TOXICITY EVALUATION OF DIFFERENT URBAN SOLID WASTE COMPOST ON GERMINATION AND GROWTH PARAMETERS OF LEPIDIUM SATIVUM L

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A laboratory experiment was conducted to study the effect of water extracts of urban solid waste compost (USWC) of different seasons on germination and growth parameters of Lepidium sativum L. Four USWC produced in spring, summer, autumn and winter were selected .Their water extracts of 100, 30, 10, 3, and 0% concentrations was prepared by diluting the original water extract of 100% concentration as five treatments with three replications and analyzed statistically as a completely randomized design. Results showed that maximum germination percentage was noted in 0% (control) and minimum in 100% concentrations. Highest radicle length was noted in 0% and 3% and lowest in 100% concentrations. Similar results were noted in plumule length. Result of different USWC water extract concentrations showed that water extract concentration of 10% resulted in 42 and 55% reductions in germination percentage and germination growth rate, respectively, compared to 100% concentration. Whereas, 3% USWC water extract concentration resulted in radicle and plumule lengths decrease by 72 and 59%, compared to 100% concentration. Our results indicated that different seasonal USWC prepared were not processed completely and as they are not fully matured, they contain high soluble organic compounds, imposing high toxicity during germination and early seedling growth of Lepidium sativum L.

Keywords: USWC, water extract concentrations, Lepidium sativum L.

1. Introduction

Seventy percent of the dry lands, which constitute 25% of world agricultural land, are used for agriculture. Dry areas; provide habitat and livelihoods for more than one billion people.

The amount of Urban solid waste (USW) generated annually in Iran is increasing due to increasing rate of urbanization and industrialization as a result, its disposal is a major environmental problem. USW compost is being manufactured from organic fraction of the USW stream. Land application of USWC, allows for the recycling of nutrients, and produces a relatively low-cost product that can be used as a soil amendment in agriculture, horticulture, and land reclamation especially for countries with arid and semi arid climates such as Iran.

In general, composting of municipal solid waste has potential as a beneficial recycling tool.

Its safe use in agriculture, however, depends on the production of good quality compost, specifically, compost that is mature and sufficiently low in metals and salt content.

There are reports that the organic toxins are present in USW compost [7]. These compounds are highly chlorinated and known to be persistent in the environment [9].

Feedstocks that contribute organic pollutants included pesticides, household wastes such as oils and solvents, and paper products because of the printing ink. A survey of municipal and commercial wastes reported that under 0.5% by weight is hazardous and researchers indicated that phthalate esters are likely the most abundant xenobiotic present in USW compost [7]. The concentrations of dioxin/furans and polychlorinated biphenyls (PCB) were higher in mixed USW compost than source-separated USW compost [7].

The aim of the present work was to evaluate the toxicity of different urban solid waste compost on germination and growth parameters of *Lepidium sativum L.*

2. Materials and Methods

Four USWC produced in spring, summer, autumn and winter were examined for their toxicity on germination and growth parameters of *Lepidium sativum L.* Different USWC were dried at 70°C, each one with equal amount was mixed with distilled water (1:2.5) in mechanical shaker for 12 h., kept at room temperature of 25°C for 3 days, their water extracts were obtained and sterilized [1, 5]. Five treatments: T_1- 100%, T_2- 30%, T_3- 10%, T_4- 3% and T_5- 0%, were prepared by diluting the original water extracts of 100% concentration with distilled water and one control (0%), each treatment with three replications in a completely randomized design. Some physico-chemical properties of different USWC measured by standard methods are presented in table 1.

Table 1. Some physico-chemical properties of MSWC produced in different seasons of year.

Parameters	Range
OM (%)	20-26
Ash (%)	60-70
OC (%)	9-13
N (%)	0.7-1.1
Na (%)	0.4-0.7
K (%)	0.5-0.9
Moisture (%)	8-20
Saturation (%)	80-90
EC (1:2.5) (dS/m)	9-11.5
pH(1:2.5)	7-7.7
C/N	10-14

The 10 sterilized *Lepidium sativum L.* seeds were placed in between two filter paper in Petri dishes of 10 cm in diameter, 5 cc of each treatment was added to each Petri dish, and all Petri dishes were incubated at 20°C for 15 days. Germination count was performed daily and at the end of experiment, germination percentage, radicle and plumule lengths in Petri dishes were measured.

