Environment & Ecology 27 (1A) : 268—270, 2009
 ISSN 0970-0420

Toxicity Effect of Lead on Green Gram (*Vigna radiata* L.) and Its Amelioration by Cu and IAA

L. V. REDDY, S. N. GUPTA, S. DHAR AND P. K. BANDOPADHYAY*

Department of Plant Physiology, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya
Mohanpur 741252, India
E-mail : p_ban2006@yahoo.co.in
**Correspondence.*

Abstract

Experiments were conducted on green gram (*Vigna radiata* L.) cv B_1 to study the toxicity effect of lead and its a impact on the growth and development of pulse crop leading to yield behavior. Amelioration of toxic effect was done by applying Cu and IAA and their combination by spraying on leaf. Results showed that, due to lead toxicity, roots were largely affected and dry weights drastically reduced compared to control. Same trend was also reported in leaf area with the increase of toxicity. All these changes affect the productivity by decreasing the length and weight of the pods following 100 seed weight obtained from the treated plants over control. Amelioration with Cu or IAA and their combination improved the performance substantially over the lead treated plants and mostly equal to control. These results justify the beneficial effect of copper and IAA in detoxification of lead on green gram.

Key words : Green gram, Lead toxicity, Amelioration, IAA, Copper.

Pulses are indispensable ingredients of vegetarian diet and one of the cheapest sources of dietary protein in India. In India pulses occupies a total area of 12.9 million hectares with an annual production of 1.9 million tones. One of the most serious ecological crisis being faced by almost all the crop plants, in present days is the increased level of pollution in the environment vis-a-vis in soil. Due to various activities of human being, such as industrialization, urbanization, agricultural practices composition of the soil gets changed. Lead (Pb^{+2}) is a common heavy metal pollutant of environment causing problems to the soil (1), and they are readily available to the plants from the soil though they are not essential for the plants causing various toxicity symptoms to plants. This toxicity under moderate to severe condition significantly reduces the growth and productivity of the crop. It was found that the effect of foliar treatment by the lead has been found to be more toxic to plant growth than the root treatment with lead (2, 3). To ameliorate the toxicity effect of lead (Pb) experiments were conducted with plant hormone IAA and micronutrient copper and sprayed over the plants during vegetative growth phase showed highly beneficial effect in detoxification of metal in green gram.

Methods

Seeds of green gram (*Vigna radiata* L. Wilczek) cv B_1 were collected from Berhampur Pulse and Oil Seed Research Station, Murshidabad, West Bengal and stored under laboratory condition and used for study. The experiments were conducted on 25.4 cm diameter earthen pot where seedlings of green gram were sown. Before sowing pots were prepared by pouring soil along with the addition of standard doses of fertilizers like N : P : K at 15:45:20 kg/ha. The pots were regularly watered and from time to time according to requirement nutrient were supplemented and each treatments kept in three replications.

Six seedling were planted in each pot. After 21 days of sowing foliar spray of lead as lead nitrate ($PbNO_3$; 100 µM and 200 µM), copper as copper sulfate ($CuSO_4$; 100 µM and 200 µM) and indole acetic acid (IAA ; 20 and 30 ppm) and its combination were applied and carried out upto the 50% of flowering stage with a gap of 7 days between the spraying.

The physiological data were recorded during different growth phase of plant at 30 DAS (days after sowing), 50 DAS and 65 DAS of samplings, and the statistical analyses were done by randomized block design method.

Table 1. Effect of lead nitrate toxicity on green gram cv B_1 and its amelioration by $CuSO_4$ and IAA treatment on root dry weight (g).

