Sunflower (*Helianthus annuus* L.) Germination Response to Metal Concentrations

L.R. Gutiérrez-Espinoza[1], A. Melgoza-Castillo[1], J.A. Ortega-Gutiérrez[1], M.T. Alarcón-Herrera[2], P. Jurado-Guerra[3], and C.E. Vélez-Sánchez Verin[1]
[1]Fac. De Zootecnia, UACH, Perif. Fco. R. Almada Km. 1, C.P. 31453 Chihuahua, Chih. (614) 343-0304, p42113@uach.mx [2]CIMAV, [3]INIFAP

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Abstract

Phytoremediation is a practice that has become important for the removal of contaminants such as metals from soil and waters. Native plants can potentially be useful for phytoremediation practices. Sunflower (*Heliantus annus* L.) is a native plant used in phytoremediation, but most of the studies for this species have focused on adult plants rather than seed. The objective of this study was to evaluate if sunflower seeds could germinate at different levels of Cd, Pb, Cr, and Ni. Treatment levels were 0, 25, 50, 100, 200, and 400 ppm of $Cd(NO_2)_3$, $Pb(NO_2)_3$, and $CdCl_2$; 0, 12.5, 25, 50, 100, and 200 ppm of $Cr(NO_2)_3$; and 0, 50, 100, 200, 400, and 600 ppm of $Ni(NO_2)_3$, dissolved in water. For each treatment, four replicates of 50 seeds each were placed in a container. The substrate used was cotton and filter paper soaked with the metal solution. No significant differences ($P<0.05$) were found as a result of treatments. Germination was low even in the control, and poor seed quality may be the reason for the low germination . An important result of this study is that sunflower seeds could withstand the solutions of metals tested and germinate at high levels of contamination.

Introduction

It is a fact that society can make changes in their lifestyle in order to halt ecosystem contamination and that it is important to search for solutions to this problem. Metal contamination can be treated using phytoremediation (Kumar et al., 1995; Lasat, 2002). Local floras have the potential to be used for phytoremediation (Nuñez-Montoya et al., 2005). Sunflower (*Helianthus annus* L.) is a species that has been efficient when used in phytoremediation pratices (Simon, 1998; Cabrera et al., 1999; Davies, 2002). This species has been considered as a hyperaccumulator of metals (Davies, 2002; Ruiz et al., 2007). Munn et al. (2008) reported that sunflower can extract from 10 to 25% of metals from soil. Growth of this species under contaminated condition was higher than plants growing under non-contaminated conditions (Mani et al., 2007).
Most of the studies for this species have tested adult plants on contaminated substrates rather than seeds. It is important to test seed response to different levels of metal contamination since it is easier to disperse sunflower seed than transplant individuals. Therefore, the objective of this study was to test the germination of sunflower seeds under different concentration levels of four common soil contaminant metals.

Materials and Methods

Sunflower seeds were collected during the summer of 2008 in the vicinity of Chihuahua City (Chihuahua, Mexico) and stored at room temperature for 2 months. The metals used for the treatments were Cd, Pb, Cr, and Ni, at different concentrations. Sets of 50 seeds were placed in four transparent plastic containers, using cotton and filter paper as substrates. The substrate was soaked with each treatment solution so as to last 60 days. Levels of metal concentrations for the treatment solutions wereas based on the Mexican Official Norm for Water 2004 (DOF, 2004) standards. Each container received one treatment: 0, 25, 50, 100, 200, and 400 ppm of $Cd(NO_2)_3$, $Pb(NO_2)_3$, and $CdCl_2$; 0, 12.5, 25, 50, 100, and 200 ppm of $Cr(NO_2)_3$; and 0, 50, 100, 200, 400, and 600 ppm of $Ni(NO_2)_3$. Containers were sealed and placed in a greenhouse. Containers were observed every day during a 60-day period and germinated seeds were counted without opening the containers. Analysis of variance was used to detect differences among treatments and the control.

Results

Germination was low for all treatments and the control, less than 1%; there were no differences among treatments for any of the metal solutions tested (Table 1). Although seed germination was low, it is important to point out that some germination occurred at all metal levels tested. This indicates that not only the adult sunflower individuals can tolerate contamination by metals, but the seeds can also tolerate metal contamination.

Low general germination rates obtained could be the result of low seed viability, compensated for by high seed production (Harper, 1977).

Table 1. Germination response of sunflower seeds (*Helianthus annus* L.) under different metal levels.

PPM	$Cd(NO_2)_3$ %	$Pb(NO_2)_3$ %	$CdCl_2$ %
0	0.04	0.040	0.040
25	0.05	0.065	0.030
50	0.05	0.035	0.030
100	0.05	0.060	0.450
200	0.05	0.065	0.450
400	0.05	0.060	0.037
$Cr(NO_2)_3$ PPM	%	$Ni(NO_2)_3$ PPM	%
0	0.04	0	0.040
12.5	0.035	50	0.030
25	0.050	100	0.040
50	0.050	200	0.045
100	0.040	400	0.045
200	0.040	600	0.030

Conclusions

There is a potential to use sunflower seeds for phytoremediation programs. The broadcasting of seeds, rather than transplanting adult plants facilitates implementation of phytoremediation practices.

Furthermore, higher doses of tolerance to metal contamination than those tested in this study could be explored. Another important need is to evaluate the growth patterns for establishment of adult plants to complete an adequate package of technological information available for the use of sunflower as a phytoremediator.

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