Plant Archives Vol. 20 Supplement 1, 2020 pp. 1777-1782 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

MORPHO-PHYSIOLOGICAL STUDY ON THE EFFECT OF LEAD STRESS AND SELENIUM FOLIAR APPLICATION ON GROWTH OF DILL PLANT *ANETHUM GRAVEOLENS* L.

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Abstract

The experiment was carried out in the green house of botanical garden belong to Department of Biology/College of Education for Pure Science Ibn AL-Haitham, University of Baghdad for growing season 2017-2018 to evaluate effect of lead stress with concentrations (0, 50, 100, 150) mg.L^{-1} and Selenium concentrations (0, 15, 30) mg.L^{-1} on growth of dill plant using pots. The experiment was designed according to completely randomized design (CRD) with three replications.

Result indicated that dill plants subjected to lead stress with height concentrations caused decrease in plant parameters (plant height, no. of branches. plant^{-1}, root length, shoot dry weight, the content of nitrogen, phosphorus and potassium, protein concentration, no. of umbellate. Plant^{-1} no. of simple umbel. Plant^{-1} and wt. of fruits. Plant^{-1}, spraying with selenium referred to significant increase in growth parameters, for the interaction between the factors the best values for growth parameter were at the concentration 30 mg.L^{-1} selenium that can minimize the harmful effect of height lead concentration 150 mg.L^{-1}.

Key words: Lead, Selenium, Metals stress, Dill plant.

Introduction

Anethum graveolens L. is a member of Apiaceae family, commonly named as dill, the fruits of it has been used as an aromatic herb in cooking and for medical purpose especially mitigation of indigestion and stimulate lactation in nursing mother (Stavri and Gibbons, 2005). Dill plant is sparse in appearance with feathery leaves and yellow flowers, it possess antihyperlipidemic and antihypercholestrolemic. (Yazdanparast and Bahramikia, 2008).

Plants are target of wide range of pollutant that vary in concentration and toxicity such pollutants enter the plant system through the soil (Arshad *et al.*, 2008) or *via* the atmosphere (Uzu *et al.*, 2010). Lead is one of the most toxic metal, it is used in industrial processes and can made severe contamination in soils, water, atmospheres and living organisms (Punamiya *et al.*, 2010). Lead induce a toxic and adverse effects to plant, it reduces plant growth, root elongation, seed germination, seedling development, chlorophyll production, cell division and transpiration. (Maestri *et al.*, 2010). It cause dysfunctions to nitrogen assimilation and photosynthesis (Seregin and Kosevnikova, 2008). It is associated not only with impaired growth and development of plant, but with the increased the content of lead in crops and that causes sever health riscks for humans and animals (Boughriet *et al,*, 2007). The effects of lead depends on the concentrations, the duration of exposure, the stage of plant development and the severity of plant stress, plant can deal with metal toxicity and have internal detoxification mechanisms like selective metal up take and excretion (Jiang and liu, 2010). Medical and aromatic plants showed height ability resist heavy metals and other pollutants than other crops, thus planting some medical plants like dill in area contaminated with heavy metals, plants growth decreased but there is no significant reduction in their yield and can accumulate heavy metals in their cells. (Lydakis Simantiris *et al.*, 2016).

Reactive oxygen species (ROS) like superoxide radical (O_2.-), hydroxyl radical (OH). And hydrogen peroxide (H_2O_2) are commonly produced following exposure to certain environmental stress such as heavy

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metals and lead to oxidative stress. When ROS exhaust defense system and antioxidant reserves, they can attack and oxidized all the biomolecules such as proteins, Lipids and nucleic acids (Yadav, 2010). Plants have a network of defense strategies to tolerate toxicities of heavy metals, they can avoid the metal entry into the cell by binding it to cell wall (Zhou *et al.*, 2010) and can initiate several cellular antioxidants defense to mitigate the harmful effect of ROS such as enzymatic and non-enzymatic antioxidants. (Sharma *et al.*, 2012). Aghaz *et al.*, (2012) referred in his study to the effect of lead with two concentrations (300,600 μM) on growth, biochemical, physiological parameters and lead accumulation in 10 dill ecotypes, three of them show few reduction in growth parameters compared with the rest of ecotype that show lead tolerant.

Selenium is an essential element for humans, animals and plants, its deficiency in the diet is problem, selenium compounds have been use as foliar or base application to enhance selenium content in crops. It play a vital role to counteract various abiotic stress induced in plant by drought, salinity, cold, height light and heavy metals (Feng *et al.*, 2013). Selenium induced recovery from the damage caused by stress by reducing generation of excess excitation energy and increase the content of chlorophyll (Hajiboland, 2014). It consider a key mechanism for counteracting metal stress in plant, it can reduce the excess ROS generation especially that of the spontaneous dismutation of O_2.- to H_2O_2. (Mroczek-Zdyrska and wojcik, 2012).

