Journal of
NUCLEAR
Technology in Applied Science
ISSN 2314-8209 e-ISSN 2314-8217

J. Nucl. Tech. Appl. Sci., Vol. 10, PP. 41 : 53 (2022)

Growth and Yield of Chickpea Treated With Different Levels of Lead and Molybdenum Using ^{15}N Tracer Technique

Moursy, A.A.* and Ismail, M.M.

Received: 10/03/2022
Accepted: 09/06/2022
DOI:10.21608/jntas.2022.126589.1047

E.mail:ahmad1a2m3@yahoo.com

ABSTRACT

A pot experiment was carried out in greenhouse to study the effect of lead (Pb) applied as a toxic metal with and without molybdenum (Mo) on growth, dry matter yield of chickpea plants and N fixation using ^{15}N dilution technique. The experiment was laid out in randomized complete block design in three replicates of each treatment. Before sowing, the legume chickpea seeds inoculated with *Rhizobium Leguminesarum*. Lead was applied as lead sulfate at rates of 0,50 and 100 mg Pb kg^{-1} soil, while, molybdenum was applied as molybdenum sulfate at levels of 0, 1, 2 and 3 mg Mo kg^{-1} soil. Results demonstrated that, in general trend, the highest weights of seeds and shoots were 15.36 g pot^{-1} and 19.68 g pot^{-1} observed in the pots received rate of (Pb 0 + Mo 3) ratio, respectively. For N-uptake by seeds and shoots, the highest values were 763.87 mg pot^{-1} and 324.34 mg pot^{-1} achieved in the pots received rate of (Pb 0 + Mo 3) ratio. While for pb-uptake by seeds and shoots, the highest values were 8.0 mg pot^{-1} and 43.0 mg pot^{-1} achieved with the rate of (Pb 100 + Mo 0) ratio. Using ^{15}N dilution technique, in seeds, the highest value of (Ndff%) was (11.85%), achieved with rate of (Pb 50 + Mo 3) ratio and dose of (Pb100 + M 1) ratio while, the highest value of (Ndfa%) was (40.21%), achieved with rate of (Pb100 + Mo 1) ratio and followed by (39.81%) with dose of (Pb100 + Mo 2) ratio, respectively.

KEYWORDS

Chickpea yield, Lead sulfate, Molybdenum sulfate, ^{15}N.

1. Egyptian Atomic Energy Authority, Nuclear Research Center, Soil & WaterResearch Department Abou-Zaabl, 13759

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is an important pulse crop grown and consumed all over the world, especially in the Afro-Asian countries. It is a good source of carbohydrates and protein, and the protein quality is considered to be better than other pulses. Chickpea has significant amounts of all the essential amino acids except sulfur containing types, which can be complemented by adding cereals to daily diet **(Jukanti1 *et al.,* 2012)**. It can be a very useful legume crop for incorporation into short-term rotation and for fixation of nitrogen in soil and its fertility **(Ali and Kumar, 2009)**. Additionally, **Şehirali (1988**) reported that, dry chickpea kernels contain 16.4-31.2% protein, 1.5-6.8% oil, 38.1-73.3% carbohydrate and 1.6-9.0% cellulose; therefore, kernels are used as a significant source of nutrient for humans.

Nitrogen (N) deficiency is frequently a major limiting factor for high yielding crops all over the world **(Salvagiotti *et al.,* 2008; Namvar *et al.,* 2011).** The most important role of N in the plant is its presence in the structure of protein and nucleic acids which are the most important building and information substances of every cell. In addition, N is also found in chlorophyll that enables the plant to transfer energy from sunlight by photosynthesis. Thus, the supply of N to the plant will influence the amount of protein, amino acids, protoplasm and chlorophyll formed. Consequently, it influences cell size, leaf area and photosynthetic Activity **(Kibe *et al.,* 2006; Alam and Haider, 2006; Caliskan *et al.,* 2008; Salvagiotti *et al.,* 2008).** Therefore, adequate supply of N is necessary to achieve high yield potential in crops. In general, N deficiency causes a reduction in growth rate, general chlorosis, often accompanied by early senescence of older leaves, and reduced yield **(Caliskan *et al.,* 2008; Erman *et al.,* 2011).**