	Treatments	On DAS 90	45	65
T_1	Control	0.154	0.323	0.362
	Pb NO_3 (µM)			
T_2	100	0.117	0.182	0.207
T_3	200	0.113	0.185	0.194
	IAA (ppm)			
T_4	20	0.264	0.462	0.494
T_5	30	0.277	0.485	0.503
	$CuSO_4$ (µM)			
T_6	100	0.193	0.364	0.419
T_7	200	0.207	0.378	0.423
	$PhNO_3$+ $CuSO_4$ (µM + µM)			
T_8	100 + 100	0.158	0.243	0.264
T_9	100 + 200	0.166	0.255	0.274
T_{10}	200 + 100	0.152	0.242	0.262
T_{11}	200 + 200	0.162	0.253	0.276
	$PbNO_3$+IAA (µM +ppm)			
T_{12}	100 + 20	0.194	0.281	0.303
T_{13}	100 + 30	0.196	0.292	0.311
T_{14}	200 + 20	0.190	0.280	0.302
T_{15}	200 + 30	0.193	0.291	0.310
$PbNO_3$ + IAA + $CuSO_4$ (µ M + ppm +µ M)				
T_{16}	100 + 20 + 100	0.207	0.308	0.335
T_{17}	100 + 30 + 100	0.218	0.316	0.339
T_{18}	100 + 20 + 200	0.216	0.315	0.336
T_{19}	100 + 30 + 200	0.222	0.322	0.342
T_{20}	200 + 20 + 100	0.204	0.308	0.331
T_{21}	200 + 30 + 100	0.206	0.304	0.334
T_{22}	200 + 20 + 200	0.204	0.312	0.333
T_{23}	200 + 30 + 200	0.218	0.318	0.340
	SE (±)	0.0016	0.0923	0.0029
	CD (5%)	0.0046	0.0068	0.0083

Table 2. Effect of lead nitrate toxicity on green gram cv B_1 and its amelioration by $CuSO_4$ and IAA treatment on leaf area (sq cm).

	Treatments	30 DAS	45 DAS	65 DAS
T_1	Control	15.820	27.110	31.883
$PbNO_3$ (µM)				
T_2	100	12.433	13.215	14.934
T_3	200	11.807	13.108	14.751
	IAA (ppm)			
T_4	20	18.350	29.103	32.547
T_5	30	17.743	29.731	32.787
	$CuSO_4$ (µM)			
T_6	100	18.111	28.722	31.839
T_7	200	18.221	29.185	32.575
	$PbNO_3$ + $CuSO_4$ (µM + µM)			
T_8	100 + 100	17.113	24.901	30.160
T_9	100 + 200	17.795	25.010	30.867
T_{10}	200 + 100	17.108	24.779	30.132
T_{11}	200 + 200	17.652	27.915	30.781
	$PbNO_3$ + IAA (µM + µM)			
T_{12}	100 + 20	17.217	24.149	29.911
T_{13}	100 + 30	17.487	24.651	30.114
T_{14}	200 + 20	17.197	24.115	29.819
T_{15}	200 + 30	17.305	24.454	30.143
	$PbNO_3$ + IAA + $CuSO_4$ (µM + ppm +µM)			
T_{16}	100 + 20 + 100	18.845	28.855	36.154
T_{17}	100 + 30 + 100	18.915	29.148	36.252
T_{18}	100 + 20 + 200	18.770	28.917	36.191
T_{19}	100 + 30 + 200	18.949	29.621	36.816
T_{20}	200 + 20 + 100	18.689	29.020	36.109
T_{21}	200 + 30 + 100	18.740	28.486	36.179
T_{22}	200 + 20 + 200	18.729	28.933	36.626
T_{23}	200 + 30 + 200	18.908	29.384	36.771
	SE (±)	0.2183	0.1317	0.1399
	CD (5%)	0.6223	0.3756	0.3989

Results and Discussion

Table 1 represents the root dry weight in gram of each treatments over the days of samplings and from the results, it was observed that $PbNO_3$ significantly decreased the dry weight of roots of lead treated plants compared to non treated controls. It was reported that micronutrient and IAA has some beneficial effects over metal toxicity and Cu and IAA in this case also showed promising effect. Lead treated plants when ameliorate with $CuSO_4$ (100 µM and 200 µM) and IAA (20 ppm and 30 ppm) and their combination treatments substantially nullify the damaging effect.

Decrease in leaf area is one of the important criteria in respect of heavy metal toxicity and the effect was very significant in response of lead on leaf area of *Vigna radiata* L. plant compared to control (Table 2). The toxic effect of lead on leaf area (sq/cm) could be minimized by the application of $CuSO_4$ and IAA alone or their combination. The effet of these compound in reversal of toxic effect substantially to normalize the leaf structure. However, the best results obtained when combination of Cu and IAA was applied.

Pod weight and 100-seed weight were analyzed and the results showed that single pod weight and 100-seed weight were much decreased in Pb treated plants over control (Table 3). Maximum single pod weight and 100-seed weight reflected in Cu and IAA treatment separately, whereas maximum improvement in respect of both the parameters were observed when

Table 3. Effect of lead nitrate toxicity on green gram cv B_1 and its amelioration by $CuSO_4$ and IAA treatment on pod weight and 100 seed weight (g).

	Treatments	Pod weight 50 DAS	Pod weight 65 DAS	100 Seed weight 50 DAS	100 Seed weight 65 DAS
T_1	Control	0.613	0.699	3.372	4.293
	$PbNO_3$ (µM)				
T_2	100	0.420	0.507	2.441	3.543
T_3	200	0.373	0.496	2.219	3.461
	IAA (ppm)				
T_4	20	0.675	0.750	3.731	4.110
T_5	30	0.710	0.900	3.907	4.275
	$CuSO_4$ (µM)				
T_6	100	0.715	0.877	4.077	5.413
T_7	200	0.740	0.909	4.143	5.850
	$PbNO_3$ + $CuSO_4$ (µM + ppm)				
T_8	100 + 100	0.471	0.613	3.192	4.067
T_9	100 + 200	0.496	0.661	3.209	4.121
T_{10}	200 + 100	0.449	0.640	3.107	4.033
T_{11}	200 + 200	0.475	0.651	3.189	4.115
	$PbNO_3$ + IAA (µM + ppm)				
T_{12}	100 + 20	0.417	0.579	2.863	3.893
T_{13}	100 + 30	0.454	0.564	2.933	4.110
T_{14}	200 + 20	0.421	0.571	2.815	4.069
T_{15}	200 + 30	0.450	0.590	2.905	4.115
	$PbNO_3$ + IAA + $CoSO_4$ (µM + ppm + µM)				
T_{16}	100+20+100	0.599	0.765	3.217	4.607
T_{17}	100+30+100	0.615	0.789	3.337	4.703
T_{18}	100+20+200	0.627	0.794	3.477	4.841
T_{19}	100+30+200	0.642	0.803	3.544	4.921
T_{20}	200+20+100	0.580	0.709	3.195	4.280
T_{21}	200+30+100	0.628	0.722	3.287	4.217
T_{22}	200+20+200	0.615	0.734	3.265	4.348
T_{23}	200+30+200	0.632	0.777	3.376	4.417
	SE (±)	0.0092	0.0289	0.0194	0.0273
	CD (5%)	0.0263	0.0826	0.0553	0.0779

they were given in combination. This showed the synergistic effect over control.

Thus it may be concluded that $PbNO_3$ had high toxic effect on normal plant growth, especially to *Vigna radiata* L. and the role of $CuSO_4$ and IAA in mitigating the toxic effect of Pb showed encouraging results. The mode of action of IAA and $CuSO_4$ alone and their synergistic effect were not much understood. However, the possible reason for their betterment effect might be due to rectification of metabolic processes along with enzymatic activity in the plant cells due to fortification of Cu as nutrient and IAA as accelerator on metabolic processes, mainly in root cells where maximum damaging effect were observed. It has been reported that decrease of biomass due to toxicity of Pb caused by degradation of chlorophyll *a, b* and as decrease in microbial infection in the root system of *Vigna raiata* L. (4–6) and improvement of crop with indole acetic acid and copper helps to restore the damaging effect of photosynthetic machinery and microbe cell interaction. These results corroborated with the findings of Bhattacharya and Chowdhari (7).

References

1. Nriagu J. O. and J. M. Pacyna. 1998. Quantitative assessment of worldwide contamination of air, water and soils by trace metals Nature 333 : 134—139.
2. Salim R., M. M. Al Subu, A. Deuleh and S. Khalaf. 1992. Effects on grown and oxidative metabolism of pea plants. J. Expl. Bot. 52 : 2115—2126.
3. Kala R., V. K. Gupta and S. P. Gupta. 1992. Effect of heavy metal application to Ustipsamment on growth of some pulse crops. Ann. Arid Zone. 31 : 233—234.
4. Olivera J. A. de, M. A. Oliva and J. Cambraia. 1994. Effects of cadmium on chlorophyll content and peroxidase activity in soyabean. Revista Brasileira de Fisiologia Vegetal 6 : 97—101.
5. Drazkiewicz M. 1994. Chlorophyllase occurrence, function, mechanism of action, effect of external and internal factors. Photosynthetica 30 : 321—331.
6. Athar Rana, M. Ahmad, R. Athar and M. Ahmad. 2002. Heavy metal toxicity in legume microsymbiont system. J. Pl. Nutr., 25 : 369—386.
7. Bhattacharya M. O. and M. A. Chowdhari. 1994. Heavy metal (Pb^{2+} and Cd^{2+}) stress induced damages in vigna seedlings and possible involvement of phytochelatin like substances in mitigation of heavy metal stress. Indian J. Exp. Biol. 33 : 236—238.