Materials and Method

The experiment was conducted in green house belong to Department of Biology, College of Education for pure Science Ibn AL-Haithem, University of Baghdad, during the growth season 2017-2018. The experiment was performed in completely randomized design and consisted of 36 treatment replicated three times, with lead as main factor and selenium as subfactor. Healthy seed of dill plants sown in pot 30 cm in diameter filed with 10kg dry soil in 22/10/2017. Irrigation was carried at intervals during the experiment with tap water.

Plants were subjected to three lead concentrations (50, 100, 150)mg.L^{-1} in the form of lead nitrate $pb(NO_3)_2$, at fifty six days and at sixty one days and at sixty six days after sowing. Foliar application of selenium in the form of sodium selenite Na_2SeO_3 with two concentration (15, 30)mg.L^{-1} was carried out twelve days after the first subjection to lead stress, control plants were sprayed with distilled water. During the growth season pots were kept free of weeds. After twenty three days from lead exposure three plants were sample, plant height, no. of branches.$plant^{-1}$ were measured, shoots were dried in oven 65°C and dry weight were calculated. The roots were carefully removed from the sand and washed with distilled water to measure root length. Determination of macronutrient status was calculated, known dry shoot weight was digested according to (Agiza *et al.*, 1961), chemical analysis of nitrogen (Chapman and Pratt, 1961), phosphorus (Matt, 1970) and potassium (Page, 1982), were done by standard methods, protein concentration was calculated (Thachuk *et al.*, 1977).

Two plants were harvest in 20/4/2018, number of umbellate and number of simple umbel per plane were measured, the weight of fruit per plant were calculated.

The data obtained from the experiment was statistically analyzed at least significant difference 0.05 (SAS).

Results and Discussion

Results of table 1, indicated that lead stress had an adverse effects on average of plant height, no. of branches.$plant^{-1}$, root length and shoot dry weight by increasing lead concentrations from 0 to 150 mg.L^{-1}, it can be seen reduction in growth parameters by about (26.52, 23.34, 34.79, 25.30)% respectively, in contrast selenium application from 0 to 30 mg.L^{-1} had positive increase in average of parameters by about (14.50, 29.31, 22.40, 27.42)%.

For the interaction selenium at the concentration 30 mg.L^{-1} diminished the adverse effect of lead stress at the concentration 100 mg.L^{-1} and gave the best value for plant height 24.23(cm), no. of braches.$plant^{-1}$ 6.25, root length 10.00(cm) and shoot dry weight 0.73(gm.) in comparison with the values at same concentration of lead concentration but without selenium spraying. Also 30 mg.L^{-1} selenium gave positive effect on the parameters and decreased the adverse effect of 150 mg.L^{-1} lead concentration and gave the values for plant height 23.02(cm), no. of branches.$plant^{-1}$ 6.35, root length 8.80(cm) and shoot dry weight 0.72(gm) in comparison with the same lead concentration and with out selenium spraying.

The content of macronutrient and protein percentage were decrease in response to lead stress, the result of table (2) showed decrease in average of nitrogen, phosphorus, potassium content and protein percentage by about (42.68, 45.85, 38.96, 23.50)% with increase in lead concentration up to 150 mg.L^{-1}, while spraying with selenium up to 30 mg.L^{-1} caused an increase in average of nutrients content and protein percentage by about (68.45, 54.84, 31.88, 34.92)% respectively.

Table 1: Effect of lead stress and selenium on some morphological parameters of dill Plant.

