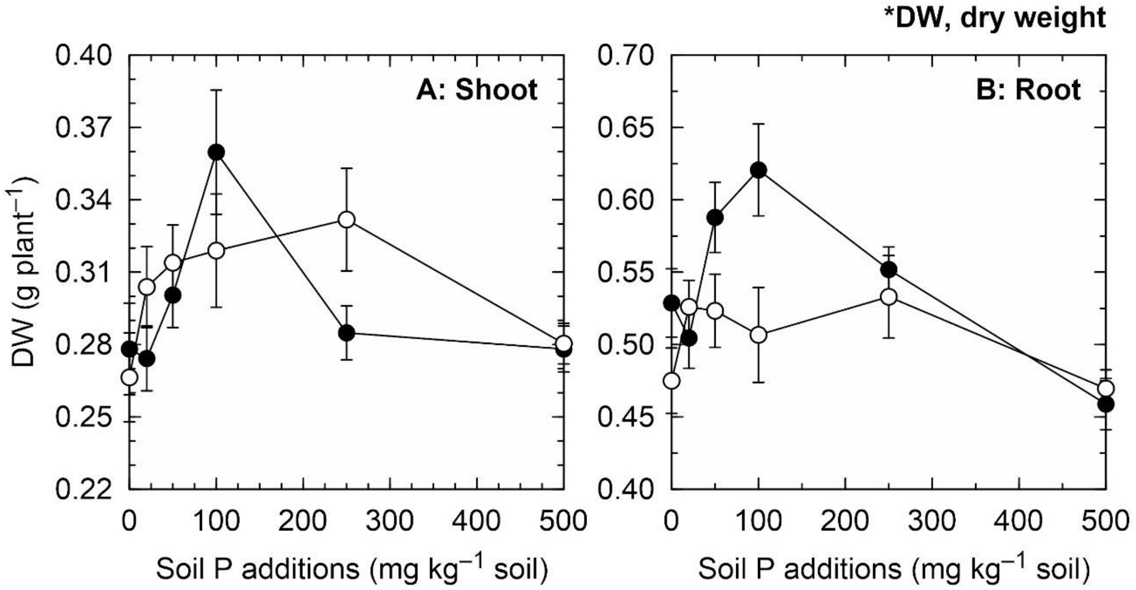

Fig. 1: Soil phosphate addition dose-response on the weights of shoots and roots in As tolerant (●) and non-tolerant (○) *Holcus lanatus* phenotypes. Adapted with permission from Khan, *et al.* (*Environ. Exp. Bot.* 2013, *96*, 43–51).

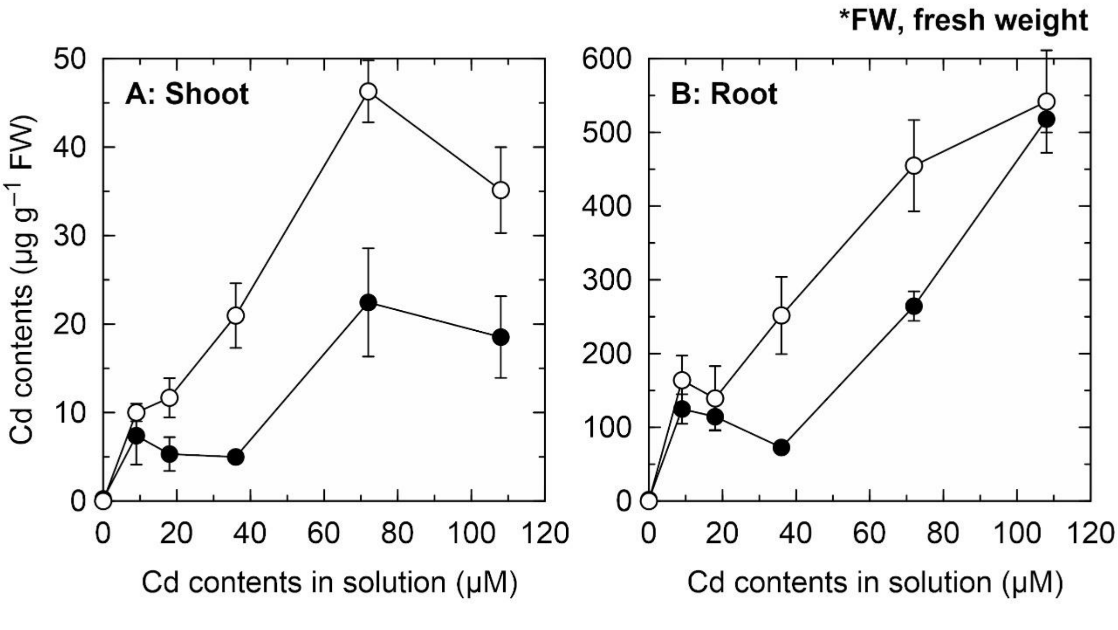

Fig. 2: The relationship between tissue Cd contents and external Cd contents in shoots and roots of the two *Holcus lanatus* clones from a metal-contaminated (Hallen Wood, Avonmouth, UK) (●) and an uncontaminated site (Totley, Sheffield, UK) (○) grown in Cd-amended hydroponic cultures. Adapted with permission from Hendry, *et al.* (*Acta Bot. Neerl.* 1992, *41*, 271–281).