The data was analyzed statistically using MSTAT-C and mean values were compared by Duncan Multiple Range Test at 5% significance.

3. Results and Discussion

3.1. *Effect of different water extract concentrations on germination and growth parameters of Lepidium sativum L.*

Results of different water extract concentrations on seed germination of Lepidium sativum L. showed that control (0%) and 3% concentrations had highest and 30% and 100% had lowest germination percentage (table 2). But all treatments showed reduction in germination compared to control (0%), this reduction of germination, is attributed to increasing concentration of toxic soluble organic matter present in growth media [11, 12]. Plumule length of Lepidium sativum L. in control and 3% concentrations was maximum and in 30% and 100% was minimum (table 2).The reduction of Plumule length in 3%, 10%, 30% and 100% concentrations levels were 11%, 17.3%, 26.9%, 62.4%, respectively, compared to control. [4, 10].

Table 2. Effect of different water extract concentrations on germination percentage, radicle length, plumule length and germination growth rate of Lepidium ativum L.

Treatments	Germination (%)	Radicle length (cm)	Plumule length (cm)	Germination growth rate
T_1	55.57d	2.184 e	1.693 e	2.24 c
T_2	92.22 c	3.419 d	3.293 d	4.6 b
T_3	96.67 b	4.886 c	3.718 c	4.98 a
T_4	99.07 b	7.807 b	4.01 b	5.2 a
T_5	100 a	11.5 a	4.5 a	5.3 a

T_1 = 100%, T_2 = 30%, T_3 =10%, T_4 = 3%, T_5 = 0%
Means within a column followed by the same letter are not significantly different at $p = 0.05$.

Radicle length of *Lepidium sativum L.* in control and 3% concentrations was maximum and and in 30% and 100% was minimum (table 2). Comparing radicle length of all concentration levels to control, revealed that 3%, 10%, 30% and 100% concentrations showed reduction by 32%, 57.5%, 70% and 81%, respectively. The presence of soluble organic matter in growth media, imposes toxicity to seed, delays germination, resulted in phyto-toxicity, and highest negative impact is noted on radicle length, followed by plumule length of *Lepidium sativum L.*

Germination growth rate was highest in control (0%) and lowest in 100% concentration level. Treatments of 3% and 10% concentration levels were at a par and showed no significant differences compared to control, but their germination growth rates were significantly higher than 30% and 100% concentration levels.

Plumule length to radicle length ratio increased by increasing the concentration levels, indicating the highest toxicity impact on radicle length followed by plumule length (data not shown).

All composts with 100% concentration showed lowest germination percentage, plant plumule and radicle lengths (table 3) and minimum germination percentage, plumule and radicle lengths were noted in winter (C_4T_1), autumn (C_3T_1), winter composts of 100% concentration, respectively.

Table 3. Interaction effect of different seasonal compost produced and concentrations on germination percentage, Plant plumule and radicle lengths and germination growth rate (GGR) of Lepidium sativum L.

Compost	Conc (%)	Germination (%)	Plant plumule length (mm)	Plant radicle length (mm)	GGR
	T_1	80d	1.46h	0.4gh	3.9d
C_1	T_2	100a	3.57ef	1.67f	5.0a
	T_3	100a	4.17abcd	3.5e	5.2a
	T_4	100a	4.59a	8.17b	5.2a
	T_5	100a	4.5a	11.5a	5.27a
	T_1	66ef	1.5h	0.5gh	3.1e
C_2	T_2	90bc	2.44h	1.67f	4.7bc
	T_3	100a	3.03c	3.31e	5.2a
	T_4	95ab	4.1bcd	6.33c	4.9ab
	T_5	100a	4.5a	11.5a	5.27a
	T_1	70e	1.2h	0.2h	0.95f
C_3	T_2	85cd	3.0c	1.42f	4.2cd
	T_3	100a	3.03c	2.91e	5.2a
	T_4	100a	4.0 bcd	5.84c	5.2a
	T_5	100a	4.5a	11.5a	5.27a
	T_1	50g	1.65gh	0.0h	0.4g
C_4	T_2	78d	2.5g	1.0fg	3.9d
	T_3	80d	2.16fg	3.5e	4.1d
	T_4	100a	2.92cd	6.41c	5.2a
	T_5	100a	4.5a	11.5a	5.27a