Lead concentrations (mg. L^{-1})	Plant height (cm)			
	Selenium concentrations (mg.L^{-1})			
	0	15	30	Lead average
0	26.43	31.00	27.09	28.17
50	23.00	24.75	25.17	24.31
100	19.50	23.50	24.23	22.41
150	18.00	21.07	23.02	20.70
Selenium average	21.73	25.08	24.88	
LSD (0.05)	Lead concentration = 1.11 Selenium concentration = 0.96 Interaction = 1.92			
Lead concentrations (mg. L^{-1})	No. of branches.plant^{-1}			
	Selenium concentrations (mg.L^{-1})			
	0	15	30	Lead average
0	6.33	7.50	7.00	6.94
50	5.34	6.22	6.50	6.02
100	4.50	5.70	6.25	5.49
150	4.02	5.60	6.35	5.32
Selenium average	5.05	6.26	6.53	
LSD (0.05)	Lead concentration = 0.81 Selenium concentration = 0.70 Interaction = 1.40			
Lead concentrations (mg. L^{-1})	Root length (cm)			
	Selenium concentrations (mg.L^{-1})			
	0	15	30	Lead average
0	9.95	12.80	11.67	11.47
50	9.10	11.57	11.50	10.72
100	8.75	9.10	10.00	9.28
150	6.47	7.71	8.80	7.48
Selenium average	8.57	10.16	10.49	
LSD (0.05)	Lead concentration = 0.89 Selenium concentration = 0.78 Interaction = 1.55			
Lead concentrations (mg. L^{-1})	Shoot dry weight (gm)			
	Selenium concentrations (mg.L^{-1})			
	0	15	30	Lead average
0	0.72	0.92	0.86	0.83
50	0.70	0.74	0.83	0.76
100	0.60	0.70	0.73	0.68
150	0.45	0.68	0.72	0.62
Selenium average	0.62	0.76	0.79	
LSD (0.05)	Lead concentration = 0.03 Selenium concentration = 0.03 Interaction = 0.05			

Table 2: Effect of lead stress and selenium on some physiological parameters of dill Plant.

Lead concentrations (mg. L^{-1})	Nitrogen content			
	Selenium concentrations (mg.L^{-1})			
	0	15	30	Lead average
0	16.27	21.35	24.09	20.57
50	12.95	15.55	21.24	16.58
100	10.36	14.29	18.92	14.52
150	7.57	12.60	15.19	11.79
Selenium average	11.79	15.95	19.86	
LSD (0.05)	Lead concentration = 0.76 Selenium concentration = 0.66 Interaction = 1.31			
Lead concentrations (mg. L^{-1})	Phosphorus content			
	Selenium concentrations (mg.L^{-1})			
	0	15	30	Lead average
0	2.17	3.23	2.93	2.77
50	1.73	2.61	2.65	2.33
100	1.39	2.03	2.13	1.85
150	0.91	1.71	1.88	1.50
Selenium average	1.55	2.39	2.40	
LSD (0.05)	Lead concentration = 0.17 Selenium concentration = 0.15 Interaction = 0.30			
Lead concentrations (mg. L^{-1})	Potassium content			
	Selenium concentrations (mg.L^{-1})			
	0	15	30	Lead average
0	19.01	26.69	23.23	22.97
50	15.83	17.99	18.89	17.57
100	13.20	16.74	17.31	15.75
150	9.68	15.66	16.71	14.02
Selenium average	14.43	19.27	19.03	
LSD (0.05)	Lead concentration = 0.73 Selenium concentration = 0.63 Interaction = 1.27			
Lead concentrations (mg. L^{-1})	Protein %			
	Selenium concentrations (mg.L^{-1})			
	0	15	30	Lead average
0	14.07	14.50	17.50	15.36
50	11.57	13.13	16.63	13.77
100	10.94	12.75	16.19	13.29
150	10.51	11.57	13.19	11.75
Selenium average	11.77	12.99	15.88	
LSD (0.05)	Lead concentration = 0.23 Selenium concentration = 0.20 Interaction = 0.40			

The interaction between lead concentration 100 mg.L^{-1} and Selenium 30mg.L^{-1} demonstrated a better tolerance to lead stress, the values were 18.92, 2.13, 17.31 and 16.19 respectively for nitrogen, phosphorus, potassium content and protein concentration in comparison with 100mg.L^{-1} lead and without selenium spraying. The same concentration of selenium 30mg.L^{-1} decrease the unfavorable effect of 150mg.L^{-1} lead concentration and gave the values 15.19, 1.88, 16.71, 13.19 for parameters in comparison with the same lead concentration and without selenium spraying.

Data present in table 3, showed that average of no.

Table 3: Effect of lead stress and selenium on some flowering growth and yield of dill Plant.

Lead concentrations (mg. L^{-1})	No. of umbellate Plant^{-1}			
	Selenium concentrations (mg.L^{-1})			
	0	15	30	Lead average
0	285.00	335.00	295.00	305.00
50	275.00	299.00	290.00	228.00
100	225.00	255.00	231.00	237.00
150	162.00	210.00	232.00	201.33
Selenium average	236.75	274.75	262.00	
LSD (0.05)	Lead concentration = 3.86 Selenium concentration = 3.34 Interaction = 6.69			

Lead concentrations (mg. L^{-1})	No. simple umbel. Plant^{-1}			
	Selenium concentrations (mg.L^{-1})			
	0	15	30	Lead average
0	17.50	21.00	19.00	19.17
50	17.00	19.50	17.50	18.00
100	12.00	18.50	16.00	15.50
150	9.50	14.50	15.00	13.00
Selenium average	14.00	18.38	16.88	
LSD (0.05)	Lead concentration = 0.96 Selenium concentration = 0.83 Interaction = 1.66			

Lead concentrations (mg. L^{-1})	Wt. of fruits. Plant^{-1}			
	Selenium concentrations (mg.L^{-1})			
	0	15	30	Lead average
0	1.75	2.40	2.10	2.08
50	1.60	2.08	1.85	1.84
100	1.10	1.71	1.80	1.54
150	0.90	1.20	1.67	1.26
Selenium average	1.34	1.85	1.86	
LSD (0.05)	Lead concentration = 0.04 Selenium concentration = 0.03 Interaction = 0.06			

umbellate.plant^{-1} and simple umbel.plant^{-1} and weight of fruits.Plant^{-1} decreased with high concentration of lead the decrease rate were (33.99, 32.19, 39.42)% for the parameters respectively. The result also indicate that foliar spraying with 15mg.L^{-1} selenium increased the average of no. umbellate and simple umbel.plant^{-1} by about (16.05, 31.29)% and foliar spraying with 30 mg.L^{-1} selenium increased the average of wt. of fruits.Plant^{-1} by about 38.81%.

The interaction effect between the two factors was significantly at the concentration 15 mg.L^{-1} selenium that minimize the adverse effect of 100 mg.L^{-1} lead and the values were 255.00, 18.50 for no. of umbellate.plant.$^{-1}$ and simple umbel.plant^{-1}, while the concentration 30 mg.L^{-1} selenium can decrease the adverse effect of 150 mg.L^{-1} lead and the values were 232.00, 15.00 for parameters. Results for wt. of fruits.Plant^{-1}, selenium at the concentration 30mg.L^{-1} had positive effect and decreased the adverse effect of 100, 150 mg.L^{-1} lead, the values were 1.80, 1.167 with comparison with non sprayed selenium plant.

Lead stress affects physiological processes in plant, it causes a reduction in photosynthetic capacity and disturbances of electron transport, nutrient imbalance so plant growth parameters and yield were reduced (Ali *et al.*, 2017) and reduced the photosynthetic pigments because it prevent the incorporation of iron in phytoporphyrin ring of chlorophyll molecule so causes reduction in chlorophyll (Liu *et al.*, 2008). Selenium initiated activation of these processes, it can act directly on protein-enzymes locatized in chloroplast or by modification of the membrane lipid composition (Filek *et al.*, 2010). It can stimulate the energy flux through out the transport system in PS II and increase in photosynthetic efficiency, thereby leading to increase the mass of plant tissue and organs (Hawrylak Nowak *et al.*, 2015). Selenium decrease the heavy metals up take, it is an important factor in maintaining water balance in cells (Ajiboso and Adenuga, 2012). Lead affects plant mineral uptake and decrease their translocation from roots to aerial part (Copal and Rizvi, 2008). The reduction in content of nitrogen caused by reduction of nitrate reductase activity which is important in nitrate assimilation process (Sengar *et al.*, 2009). Strong interaction between potassium and lead,the two ions may compete for entry into plant through the same potassium channels also lead affects K^+ ATPase of cell membrane proteins cause an efflux of potassium from plant roots (Sharma and Dubey, 2003). Selenium influence the distribution of elements essential for plant growth and development such as nitrogen, phosphorus and potassium (Tobiasz *et al.*, 2014).

As an indicator of oxidative stress, an increase in reactive oxygen species (ROS) in the cells, the enhanced generation of ROS may pose a threat to plants and as indirect indicator of oxidative stress an increase in the concentrations of antioxidant enzymes.(Seppanen *et al.*, 2003). Selenuim can regulate ROS levels in stressed plants, it can stimulate dismutation of $O•_2$ in to H_2O2 and by direct reaction between Se-containing compounds and ROS can also regulate antioxidative enzymes (Cartes *et al.,* 2010). Selenium increase the activity of both nucleic acid DAN, RNA and growth cellular differentiation by linking between amino acids especially Seleno-methionin, seleno-cystin which have the ability to connect with another amino acid (Castillo-Godine *et al.*, 2016).

Conclusions

Selenium is important element for plants, it can play a vital role in recovery from the damage caused by lead stress by reducing the excess generation of reactive oxygen species. Accordingly, this study considered selenium foliar application at the concentration 30 mg.L^{-1} to gave better tolerance to plants to overcome the adverse effects of lead stress.

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