Molybdenum (Mo) which is an important microelement for chemical reactions in plant, is commonly used for seed priming which is more effective than soil or foliar applications **(Mahler, 2005) and Hernandez *et al.* (2009),** they also reported that the high levels of Mo in the soil may be harmful; although low quantities of seed treatment by Mo (0.03 pound per acre) are useful for plant growth, Therefore, only about 0.2 to 5 ppm of Mo is needed for plants. Similarly, sandy soil the Mo and other fertilizer applications depend on the soil moisture and pH. Contrarily, **Bambara and Ndakidemi (2010)** demonstrated that the Mo is less available in acidic soil and foliar application can overcome this problem. Although foliar application of Mo is beneficial, but the seed and soil applications remain effective for longer period under normal conditions. Molybdenum is required for the formation of the nitrate reductase enzyme and in the legume it plays an additional role in symbiotic nitrogen fixation. The nitrogen fixing enzyme, nitrogenase is composed of molybdenum and iron and without adequate quantities of these elements, nitrogen fixation can't occur **(Robinson, 1973)**.

Lead has been listed as a hazardous heavy metal pollutant due to its high toxicity (**Qi *et al.,* 2018).** Long-term exposure to low concentrations of Pb leads to high toxic levels. The main source of Pb contamination in the soil is its geogenic contribution, which reduces the soil microbial activities. The effects of Pb on soil are several, such as reducing soil nutrients; microbial diversity, and soil fertility **(Dotaniya *et al.,* 2020).** Furthermore, earthworms (*Eisenia fetida*) are usually affected by Pb toxicity, which may cause earthworm mortality. Reducing Pb bioavailability in the soil through phytoremediation or phytostabilization strategies is an important issue that should be a focus of concern **(Lan, 2020)**. Many studies were done on the effect of Pb on agricultural soil in different geographical locations. **Vega *et al.* (2010)** reported the impact of soil properties on absorption and retention of Pb. The results indicated that soil pH and cation exchange capacity were the important parameters influenced by Pb accumulation.

Nitrogen assimilation is an important plant metabolic process, which not only controls development plant growth but also plays an important role in plant survival under stress conditions. As said by **Burger and Jackson (2003)** nitric oxide is a major nitrogen source and is required during different metabolic processes.

Nitrate is converted into NH^{4+} via a process constituted of two steps; during the first step, NO_3 is converted into nitrite with the action of the enzyme nitrate reductase, and in the second step nitrite is converted into NH^{4+} with the action of nitrite reductase.

Metal toxicity significantly reduces nitrogen assimilation process. However, the level of reduction depends on the sensitivity and localization of enzymes to heavy metal toxicity. Moreover, concentration, mobility and duration of heavy metal ions in growth medium further aggravate alterations in the process of nitrogen assimilation.

The exposure to metals at higher concentrations could result in severe damage to various metabolic activities leading consequently to the death of plants. The exposure of excess levels of metals to plants inhibits physiologically active enzymes **(Gadd, 2007)** inactivates photosystems **(Sandmann, 1980)**, and can possibly destroy the mineral metabolism.

Therefore, in this study, it was aimed to study the effect of Pb applied as a toxic metal and with or without on the productivity of chickpea yield under wheat yield as a reference crop and N fixation using ^{15}N dilution.

MATERIAL AND METHODS

Experimental site:

A pot experiment was carried out at the Soil and Water Research Dept., Nuclear Research Center, Egyptian Atomic Energy Authority, Inshas, Egypt.

The soil tested through this study (as growth medium) was obtained from Inshas, Sharkia Governorate from (0-15 cm depth) layer. The Soil samples were air dried ground and sieved to pass through a 2 mm sieve. Some physical and chemical characteristics of the tested soil are presented in Table (1).

Table (1) : *Physical and chemical properties in soil.*

Property	Value
Particle size distribution (%)	
Coarse sand	64.1
Fine sand	26.4
Clay	6.8
Silt	2.7
Soil Texture	Sand
pH (1:2.5 paste)	7.97
E.C. (ds m^{-1})	0.27
Total N (%)	0.007
Pb (mg /kg soil)	0.06
Cations (meq 100 g^{-1} soil)	
Ca	1.25
Mg	1.00
Na	0.32
K	0.09
Anion (meq 100 g^{-1} soil)	
SO_4^{--}	0.53
CO_3^{--}	0.00
HCO^-_3	0.88
Cl^-	1.25

Plant Material: Seeds of chickpea and wheat cultivar were kindly supplied by the Agriculture Research Centre, Giza, Egypt.

Experimental set-up: Plastic pots of 20 cm diameter and 16 cm height were chosen for the experimentation purpose. The pots were sealed from the bottom in order to avoid leaching of heavy metal from soil. Twenty Kg of aerial dry sand soil was filled in each pot reaching up to a height of 14 cm and diameter of 16 cm and the experimental treatments were arranged in a complete randomized block design with three replicates.

Metal treatments:

Plastic pots were divided into two groups, the first group was planted (by chickpea seeds) and the second group was planted by the reference crop (wheat seeds), N-15 labelled (5% atom excess) as urea was applied at one level (60 kg N fed $^{-1}$) after 21 days from planting. Under first group, before sowing, chickpea seeds were inoculated with Rhizobium Leguminous. Also, before sowing, lead was applied as lead sulfate at the rate of 0, 50 and 100 mg Pb kg $^{-1}$ soil and molybdenum was applied as molybdenum sulfate at levels of 0, 1, 2 and 3 mg Mo kg $^{-1}$ soil and the all were mixed thoroughly with the soil. A basal dose of P and K was applied according to recommended rate as a source of single super phosphate and potassium sulfate with two groups. Wheat and chickpea were sown (4 seeds pot $^{-1}$) and soil moisture was maintained at 60% of soil at water holding capacity.

Metal accumulation:

After 120 days of growth, shoot, and seeds pods for both plants were collected separately, washed by distilled water, dried at 70°C, weighed, ground and kept for analysis. Plant samples were digested and analyzed according to ***Page et al.* (1982).** Total Pb was determined using Atomic Absorption Spectrometry model GBC 902. Total P assayed calorimetrically using stannous chloride and ammonium molybdate. Nitrogen % was determined using kjeldahl method, ^{15}N-analyzed by an automated emission spectrometer (NOI-6PC) following the description of **(IAEA) 2001.**

***Statistical Analysis*:** Results in this work were subjected to ANOVA analysis followed by Duncan's multiple range test (DMRT) according to **SAS software program (1987).**

RESULTS

Seeds and shoots weights of chickpea yield:

Data listed in Table (2), shows that seeds shoots weights significantly ($P > 0.05$) affected by the applications of different levels of molybdenum (Mo) also lead (Pb) and their interactions under rate of nitrogen source which applied as urea fertilizer (5% atom excess) at one dose . Furthermore, in general trend, the highest weights of seeds and shoots were 15.36 g pot $^{-1}$ and 19.68 g pot $^{-1}$ observed in the pots received rate of (Pb 0 + Mo 3) ratio, respectively. While, the lowest weights of seeds and shoots were 4.07 g pot $^{-1}$ and 6.57 g pot $^{-1}$ observed at the rate (Pb 100 + Mo 0) ratio, respectively. On the other hand, concerning the means effect, the highest weights of seeds and shoots yields of chickpea were 11.03 g pot $^{-1}$ and 17.16 g pot $^{-1}$ recorded with the interaction of (Pb 0 x Mo), while the lowest weights were 5.76 g pot $^{-1}$ and 9.88g pot $^{-1}$ recorded with the interaction of (Pb 100 x Mo), respectively.

N-Uptake in seeds and shoots of chickpea yield

Data presented in Table (3), shows that N-uptake by seeds and shoots significantly ($P > 0.05$) affected by the applications of different levels of molybdenum (Mo) also lead (Pb) and their interactions under rate of nitrogen source. Moreover, the highest values of N-uptake by seeds and shoots of chickpea yield were 763.87 mg pot $^{-1}$ and 324.34 mg pot $^{-1}$ achieved in the pots received rate of (Pb 0 + Mo 3) ratio, whereas the lowest values recorded of 65.78 mg pot $^{-1}$ and 94.92 mg pot $^{-1}$ achieved at the rate of (Pb 100 +Mo 0) ratio, respectively. On the other hand, concerning the means effect, the highest values recorded 376.50 mg pot $^{-1}$ and 261.01 mg pot $^{-1}$, recorded with the interaction of (Pb 0 x Mo), while the lowest values of N-uptake were 130.93 mg pot $^{-1}$ and 150.57 mg pot $^{-1}$ recorded with the means of (Pb 100), respectively.

Table (2) : *Seeds and shoots of chickpea yield as affected by addition of different levels of molybdenum (Mo) also lead (Pb) and their interactions under one dose of nitrogen source as urea fertilizer.*

Seeds weight of chickpea yield (g pot^{-1})					
Pb (mgkg^{-1})	Mo concentration (mg kg^{-1})				
	Mo 0	Mo 1	Mo 2	Mo 3	Means
Pb 0	6.06	8.98	13.72	15.36	11.03
Pb 50	4.77	6.42	7.61	9.31	7.03
Pb 100	4.07	5.25	6.50	7.23	5.76
Shoots weight of chickpea yield (g pot-1)					
Pb 0	11.86	18.07	19.01	19.68	17.16
Pb 50	7.62	8.24	14.51	15.57	11.49
Pb 100	6.57	7.90	12.24	12.82	9.88

L.S.D at 0.05	*Seeds*	*Shoots*
Molybdenum (Mo)	*= 6.789*	*10.123*
Lead (Pb)	*= 9.601*	*14.316*
Inter (Mo x Pb)	*= 13.567*	*20.246*

Table (3) : *N uptake by seeds and shoots of chickpeas yield as affected by addition of different levels of mo lybdenum (Mo) also lead (Pb) and their interactions under dose of nitrogen source as urea fertilizer.*

N-Uptake in seeds of chickpea yield (mg pot^{-1})					
Pb (mgkg^{-1})	Mo concentration (mg kg^{-1})				
	Mo 0	Mo 1	Mo 2	Mo3	Means
Pb 0	144.14	247.80	350.17	763.87	376.50
Pb 50	102.35	176.47	218.58	317.40	203.70
Pb 100	65.78	144.82	152.56	160.56	130.93
N-Uptake in shoots of chickpea yield (mg pot-1)					
Pb 0	170.33	261.31	288.05	324.34	261.01
Pb 50	114.50	132.79	239.01	264.09	187.60
Pb 100	94.92	115.14	211.60	180.63	150.57

L.S.D at 0.05	*Seeds*	*Shoots*
Molybdenum (Mo)	*= 279.37*	*160.66*
Lead (Pb)	*= 395.09*	*227.20*
Inter (Mo x Pb)	*= 558.74*	*321.31*

Pb-Uptake in seeds and shoots of chickpea yield:

Data listed in Table (4), shows that Pb- uptake in seeds and shoots statistically ($P > 0.05$) affected by the applications of different levels of molybdenum (Mo) also lead (Pb) and their interactions under rate of nitrogen source which applied as urea fertilizer (5% atom excess) at one dose . Furthermore, the highest values of Pb–uptake by seeds and shoots of chickpea yield were 8.0 mg pot^{-1} and 43.0 mg pot^{-1} achieved with the rate of (Pb 0 + Mo 0) ratio, while the lowest values were 0.8 mg pot^{-1} and 5.4 mg pot^{-1} observed with the rate of (Pb 0 + Mo 3) ratio, respectively. On the other hand, under rate of (Pb 50 + Mo

3) ratio, Pb-uptake by seeds and shoots were (2.5 mg pot^{-1} and 17.0 mg pot^{-1}), while, under rate of (Pb 100 + Mo 3) ratio, the results recorded (4.6 mg pot^{-1} and 19,20 mg pot^{-1}), respectively. concerning the means effect, the highest means values were 6.55 mg pot^{-1} and 26.88 mg pot^{-1} recorded with the means of (Pb 100), while the lowest mean values were 1.10 mg pot^{-1} and 6.38 mg pot^{-1} recorded with the means of (Pb 0), respectively.

Table (4) : *Pb uptake by seeds and shoots of chickpea yield as affected by addition of different levels of molybdenum (Mo) also lead (Pb) and their interactions under one dose of nitrogen source as urea fertilizer.*

Pb-Uptake in seeds of chickpea yield (mg pot^{-1})					
Pb ($mgkg^{-1}$)	Mo concentration (mg kg^{-1})				
	Mo 0	Mo 1	Mo 2	Mo3	Means
Pb 0	1.4	1.1	1.1	0.8	1.10
Pb 50	4.0	3.3	3.0	2.5	3.20
Pb 100	8.0	7.2	6.4	4.6	6.55
Pb-Uptake in shoots of chickpea yield (mg pot^{-1})					
Pb 0	7.0	6.8	6.3	5.4	6.38
Pb 50	31.0	21.1	18.2	17.0	21.82
Pb 100	43.0	24.0	21.3	19.2	26.88

L.S.D at 0.05	*Seeds*	*Shoots*
Molybdenum (Mo)	*= 3.955*	*18.341*
Lead (Pb)	*= 5.593*	*25.940*
Inter (Mo x Pb)	*= 7.100*	*36.682*

Using ^{15}N isotopic dilution:

Nitrogen derived from fertilizer (Ndff%) by seeds and shoots of chickpea yield.

Data listed in Table (5), shows that nitrogen derived from fertilizer (Ndff%) markedly affected by the application of different levels of molybdenum also lead (Pb) and their interactions under dose of nitrogen source as urea fertilizer. Furthermore, of seeds, at zero (Pb), the highest values of (Ndff %) was 14.22% observed with (Mo), followed by (12.70%), with (Mo1). On the other hand, for means, the highest values was (11.85%), achieved with rate of (Pb 50 +Mo 3) ratio and dose of (Pb 100 + Mo 1) ratio, respectively. of shoots, at zero (Pb) the highest value of (Ndff %) was 15.46% achieved with rate of (Mo 0), followed by 14.21% which recorded with rate of (Mo 2), respectively. At (Pb), the highest value of (Ndff%) was 13.03% achieved with rate of (Pb 50 + Mo 1) ratio, followed by 10.53% observed with rate of (Pb100 + Mo 1) ratio, respectively.

Nitrogen derived from fertilizer (Ndff%) by seeds and shoots of wheat yield as a reference crop:

Data listed in Table (6), shows that nitrogen derived from fertilizer (Ndff%) markedly affected by the application of different levels of molybdenum (Mo) also lead (Pb) and their interactions under dose of nitrogen source as urea fertilizer. Furthermore, of seeds, at zero (Pb), the highest values of (Ndff %) was 23.02% observed with (Mo), followed by (21.10%) observed with rate of (Mo 1). On the other hand, under (Pb), the highest values was (19.82%), achieved with rate of (Pb 50 +Mo 2) and followed by 20.40% with dose of (Pb 100 + Mo 1) ratio, respectively. of shoots, at zero (Pb), the highest value of (Ndff %) was 16.84% achieved with rate of (Pb 0 + Mo 0), followed by14.01% which achieved at the same rate, respectively. At (Pb), the highest value of (Ndff%) was 12.84% achieved with rate of (Pb 50 + Mo 0) ratio, followed by 12.16% observed with rate of (Pb 100 + Mo 0) ratio, respectively.

Table (5) : *Effect of lead toxicity with different levels of molybdenum on nitrogen derived from fertilizer (Ndff%) by seeds and shoots of chickpea yield.*

Nitrogen derived from fertilizer (Ndff %) by seeds				
Pb (mgkg^{-1})	Mo concentration (mg kg^{-1})			
	Mo 0	Mo 1	Mo 2	Mo 3
Pb 0	14.22	12.70	7.55	12.09
Pb 50	9.47	12.40	9.82	11.85
Pb 100	7.17	11.85	6.79	10.44
Nitrogen derived from fertilizer (Ndff%) by shoots				
Pb 0	15.46	14.21	12.04	8.50
Pb 50	11.79	13.03	10.59	7.73
Pb 100	9.39	10.53	9.88	7.21

Table (6) : *Effect of lead toxicity with different levels of molybdenum on nitrogen derived from fertilizer (Ndff%) by seeds and shoots of wheat yield as a reference crop.*

Nitrogen derived from fertilizer (Ndff %) by seeds of wheat as a reference crop.				
Pb (mgkg^{-1})	Mo concentration (mg kg^{-1})			
	Mo 0	Mo 1	Mo 2	Mo 3
Pb 0	23.02	21.10	12.30	11.52
Pb 50	15.46	20.40	11.84	10.90
Pb 100	11.52	19.82	11.28	10.60
Nitrogen derived from fertilizer (Ndff%) by shoots of wheat as a reference crop.				
Pb 0	16.84	14.04	12.77	11.50
Pb 50	12.84	12.03	11.22	9.72
Pb 100	12.16	11.54	10.94	7.52

Nitrogen derived from air (Ndfa%) by seeds and shoots of chickpea yield:

Data listed in Table (7), shows that nitrogen derived from air (Ndfa%) markedly affected by the application of different levels of molybdenum (Pb 0 + Mo 1) also lead (Pb) and their interactions under dose of nitrogen source as urea fertilizer. Furthermore, in seeds, at zero (Pb), the highest values of (Ndfa%) was 39.81% observed with (Mo 1), followed by (38.62%) observed with rate of (Pb 0 + Mo 2). On the other hand, with (Pb), the highest value was (40.21%), achieved with rate of (Pb 100 + Mo 1) ratio and followed by 39.81% with dose of (Pb 100 + Mo 2) ratio, respectively. In shoots, at zero (Pb), the highest value of (Ndfa%) was 26.09% achieved with rate of (Pb 0 + Mo 3), followed by 8.19% which achieved at rate of Pb 0+ (Mo 0), respectively. At (Pb), the highest value of (Ndfa%) was 22.78% achieved with rate of (Pb 100 + Mo 0) ratio, followed by 20.47% observed with rate of (Pb 50 + Mo 3) ratio, respectively

Table (7) : *Effect of lead toxicity with different levels of molybdenum on nitrogen derived from air (Ndfa%) by seeds and shoots of chickpea yield.*

Nitrogen derived from air (Ndfa%) by seeds				
Pb (mgkg^{-1})	Mo concentration (mg kg^{-1})			
	Mo 0	Mo 1	Mo 2	Mo 3
Pb 0	38.23	39.81	38.62	4.95
Pb 50	38.75	39.21	17.06	8.72
Pb 100	37.76	40.21	39.81	1.53
Nitrogen derived from air (Ndfa%) by shoots				
Pb 0	8.19	1.21	5.72	26.09
Pb 50	8.10	8.31	5.61	20.47
Pb 100	22.78	8.75	9.69	4.12

DISCUSSIONS

Seeds and shoots weights of chickpea yield:

The combined application of both lead and molybdenum were not found superior to their single application even though lead played major role in augmenting the yield. In this regard, **Gurpreet *et al.* (2013)** reported that root and shoot weight collectively refers to biomass production which ultimately refers to the plant productivity. Imposition of heavy metals viz. lead and nickel in *Vigna mungo* L. caused a substantial reduction in dry weight of both root and shoot. It was observed that in comparison to lead, nickel caused more deleterious effect on dry weight in black gram. On the other hand, **Gurpreet *et al.* (2013)** showed that shoot fresh weight the decrease was 7% and 11% at 10 µM concentrations of lead and nickel, but at high concentration the decrease was 18% and 27% over control. It has been shown that roots are less affected as compared to shoot, because roots translocate further these heavy metals to shoot and cause reduction in leaf pigment and also in fresh weight of the plant. But with the nitrogen treatment some how the deleterious effects was reduced root and shoot fresh weight slightly increased, whose the increase was 55% and 60% over control at 100 µM concentration of lead and nickel in root fresh weight and in shoot fresh weight the increase was 10% and 29% over control at 100 µM control of lead and nickel. However**, Taiz and Zeiger (2013)** reported that molybdenum favors agricultural production by acting in plants as a cofactor of enzymes that participate in nitrogen metabolism, and participates as a constituent of the enzymes nitrogenase and nitrate reductase essential in assimilation of N by plants, indicating their potential as fertilizers for chickpea crops.

N-Uptake in seeds and shoots of chickpea yield:

According to **Faridul *et al.* (2015**) who found that NO_3 -N content in the soil depended on the amount of Mo applied. As well as, they observed that the highest NO_3 -N content in the soil for 0.5 mg Mo kg^{-1}, this content was significantly ($P \leq 0.05$) higher than that of other treatments, except 1mg Mo kg^{-1}. Also, the total N content of Mo-treated plants was significantly higher than that of control plants, and treatment with 0.5 mg Mo kg $^{-1}$ resulted in increased total N content (41.1%) and uptake in the above-ground portion of hairy vetch plants (41.2%) relative to that in the control. However, ***Ismail et al.* (2012)** mentioned that lead additions resulted in decrease of N-uptake by different parts of pea plant in spite of increasing fertilizer-N rate up to 40 mg N kg^{-1} soil. Pea plants treated with 50 mg Pb kg^{-1} soil plus 40 mg N kg^{-1} soil reflected relative increase in N-uptake by shoot and whole pea plants by about 32.19% and 16.6%, over than that of the control, respectively.

Pb-Uptake in seeds and shoots of chickpea yield:

Accordingly, in a pot experiment, **Ismail *et al.* (2012),** they showed that the highest values of Pb content were, 54.0, 11.55 and 55.2 mg pot^{-1} for pea shoots, pods and whole plants, respectively under treatment of 200 mg Pb kg^{-1} soil + 40 mg N kg^{-1} soil. **Kobata and Pindias (1992)** recorded that the toxic limit of Pb was 30-300 mg Kg^{-1} in plant. Accumulation of Pb in plants causes physiological problems, such as DNA damage and destroying root and shoots systems **Gichner *et al.* (2008),** and affects the enzymatic activities **Reddy *et al.* (2005).** The effect of Pb toxicity on plants was studied by **Ali and Nas (2018).**

Using ^{15}N isotopic dilution:

The addition of lead at different levels led to a deficiency of nitrogen derived from the fertilizer, as well as nitrogen taken from the air. On the contrary, the addition of molybdenum had a clear effect on increasing nitrogen, whether taken from the fertilizer or the air

CONCLUSION

Based on the results, it can be concluded that, the highest weights of seeds and shoots were 15.36 g pot^{-1} and 19.68 g pot^{-1} observed in the pots received rate of (Pb 0 + Mo 3) ratio, respectively. While, the lowest weights of seeds and shoots were 4.07 g pot^{-1} and 6.57 g pot^{-1} observed at the rate (Pb 100 + Mo 0) ratio, respectively. The highest values of N-uptake by seeds and shoots of chickpea yield were 763.87 mg pot^{-1} and 324.34 mg pot^{-1} achieved in the pots received rate of (Pb 0 + Mo 3) ratio, whereas the lowest values recorded of 65.78 mg pot^{-1} and 94.92 mg pot^{-1} achieved at the rate of (Pb 100 +Mo 0) ratio, respectively. On the other hand, the highest values of Pb – uptake by seeds and shoots of chickpea yield were 8.0 mg pot^{-1} and 43.0 mg pot^{-1} achieved with the rate of (Pb 100 + Mo 0) ratio, while the lowest values were 0.8 mg pot^{-1} and 5.4 mg pot^{-1} observed with the rate of (Pb 0 + Mo 3) ratio, respectively. Using ^{15}N isotopic dilution, of seeds, at zero (Pb), the highest values of (Ndff %) was 14.22% observed with (Mo 0), followed by (12.70%), with (Mo 1). On the other hand, for interaction, the highest values was (11.85%), achieved with rate of (Pb 50 +Mo 3) ratio and dose of (Pb 100 + Mo 1) ratio, respectively. Whereas, for Nitrogen derived from air (Ndfa%), for interaction, the highest values was (40.21%), achieved with rate of (Pb 100 +Mo 1) ratio and followed by 39.81% with dose of (Pb 100 + Mo 2) ratio, respectively.

AUTHOR CONTRIBUTIONS

Conceptualization, All authors; methodology, Ahmed A. Moursy and Ismail, M.M; formal analysis, all authors; resources and writing-original draft preparation, all authors; writing-review and editing, all authors. Funding: This research received no external funding.Conflicts of Interest: The authors declare no conflict of interest.

REFERENCES

- **Alam, M. Z. and Haider, S. A. (2006):** Growth attributes of barley (*Hordeum Vulgare L.*) cultivars in relation to different doses of nitrogen fertilizer. *Journal of Life and Earth Sci.* **1**(2): 77.
- **Ali, M. and Nas, F.S. (2018) :**The effect of lead on plants in terms of growing and biochemical parameters: A review. *MOJ Ecol. Environ. Sci.,* **3**:265. doi: 10.15406/mojes.2018.03.00098.
- **Ali, M. and Kumar, S. (2009):** Major technology advances in Pulses. *Journal of Food Legumes*, **23**: 169.
- **Bambara, S. and Ndakidemi, P.A. (2010):** The potential roles of lime and molybdenum on the growth, nitrogen fixation and assimilation of metabolites in nodulated legume: A special reference to *Phaseolus vulgaris* L. *Afr. J. Biotechnol.*, **8**(17): 2482.

- **Burger, M. and Jackson, L.E. (2003):** Microbial immobilization of ammonium and nitrate in relation to ammonification and nitrification rates in organic and conventional cropping systems. *Soil Biol. Biochem.,* **35**(1):2936.

- **Caliskan, S.; Ozkaya, I.; Caliskan, M. E. and Arslan, M. (2008):** The effect of nitrogen and iron fertilization on growth, yield and fertilizer use efficiency of soybean in Mediterranean type soil. *Field Crops Res*., **108**: 126.

- **Dobermann, A. (2008):** Nitrogen uptake, fixation and response to N in soybeans: A review. *Field Crops Res*., 108: 1-13.

- **Dotaniya, M.L.; Dotaniya, C.K.; Solanki, P.; Meena, V.D. and Doutaniya, R.K. (2020)**: Lead Contamination and Its Dynamics in Soil–Plant System. In: Gupta D.K.,Chatterjee S., Walther C., editors. *Lead in Plants and the Environment. Springer; Cham., Switzerland*. pp. 83–98.

- **Erman, M.; Demir, S.; Ocak, E.; Tufenkci, S.; Oguz, F. and Akkopru, A. (2011):** Effects of Rhizobium, arbuscular mycorrhiza and whey applications on some properties in chickpea (*Cicer arietinum L.*) under irrigated and rain fed conditions 1-Yield, yield components, nodulation and AMF colonization. *Field Crops Res.,* **122**(1): 14.

- **Faridul, A.; Tae, Y. K.; Song, Y. K; Sadia, S. A; Prabhat, .P.; Pil Joo, K. and Yong, B.L. (2015):** Effect of molybdenum on nodulation, plant yield and nitrogen uptake in hairy vetch (*Vicia villosa* Roth). *Soil Sci and Plant Nutr* , **61**: 664.

- **Gadd, G.M. (2007):** Geomycology:biogeochemical transformations of rocks, minerals, metals and radionuclides by fungi, bioweathering and bioremediation. *Mycol. Res.,* 111: 3.

- **Gichner, T.; Žnidar, I. and Száková, J. (2008):** Evaluation of DNA damage and mutagenicity induced by lead in tobacco plants. *Mutat. Res. - Genet. Toxi. Env. Mutagen*., 652: 186. doi: 10.1016/j.mrgentox.

- **Singh, G.; Agnihotri, R. K.; Singh, D. and Sharma, R. (2013):** Effect of pb and ni on root development and biomass production of black gram (*vigna mungo* l.): overcoming through exogenous nitrogen application. *internj of agric and crop sci.*, **5** (22): 2689.

- **Hernandez, J.A.; Simon, J.G. and Luis, M.R. (2009):** Molybdenum trafficking for nitrogen fixation. *Biochem*., **48**(41): 9711.

- **Ismail, M. M.; Sherien, M. E; Abdel-Aziz, H. A. and Elbaz, A. S. (2012):** Nitrogen fixed by pea plant as affected by lead, cadmium and rates of N-fertilizer using ^{15}N tracer technique. Third International Conference on Radiation Sciences and Applications 12 – 16 November 2012/ Hurghada, Egypt.

- **IAEA, Vienna (2001)**: Use of isotope and radiation methods in soil and water management and crop nutrition. Manual. *Training Course Series No. **14**. IAEA, Vienna.*

- **Jukanti1, K.; Gaur, P.M.; Gowda, C.L.L. and Chibbar, R.N. (2012):** Nutritional quality and health benefits of chickpea (*Cicer arietinum* L.*). Br. J. Nutr.*, **108** (1): 11.

- **Kibe, A. M.; Singh, S. and Karla, N. (2006):** Wat ernitrogen relationship for Wheat growth and productivity in late sown conditions. *Agric. Water Manag*., **8**(4): 221.

- **Kobata, P.A. and Pindias, H. (1992):** Trace elements in soils and plants. 2nd Ed., CRC Press-Inc., Boca Ratom Annarbor, London.

- **Lan, M.M.; Liu, C.; