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Effect Of Foliar Salicylic Acid Application On Growth And Yield Of Mung Bean (Vigna Radiate L.) Planted In Soil Polluted In Some Heavy Metals (Pb, Cd, Ni).

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ABSTRACT

The experiment was performed in soil Science and Water Resources Department - College of Agriculture-University of Baghdad/Aljaderia in 22/3/2016 to study the effect of sprinkling with salicylic acid on growth and yield of mung bean planted in soil polluted by some heavy metals (Lead , Cadmium, and Nickel).The experiment was performed according to CRD in three repetitions , four coefficients :P_0, P_1, P_2, and P_3 salicylic acid were added in three concentrations 0,150 and 250 mg.L^{-1} after one month , two months and three months from plantation. The results showed an increase in heavy metals in both plant and in soil after harvest and the uptake amounts of the heavy metals by plant by increasing the added concentrations from heavy metals. Treatment P_3 increased significantly as the concentrations of metals in shoot gross reached 60.15 , 2.74 and 43.46 mg .Kg^{-1} dry matter of Pb ,Cd and Ni respectively .The concentrations of total heavy metals in soil after harvest for the same treatment P_3 reached 162.90 ,6.82 and 158.82 mg .Kg^{-1} for the same metals .The absorbed amounts for the same treatment were 0.019 ,8.7x10^{-4} and 0.013 mg .Kg^{-1} dry matter of Pb , Cd and Ni respectively. Also the results explained the significant effect of added salsalic acid in reduce heavy metals in the total shoot group of the plant .The second concentration has significantly increased as it amount 24.71 ,1.29 and 21.93 mg.Kg^{-1} dry matter of Pb ,Cd and Ni respectively .Also the same concentration in introducing less values for the total heavy metals in the soil as it is estimated 86.03 ,2.82 and 67.57 mg .Kg^{-1} soil of Pb ,Cd and Ni respectively .Further more there was an increase in the absorbed amonunts by the plant as it amount 0.022 , 8.2x10^{-4} and 0.017 mg .Kg^{-1} dry matter of Pb ,Cd and Ni respectively

Keywords: Orgnic acid - pollution - heavy metals-Soil.

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INTRODUCTION

Pb, Cd, Ni are considered as the most metals that polluted soil , water and air and the most important sources of this pollution remains and wastes of factories fuel combustion, cars silencers ,power factories ,untreated water , oil refineries (3) . stated that the accumulation of heavy metals, such as Ni, , Cd, and pb in soils was significantly affected by land use patterns (21).The hazard of these metals increases when they remain in soils and subjected to chemical changes .It causes pollution of plants , fruits and vegetables that man eats which is reflected on his health (18) as they cause cancers, genetic mutation physical distortion and other effects on nerve and digestive system and on brain cells (20).Also heavy metals causes inhibition of plants growth through their effects on cells cleavage and expansion and hormones organization as metabolic various processes disturbances such as photosynthesis, breath and enzyme activity in addition to reduction of stability of membrane , chlorophyll , carbohydrate and proteins (6) .These metals have unpaired electrons in their orbits which make receive and donate their individual electrons to oxygen resulted in free radicals reactive oxygen species that cause the decomposition of cell membrane , oxidizing of enzymes reduction of cytocinenate , jebrlinate , oxinate and oxidization of atomic and amino acids (14).Salicylic acid which has chemical name compound 2-hydroxy benzoic acid compound is one of phenol compounds widely distributed in plants species . Salicylic acid perform an important role in resisting biotic stresses as well as its role in resisting abiotic stress the plant confront .It increased the plant endurance to water stress , salt stress heat stress heavy metal stress as it accelerate the creation of chlorophyll , carotene pigment , accelerate photosynthesis and growth rate (8, 10) ,invoke flowering , control lacuna, prevent ethylene creation , has a converse role to the effect of Abssesic acid , prevent ,oxine and internal cytocanine , increase atomic and amino acid rate .The study aims to learn the effect of sprinkling Salicylic acid on growth and yield of mung bean planted in a soil polluted with Pb,Cd,Ni .

