Evaluation of Jatropha and Jacaranda growth performance in cadmium and lead contaminated soil

By

HAYAM MOHAMED ALI EBRAHIM

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LIST OF APPREVIATIONS

HMs	Heavy metals
Cd	Cadmium
Pb	Lead
L	LOW
M	Medium
H	High
D.W.	Dry weight
F.W.	Fresh weight
BCF_S	Bioconcentration factor of shoots
BCF_r	Bioconcentration factor of roots
TAR	Total accumulation rate
TF	Translocation factor
TIb	Tolerance index of biomass
TIr	Tolerance index of roots
EC	Electrical conductivity
pH	Power of hydrogen
ROS	Reactive oxygen species
O.M.	Organic matter
µM	Micro mole
mM	Milli mole
$SO_2^{\cdot-}$	Superoxide
SPAD	Soil plant analysis diagnosis
mg Kg^{-1}	Milligram/kilogram
%	Percentage
H_2O_2	Hydrogen peroxide
TWW	Treated wastewater

5- SUMMARY

A pot experiment was conducted at Antoniadis Garden, Hort. Res. Inst. Alex. Branch, Ministry of Agric., Egypt to study the combinations effect of Cd and Pb at different levels during the period of 1st April 2020 to 1st August 2021 on vegetative growth, chemical composition and phytoextraction potential of *Jatropha curcas* and *Jacaranda mimosifolia* plants, as well as, the soil properties after the experimental period.

The treatments were conducted as follows:

1- control.

2- L Cd + L Pb (Cd nitrate and Pb nitrate at 40 and 400 mg/kg soil, respectively).

3- M Cd + M Pb (nitrate of Cd and Pb at 80 and 800 mg/kg soil, respectively).

4- H Cd + H Pb (nitrate of Cd and Pb nitrate at 120 and 1200 mg/kg soil, respectively).

5- L Cd + H Pb.

6- H Cd + L Pb.

7- M Cd + H Pb.

8- H Cd + M Pb.

The experimental design was randomized complete design (RCD). The results could be summarized as follows:

Effect of Cd and Pb treatments on vegetative traits, chemical composition and phytoextraction potential of jatropha and jacaranda plants, also soil characters after the plantation.

5.1. Aerial parts traits:

- The two species tolerated Cd and Pb till the highest concentrations with survival 100%.
- All treatments of Cd and Pb in the most cases caused significant reduction in plant height, stem diameter, branches number, area/leaf and fresh and dry weights of leaves and stems in relative to the control of two plant kinds. The values of such traits were related with the levels of HM_S in the treatment.

5.2. Root parameters:

- The length of the longest root and roots fresh and dry weights of the two species were negatively affected by all used combinations of Cd and Pb in comparison to the control treatments, with one exception in case of L Cd L Pb which resulted in nonsignificant increase in the root length of jatropha over than the control.
- The differences among the applications treatments of Cd and Pb did not reach the significant level in the most cases of such traits for the two species.

5.3. The leaf chemical composition:

- The all used Cd and Pb treatments caused significantly decreases in the leaf green color degree and the percentages of N, P, K and total carbohydrate in comparing to the control of two plant kinds. Also, the differences among Cd and Pb used combinations reached the significant level in the some cases of such parameters.

5.4. Cd and Pb contents and uptake in the plant organs:

- The contents and uptake of Cd and Pb in the leaves, steams, roots and total uptake/plant of jatropha and jacaranda plants were related with their levels in the soil. Where high level of either Cd or Pb in the treatment raised its contents and uptake in the plant organs.
- The contents of Cd and Pb in the fallen leaves of the two plant kinds were negligible in relative to their contents in the green leaves. Therefore, the risk of the fallen leaves is not dangerous.
- The content and uptake of Cd and Pb of jatropha were in order of roots > leaves > stems. While in jacaranda the content of Cd was in order of roots > stems > leaves for some treatments and it was stems > roots > leaves for the other ones. On the other side the uptake of Cd and Pb and the content of Pb were in order of roots > stems > leaves of jacaranda, with some exceptions.

5.5. Relationship between Cd and Pb concentration in the plant organs and their concentrations in the soil:

- In general, the values of BCF_S, BCF_r, TAR, TI_b and TI_r were dependent on the levels of Cd and Pb in the soil.

For jatropha, BCF_S and $BCF_r < 1$ of Cd and Pb, while TF% > 100 (> 1) with one exception of Pb TF% of control. TAR was increased with increasing Cd and Pb levels in the soil. Also, TI_b and TI_r were less than one and the values of $TI_b > TI_r$ under the same treatment except for L Cd L Pb $TI_r > TI_b$. From the results of BCF_S, BCF_r, TF, TAR, TI_b and TI_r it can be concluded that jatropha plants can use as a phytoextractor for Cd and Pb contaminated soil.

Concerning jacaranda plant, Cd BCF shoots and roots < 1 and Cd TF % > 100 (> 1). It means that jacaranda can use as a phytoextractor for Cd contaminated soil, while, Pb BCF shoots and roots < 1 and TF% < 100 (< 1), it means that jacaranda can use as a phytostabilizator for Pb contaminated soil. Also, TAR of Pb > Cd under the same treatment and TAR of Cd and Pb was related to their levels in the soil. TI_b and TI_r did not take certain trend for the different treatments and they were < 1.

5.6. Soil properties at the end of experiment:

- In general, after planting of either jatropha or jacaranda in various levels of Cd and Pb contaminated soil, some changes in soil parameters were occurred. Where, soil pH, EC, Na^{+}, Cl^{-}, $HCO3^{-}$ and SO_4^{-} values increased over than before planting.
- On contrast, the values of O.M, $CaCO_3$, Ca^{++}, Mg^{++}, K^{+}, and available N, P, and K were reduced in comparison their values prior to planting.
- Also, the levels of Cd and Pb after plantation were decreased in relative to their added levels before planting.