C_1 = spring compost, C_2 = summer compost, C_3 = autumn compost, C_4 = winter compost, T_1 = 100%, T_2 = 30%, T_3 = 10%, T_4 = 3%, T_5 = 0% (control)
Values in the same column followed by the same letters are not significantly different at 0.05 level according to DMRT.

As mentioned earlier, all composts produced during different seasons showing reduction in measured plant growth parameters with their increasing water extract concentrations compared to control (T_5). Indicating, thereby, toxicity effects due to the release of soluble organic matter substances, produced because of improper processing of compost.

Similar results were reported by Zucconi et al. [11], Zucconi [12], Muthuchelian et al. [10], Astaraei and Ivani [2] and Astaraei and Sampietro

4. Conclusion

The results obtained, clearly, indicate the present of organic toxins in USWC produced in USWC Recycling industry of Mashhad city. Nearly, all seasonally, USWC produced showed their adverse effects on tested plant, indicating that the physical and chemical makeup of USW compost tends to shift with time and source and thus careful yearly monitoring of USW compost quality is required (6).

Standardizing the analytical procedures used to assess quality of the final product, as well as a standardized index of compost quality need to be developed for the industry.

This will allow easy monitoring of the quality of USW compost and allow comparison of products among different facilities. Year to year variation in the properties of compost from the same source prevents researchers from drawing conclusions and inhibits research and effective use of the material [8].

References

1. Agrawal, R.L., "Seed Technology," *Oxford and IBM Publishing Co. London*, pp. 515–564, 1982.
2. Astaraei, A .R. and R. Ivani, "Effect of organic sources as foliar spray and root media on nutrition of cowpea plant," *American-Euroasian J, Agric. & Enviro. Sci.* 3(3), 352–356, 2008.
3. Astaraei, A.R. and D.A. Sampietro, "Allelopathic effect of almond on cress and fenugreek," *Allelopathy Journal*. 22 (1), 239–244, 2008.

4. Baur, P., H. Marzouk, J. Schonherr, and T. Grayson, "Partition coefficient of active ingredients between plant cuticle and adjuvant as related to rates of foliar uptake," *J. Agric. Food Chem.*, 45, 3659–3665, 1997.
5. Fernandez, G., and M. Johnston, "Seed vigor testing in lentil, bean and chickpea," *Seed Sci. Technol.*, 23, 617–627, 1995.
6. Hicklenton, P., V. Rodd, P.R. Warman, "The effectiveness and consistency of source-separated municipal solid waste and bard composts as components of container growing media," *Sci. Hort.*, 91, 365–378, 2001.
7. Logan, T.J., C.L. Henry, J.L., Schnoor, M. Overcash, M., and D.C. McAvoy, "An assessment of health and environmental risks of trace elements and toxic organics in land-applied municipal solid waste compost," *Compost Sci. Util.*, 7(3), 38–53, 1999.
8. Mamo, M., C.Rosen, T. Halbach, "Nitrogen availability and leaching from soil amended with municipal solid waste compost," J. *Environ. Qual.*, 28, 1074–1082, 1999.
9. Muir, D.C.G., P.H. Howard, "Are there other persistent organic pollutants? A challenge for environmental chemists," *Environ. Sci. Technol.*, 40(23), 7157–7166, 2006.
10. Muthuchelian, K., D. Neri, F. Zucconi, "Influence of marine algae and humus application on growth, photosynthesis, and metabolic content in vegan saneness L." Mosonnmogyaro van., 185-192, 1996.
11. Zucconi, F., M. Fort, A. Monaco, M. Bertoldi, "Biological evaluation of compost maturity," *Biocycle*, 22(4): 27–29. 1981.
12. Zucconi, F., "Dechino del suolo, stanchezzadel terreno," Spazio verde padova, pp. 291, 1996.