MATERIAL AND METHOD

The pots experiment was performed in 22/3/2016 in greenhouse at Soil Science and Water Resources Department /College of Agriculture /University of Baghdad /Aljaderia to study the effect of sprinkling with Salicylic acid on growth and yield of mung bean planted in the soil that polluted with some heavy metals .Amount of soil was taken from surface layer 0 -30 cm and it dried and grinded by wood hammer , sieved with 2mm opening sieve .Physical and chemical analyses were performed (table 1) .Then amount of soil samples were taken from the same field and sieved in 4mm opening sieve .Each pot contain 10 Kg of soil and prepared for planting .The experiment was designed according to CRD .The study includes four coefficients of pollution P_0 (unpolluted soil) ,

P_1 (soil polluted with 50 mg . Kg^{-1} Pb + 2 mg .kg^{-1} Cd + 50 mg Kg^{-1} Ni) P_2(soil polluted with 100 mg. Kg^{-1} Pb + 5mg .kg^{-1} Cd + 100 mg Kg^{-1} Ni) and P_3 (soil polluted with 200 mg. Kg^{-1} Pb + 10 mg .kg^{-1} Cd + 200 mg Kg^{-1} Ni) were applied as liquids to the soil before planting in volume that did not exceed 50% of the available water of the soil and was left for one week to insure the uniformity in the soil .Mung bean was planted as 10 seeds in per pot and reduced after planting to five plants in each pot .Fertilizers were added in 40 kg N h^{-1} , 75 kg P h^{-1} and 60 kg K h^{-1} .Also three concentration of Salicylic acid 0,150 and 250 mg L^{-1} were foliar applied after one month , two months and three months from planting and in three replicates .Thus the number of experimental units were 36.

Table 1: Some of chemical and physical properties of field's soil before planting

Soluble cations and anions Mmole L^{-1}							Soil textue	Total Mg kg^{-1}soil			Available Mg kg^{-1}soil			EC dS.m $^{-1}$	pH
$CO_3^=$	HCO_3^-	Cl^-	$SO_4^=$	Na^+	Mg^{++}	Ca^{++}		Ni	Cd	Pb	K	P	N		
Nill	1.0	11.6	1.46	1.5	9.2	13.1	L.S	6.89	0.007	24.78	66	7.8	2	1.3	7.8

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RESULTS

Concentration of Pb in plants (mg kg^{-1} dry matter) at harvesting

The results in table 2 showed that fourth treatment (P_3) of pollution was superior to the other treatments in Pb concentration in the vegetarian part as it gave high value 60.15 mg Pb kg^{-1} dry matter, in the meanwhile the control treatment gave less value 7.41 mg Pbkg^{-1} dry matter .Also Salicylic acid contribute to reduce Pb concentration in plant and was less value at concentration 150 mg L^{-1} (A_1) which gave 24.71 mg Pb kg^{-1} dry matter in significant difference from the other two concentrations , meanwhile the highest concentration of Pb in plant when they are not foliar applied by with Salicylic acid which gave 30.05 mg Pb kg^{-1} dry matter.

Table 2: The effect of foliar application by Salicylic acid and pollution by heavy metalson Pb concentration in plant (mg kg^{-1} dry matter)at harvesting .

Treatments	A0	A1	A2	Average
P0	8.32	6.67	7.25	7.41
P1	15.58	11.19	13.12	13.29
P2	33.78	23.03	27.83	28.21
P3	62.75	57.98	59.74	60.15
$LSD_{0.05}$		4.41		2.39
Average	30.05	24.71	26.98	
$LSD_{0.05}$		2.07		

The interference between pollution and foliar application by Salicylic acid, the highest value of Pb in the plant at fourth treatment from pollution with no foliar application and with Salicylic acid was 62.75 mg Pb kg^{-1} dry matter meanwhile the less value at foliar application with concentration 150 mg.L^{-1} as compared to control treatment 6.67 mg Pb kg^{-1} dry matter.

Concentration of Cd in plants (mg kg^{-1} dry matter)at Harvesting

The results in table 3 explained the increase of the fourth treatment (P_3) significantly on the other treatments in Cd concentration in vegetarian part as it gave high value 2.74 mg Cd kg^{-1} dry matter meanwhile control treatment gave less value 0.003 mg Cd kg^{-1} dry matter. Also Salicylic acid effects in decreasing Cd in the plant was non significant specially at concentration 250 mg.L^{-1} which gave less value 1.28 mg Cd kg^{-1} dry matter

Table 3: The effect of foliar application by Salicylic acid and pollution by heavy metals in Cd concentration in plant (mg kg^{-1} dry matter)at harvesting

Treatments	A0	A1	A2	Average
P0	0.003	0.004	0.003	0.003
P1	0.90	0.96	0.81	0.89

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P2	1.70	1.72	1.53	1.65
P3	2.93	2.49	2.80	2.74
$LSD_{0.05}$		0.11		0.12
Average	1.38	.129	1.28	
$LSD_{0.05}$		0.13		

The interaction between pollution and foliar application by Salicylic acid ,the highest value of Cd in the plant at fourth treatment from pollution with no foliar application with Salicylic acid at 2.93 mg Cd kg^{-1} dry matter. white the less value with control treatment was 0.003 mg Cd kg^{-1} dry matte

Concentration of Ni in the Plant (mg kg^{-1} dry matter)at Harvesting

The results in table 4 showed that the increase of the fourth treatment (P_3) significantly other treatments in Ni concentration in vegitatative part as it gave high value 43.46 mg Ni kg^{-1} dry matter as compared to control treatment that gave less value 3.29 mg Ni kg^{-1} dry matter .Also Salicylic acid effected in decreasing Ni content in plant at concentration 150 mg.L^{-1} which gave 21.93 mg Ni kg^{-1} dry matter with significant differences from control treatment that gave higher value at 25.63 mg Ni kg^{-1} dry matter. The interaction between pollution and foliar application by Salicylic acid ,the highest value of Ni in the plant at the fourth treatment P_3 from pollution with no foliar application with Salicylic acid which amount 47.46 mg Ni kg^{-1} dry matter while it was less in control treatment 3.25 mg Ni kg^{-1} dry matter

Table 4: The effect of foliar application by Salicylic acid and pollution by heavy metals on Ni concentration in plant (mg kg^{-1} dry matter)at harvesting

Treatments	A0	A1	A2	Average
P0	3.25	3.30	3.32	3.29
P1	20.79	17.80	18.91	19.16
P2	31.03	26.51	28.33	28.62
P3	47.46	40.11	42.81	43.46
$LSD_{0.05}$		7.38		4.26
Average	25.63	21.93	23.34	
$LSD_{0.05}$		2.69		

Total Concentration of Pb in Soil(mg kg^{-1} soil) after Harvesting

The results in table 5 indicated the increase of the fourth treatment(P_3) of pollution on the other treatments significantly in total concentration of Pb in soil as it gave higher value 162.90 mg Pb kg^{-1}soil as compared to control treatment that gave less value 18.56 mg Pb kg^{-1} soil . Salicylic acid foliar application treatment on the vegitative group of the concentration 150 mg.L^{-1} gave an increase at higher value 86.42 mg Pb kg^{-1}soil in significant difference from control treatment that gave less value and was approximately 80.51 mg Pb kg^{-1}soil.The interaction between pollution and foliar application by Salicylic acid ,the highest value of Pb in the plant at fourth treatment from pollution with foliar application and Salicylic acid of concentration 150 mg L^{-1} gave 165.31 mg Pb kg^{-1} soil while it less at foliar application concentration 15.50 mg Pb kg^{-1}soil.

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Table 5: The effect of foliar application by Salicylic acid and pollution by heavy metals on total concentration of Pb in Soil(mg kg^{-1} soil) after harvesting

Treatments	A0	A1	A2	Average
P0	15.50	16.90	17.10	18.56
P1	58.11	61.60	60.31	60.00
P2	90.22	101.90	100.03	97.38
P3	158.61	165.31	164.81	162.90
$LSD_{0.05}$		5.15		12.43
Average	80.51	86.42	85.56	
$LSD_{0.05}$		4.30		

Total concentration of Cd in Soil(mg kg^{-1} soil) after harvesting

The results in table 6 observed that the increase of the fourth treatment(P_3) of pollution on the other treatments significantly in total concentration of Cd in soil as it gave higher value 6.82 mg Cd kg^{-1} soil compared to control treatment at 0.003 mg Cd kg^{-1} soil . Salicylic acid foliar application treatment effects on the vegetative group at the concentration 150 mg.L^{-1} had an increase at higher value 2.82 mg Cd kg^{-1} soil in significant difference from control treatment that gave less value at 2.59 mg Cd kg^{-1}soil . interaction between pollution and foliar application by Salicylic acid ,the highest value of Cd in the plant at fourth treatment from pollution with foliar application of Salicylic acid in concentration 250 mg L^{-1} which amount 7.00 mg Cd kg^{-1} soil while the less value was at foliar application with concentration 0.002 mg Cd kg^{-1} soil .

Table 6: The effect of foliar application by Salicylic acid and pollution by heavy metals on total Concentration of Cd in Soil(mg kg^{-1} soil) after Harvesting

Treatments	A0	A1	A2	Average
P0	0.003	0.003	0.002	0.003
P1	0.91	1.00	0.96	0.95
P2	2.89	3.28	3.00	3.05
P3	6.59	7.00	6.88	6.82
$LSD_{0.05}$		2.57		2.34
Average	2.59	2.82	2.71	
$LSD_{0.05}$		0.10		

Total Concentration of Ni in Soil(mg kg^{-1} soil) after Harvesting

The results in table 7 indicated the increase of fourth treatment(P_3) of pollution on the other treatments significantly in total concentration of Ni in soil as it gave high value 158.82 mg Ni kg^{-1}soil compared to control treatment gave less value 3.01 mg Ni kg^{-1}soil. Salicylic acid foliar application treatment on the vegetative group the concentration 150 mg L^{-1} increase which gave higher value 67.57 mg Ni kg^{-1}soil significantly difference from concentration 250 mg L^{-1} less value that gave 65.97 mg Ni kg^{-}

^{1}soil. The interaction between pollution and foliar application by Salicylic acid ,the highest value of Ni in the Soil at fourth treatment from pollution with foliar application of Salicylic acid in concentration 150 mg L^{-1} which amount 161.70 mg Ni kg^{-1}soil while it was the less value was at foliar application of concentration 2.93 mg Ni kg^{-1}soil

Table 7: The effect of foliar application by Salicylic acid and pollution by heavy metals on total Concentration of Ni in Soil(mg kg^{-1} soil) after harvesting

Treatments	A0	A1	A2	Average
P0	3.12	3.00	2.93	3.01
P1	35.11	29.00	27.67	30.59
P2	72.50	76.60	74.40	74.50
P3	155.88	161.70	158.90	158.82
$LSD_{0.05}$		35.58		20.54
Average	66.65	67.57	65.97	
$LSD_{0.05}$		1.13		

The plant height (cm)

The results in table 8 indicated the increase of control treatment(P_0) of (no pollution) on the other treatments significantly in plants height it gave higher value 36.7 cm while fourth treatment(P_3) gave less value 8.9 cm . Salicylic acid effected significantly in increasing the plant height and the highest value at concentration 150 mg L^{-1} which gave 21.8cm from the two other treatments and the less value with no foliar application by Salicylic acid which gave 17.1cm .The interaction between pollution and foliar application by Salicylic acid ,the highest value of the plant heights at treatment with foliar application of Salicylic acid in concentration 150 mg L^{-1} which amount 41.0 cm while the less value was in foliar application with fourth treatment and no sprinkling with Salicylic acid that amounted 8.5 cm .

Table 8: The effect of foliar application by Salicylic acid and pollution by heavy metals on the plant Height (cm)

Treatments	A0	A1	A2	Average
P0	31.0	41.0	38.3	.367
P1	19.5	27.2	25.7	.241
P2	9.3	9.7	8.5	9.2
P3	8.5	.94	.87	8.9
$LSD_{0.05}$		3.8		2.2
Average	17.1	.218	20.3	
$LSD_{0.05}$		1.9		

Dry weight (gm.plant $^{-1}$)

The results in table 9 indicated the increase of control treatment(P_0) of (no pollution)on the other treatments significantly in plants heights it gave higher value at 2.789 gm plant $^{-1}$ while fourth treatment gave less value 0.322 gm plant $^{-1}$. Salicylic acid effects significantly in increasing the dry weight and the highest value at concentration 150 mg L^{-1} which gave 1.393 gm plant $^{-1}$. while it was of less value when it was not sprinkled by . Salicylic acid which gave value 1.032 gm plant $^{-1}$ .The interaction between pollution and foliar application by Salicylic acid ,the highest value of the plant weight in comparison was in treatment with foliar application of Salicylic acid in concentration 150 mg L^{-1} which amount 3.200 gm plant $^{-1}$ while the less value was at fourth treatment (P_3) and no foliar application with Salicylic acid amount 0.233 gm plant $^{-1}$.

Table 9: The effect of foliar application by Salicylic acid and pollution by heavy metals on dry weight (gm.plant $^{-1}$)

Treatments	A0	A1	A2	Average
P0	2.167	3.200	3.000	2.789
P1	1.303	1.450	1.423	1.392
P2	0.437	0.533	0.480	0.483
P3	0.223	0.390	0.353	0.322
$LSD_{0.05}$		0.310		0.179
Average	1.032	1.393	1.314	
$LSD_{0.05}$		0.155		

Uptake of Pb in the plant (mg. Kg^{-1} dry matter) at Harvesting

The results in table 10 indicated the increase of control treatment on other treatments with no significantly difference with most treatments in Pb absorption in the plant as it gave higher value 0.020 mg Pb kg^{-1} dry matter. There were no significant differences for foliar application in Salicylic acid in Pb uptake in the plant. The interaction between pollution and foliar application by Salicylic acid, the highest value of the fourth treatment from pollution with foliar application and Salicylic acid in concentration 150 mg L^{-1} which amounted 0.022 mg Pb kg^{-1} dry matter plant meanwhile the less value was at foliar application with same concentration with third treatment of pollution which amount 0.012 mg Pb kg^{-1} dry matter.

Table 10: The effect of foliar application by Salicylic acid and pollution by heavy metals on uptake of Pb by the plant (mg. Kg^{-1} dry matter) at Harvesting

Treatments	A0	A1	A2	Average
P0	0.018	0.021	0.021	0.020
P1	0.020	0.016	0.019	0.018
P2	0.015	0.012	0.013	0.013
P3	0.014	0.022	0.021	0.019
$LSD_{0.05}$		0.005		0.003
Average	0.016	0.018	0.018	
$LSD_{0.05}$		0.002		

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Uptake of Cd by the plant (mg. Kg^{-1} dry matter) at Harvesting

The results in table 11 explained the increase of the second treatment(p_1) on other treatments significantly as it gave higher value $1.2*10^{-3}$ mg Cd kg^{-1} dry matter. Salicylic acid foliar application treatment on the shoot group at the concentration 150mg.L^{-1} which gave higher value $8.2*10^{-4}$ mg Cd kg^{-1} dry matter in significant difference from control treatment that gave less value at $6.4*10^{-4}$ mg Cd kg^{-1} dry matter. The interaction between pollution and foliar application by Salicylic acid, the highest value was in the second treatment of concentration 150 mg.L^{-1} which amount $1.4*10^{-3}$ mg Cd kg^{-1} dry matter while it was less at control treatment that amounted $6.5*10^{-6}$ mg Cd kg^{-1} dry matter

Table 11: The effect of foliar application by Salicylic acid and pollution by heavy metals on uptake of Cd by the plant (mg. Kg^{-1} dry matter) at Harvesting

Treatments	A0	A1	A2	Average
P0	$6.5*10^{-6}$	$1.28*10^{-5}$	$9*10^{-6}$	$9.4*10^{-6}$
P1	$1.2*10^{-3}$	$1.4*10^{-3}$	$1.2*10^{-3}$	$1.2*10^{-3}$
P2	$7.4*10^{-4}$	$9.2*10^{-4}$	$7.3*10^{-4}$	$7.9*10^{-4}$
P3	$6.5*10^{-4}$	$9.7*10^{-4}$	$9.9*10^{-4}$	$8.7*10^{-4}$
$LSD_{0.05}$		$2.4*10^{-5}$		$1.4*10^{-5}$
Average	$6.4*10^{-4}$	$8.2*10^{-4}$	$7.2*10^{-4}$	
$LSD_{0.05}$		$2.4*10^{-5}$		

Uptake of Ni by the plant (mg. Kg^{-1} dry matter) at Harvesting

The results in table 12 explained the increase of the second treatment (p_1) on other treatments significantly as it gave higher value 0.026 mg Ni kg^{-1} dry matter. There were no significant difference by foliar application with Salicylic acid in Ni uptake by the plant .The interaction between pollution and foliar application by Salicylic acid ,the highest value was in the second treatment as compared control treatment which amounted 0.027 mg Ni kg^{-1} dry matter while it was less value at control treatment that amount 0.007 mg Ni kg^{-1} dry matter.

Table 12: The effect of foliar application by Salicylic acid and pollution by heavy metals on uptake of Ni by the plant (mg. Kg^{-1} dry matter) at Harvesting

Treatments	A0	A1	A2	Average
P0	0.007	0.010	0.009	0.009
P1	0.027	0.025	0.026	0.026
P2	0.013	0.014	0.013	0.013
P3	0.010	0.015	0.015	0.013
$LSD_{0.05}$		0.009		0.006
Average	0.014	0.017	0.016	
$LSD_{0.05}$		0.008		

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DISCUSSION

The reduction of the plant height is occurred because of heavy metals role in the physiology and plant growth .once the concentration of these metals increased the plant growth stopped and thus the growth rate of shoot and root group reduced which lessens the preparation of the water necessary for the plant growth and cause the plant dwarfing in early time .These results agreed with Ali *et al*., (4) and Abbas *et al* ., (1) who emphasized an reduction of the plant height in parallel with the increase of heavy metals concentration. Also the reduction in dry matter due to the poisonous effect of accumulated metals that influence on all plant vital activities .The reason is reduction in the photosynthesis ,evaporation and reduction of carbon dioxide to the plant tissue (11 , 12).The increase in accumulation of heavy metals in vegetarian parts with increase of their concentrations that indicates the great ability of the plant in accumulation of these metals including mechanism that constrain the absorption of heavy metals and transport it to the vegetative group or making protein – metal complex, metallothioninies as the resistance methods different towards metal where it made the metal inert within the cavities by mechanism of bioaccumulation (17 , 1) .The increase in concentration of heavy metals in soil after harvest to the added amounts by these metals before planting which propotion directly with the increase in each treatment (2, 16).

Salicylic acid contribute in reduce the effects of heavy metals through its role as heat inhibition of free roots and effects of oxidization as it could sweep electrons through electrons consequences in Salicylic acid (3) in addition to peroxidase, catalase Super oxide dismutase which scavenging of free roots and inhibit H_2O_2 that played substantial role in generating active oxygen(20) . Also it has a role in the plant growth , movement of gaps , absorption of nutrition produce of ethylene , effect on forming chlorophyll and carotene , increasing the speed of photosynthesis , increasing of plant indurations , increasing of biomass and invoke the genes responsible for proteins production that resist the diseases (8) and it agrres with Mishra and Choudhuri (15) ; Metwally *et al*.,(13); Choudhuri and Panda (7) and Al-dulaimy (3) in indicate Salicylic acid role in reducing endurance of heavy metals .

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