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Amelioration of Lead Toxicity in *Pisum sativum* (L.) by Foliar Application of Salicylic Acid

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Abstract

Lead is very toxic heavy metal and commonly found in the polluted soil and water. It harms the plants as well as animals and micro-organisms. Presence of lead in the soil may be the main reason for decrease in the agricultural products. Lead (Pb) is a toxic heavy metal released into the natural environment and known to cause oxidative damage and alter antioxidant mechanism in plants. Lead (Pb) is one of the most important heavy metals frequently available in the environment and its most common sources are vehicles and automobiles. However, not much is known about the interference of Pb with the biochemical processes and carbohydrate metabolism during seed germination. Lead enters the plants through soil and damages the mechanisms of plants and when animals eat these plants then lead transfer in them and cause major disorders. This study was conducted to find out the compounds with antitoxic properties. An experiment was conducted to reveal the antitoxic effect of Salicylic acid in Pea (*Pisum sativum L.*). It was noticed that Salicylic Acid showed its action selectively in Pea (*Pisum sativum L.)* and it was detected that salicylic acid displayed selective action on plant growth parameters in pea. The highest plant height 61.34 cm was observed after 44 days of the combined application of lead and salicylic acid and lowest value for plant height i.e., 7.15 cm was observed after 20 days of the combined application of lead and salicylic acid similarly highest numbers of tendrils (29.34) were observed after the 44 days of combined application of lead and salicylic acid. The same trend was observed with respect to number of leaves i.e., 45.78 and 13.56 after 44 and 20 days respectively.

Keywords: Pea; Lead toxicity; Salicylic acid; Antibiotics; Disorders

Introduction

Lead is very toxic environmental pollutant which is widely distributed in the soil and contaminated water. In plants metals enhance the physiological and chemical changes like reduction in growth, yellowing of leaves, decrease in photosynthesis and change in defensive mechanism [1]. Lead is very harmful to human beings [2] and it causes various disorders, effects nervous system, immune system, kidney damage etc. Salicylic acid has potential to regulate the stress response in plants. Salicylic acid has ability to lessen the lead toxicity in plants. The main object of recent study was to investigate the action of lead on plant growth characteristics of *Pisum sativum L.* and antitoxic effects of salicylic acid. The bioavailable fraction of metal is generally thought to be free metal ion in the soil solution in deficiency and sufficiency situation the free metal ion activity in the soil solution is low and plants have developed strategies to maximize the potential uptake of metals [3,4]. Plants are able to influence the solubility and speciation of metals in the rhizosphere by exuding chelators [5] and manipulating rhizospheric pH [6]. Some chemical transformations can change harmful contaminants into less harmful chemical species, while other processes can produce compounds that are more harmful to ecosystems or human health than the parent compound. The natural decay of some radionuclides can produce daughter products with different transport properties and health effects than the parent product [7]. Plants grown with effluent irrigation tends to accumulate higher amount of metals in their tissues. Large differences in accumulation of heavy metals by cereal and legume crops have been reported [8]. *Pisum sativum L.* is cultivated on large scale in different parts of the world, including Pakistan which is affected by higher concentrations of toxic metals receive through irrigation water from the water bodies contaminated with industrial effluents. During the last two decades its cultivation has spread widely mainly because of availability superior germplasm development by Asia vegetable Research and Development Centre (AVRDC), which is better adapted to a wide range of ecological zones. Although identified as a high yielding crop in many Asian countries, *Pisum sativum L.* is very sensitive to environmental fluctuations and its responses to toxicants such as Pb need to be explored.

Material and Methods

The loamy soil land plot was selected for the experiment which was exposed to sunlight openly. Pea seeds were provided by Ayub Agricultural Research Institute Faisalabad (AARI). Complete randomized design was used for the experiment. Four (4) treatments were given to all variants. No treatment for control variants and other variants were treated with lead acetate (Pb $(CH_3COO)_2$-0.25 mg/L, lead+salicylic acid ($C_6H_4(OH)COOH$) 10(-4) M and salicylic acid alone respectively. Same irrigation conditions were applied to all these plants. During 4 to 5 weeks, different parameters like plant height, numbers of leaves, number of tendrils, leaf length and leaf width were examined. 50 plants of each variant were examined. Experimental data was shown as mean and standard error.

Effect of lead on plant height

Table data showed that lead treatment stimulate the plants height. It results for the plants which were treated with lead alone (Table 1). Salicylic acid also stimulates plant height but initially there were no changes between the control and salicylic acid treated plants. There

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Parameter	Day of observation	Control	Lead	SA	Lead+SA
Plant height, cm	20	5.01 ± 0.37	6.85 ± 0.45	4.85 ± 0.41	7.15 ± 0.27
	26	11.54 ± 0.69	14.5 ± 0.86	12.96 ± 0.78	15.25 ± 0.76
	32	16.21 ± 0.89	26.31 ± 1.13	22.50 ± 1.03	21.55 ± 1.31
	38	29.03 ± 1.64	39.46 ± 1.06	39.52 ± 1.35	38.62 ± 1.2
	44	45.26 ± 2.29	46.32 ± 0.65	63.42 ± 1.24	61.34 ± 1.5
Number of tendrils	20	1.43 ± 0.18	2.13 ± 0.15	3.55 ± 0.18	2.41 ± 0.3
	26	3.97 ± 0.27	4.23 ± 0.28	4.02 ± 0.21	4.98 ± 0.26
	32	7.13 ± 0.40	8.07 ± 0.51	8.13 ± 0.44	7.89 ± 0.56
	38	16.74 ± 0.98	18.22 ± 0.59	19.34 ± 1.51	18.1 ± 0.6
	44	34.12 ± 1.89	29.42 ± 0.76	30.46 ± 1.12	29.34 ± 1.1
Number of leaves	20	2.64 ± 0.29	8.44 ± 0.58	11.21 ± 0.56	13.56 ± 0.57
	26	7.83 ± 0.46	22.51 ± 0.54	20.12 ± 0.62	17.82 ± 0.64
	33	13.21 ± 0.57	27.36 ± 0.61	25.49 ± 0.71	24.95 ± 0.4
	38	27.41 ± 1.31	34.58 ± 0.96	39.52 ± 1.13	35.67 ± 1.63
	44	43.37 ± 2.32	56.93 ± 0.74	51.26 ± 1.17	45.78 ± 1.57
Leaf length, cm	20	2.61 ± 0.2	1.56 ± 0.09	2.11 ± 0.12	2.03 ± 0.23
	26	3.82 ± 0.1	2.73 ± 0.05	2.91 ± 0.13	3.71 ± 0.1
	32	2.57 ± 0.08	3.65 ± 0.04	4.02 ± 0.16	3.89 ± 0.09
	38	4.07 ± 0.17	4.54 ± 0.12	3.98 ± 0.15	4.65 ± 0.1
	44	5.12 ± 0.21	4.95 ± 0.04	6.54 ± 0.18	5.34 ± 0.14
Leaf width, cm	20	2.14 ± 0.13	1.23 ± 0.06	2.13 ± 0.21	2.01 ± 0.23
	26	1.67 ± 0.08	2.61 ± 0.05	3.10 ± 0.16	1.76 ± 0.12
	32	3.11 ± 0.07	3.16 ± 0.04	2.85 ± 0.14	3.02 ± 0.16
	38	3.94 ± 0.14	4.07 ± 0.01	2.99 ± 0.06	2.94 ± 0.15
	44	4.13 ± 0.19	4.75 ± 0.03	4.23 ± 0.15	4.12 ± 0.1

Table 1: Effects of lead and salicylic acid on plant growth parameters.

were similar result in case of lead and salicylic acid treated plants. A little amount of lead may stimulate the production of gibberellic acid with growth stimulating effects [9] and also inhibit the plant height. For cadmium and *Vigna* plants similar results were obtained [10].

Effect of lead on number of tendrils

In all these variants (lead alone, salicylic acid alone and their combination), there were no phenotypic changes were detected. Insufficient amount of lead and salicylic acid cause no changes in the number of tendrils [11].

Effect of lead on number of leaves

Number of leaves increased in the experimental variants. Lead and salicylic acid alone treated variants did not show more difference till the end of observation. These variants showed their reaction in response to heavy metal [12] by increasing the number of leaves. It was considered adaptive reaction of plants to metal stress [13-23].

Effect of lead on leaf length and leaf width

In our experiment, we did not find statistical changes in leaf length and leaf width. These changes were not shown in the variants which were treated with lead, lead+salicylic acid and salicylic acid alone.

Conclusion

In this study the toxic effects of lead on the plant growth, plant height and number of leaves were observed. Strategic changes occurred in various attributes in response to lead stress. To observe the beneficiary effect of salicylic acid to ameliorate the lead toxicity a wide range of concentrations of salicylic acid is needed to be utilized. From this study it can be concluded that the growth attributes increased significantly with the increasing number of days after the combined application of lead and salicylic acid and salicylic acid ameliorated the toxic effects of lead up to great extent i.e the lowest plant height 6.85 cm was observed in the presence of lead while highest value for the plant height (63.42 cm) was noticed after the application of salicylic acid. Similar trend was observed with respect to other growth attributes.

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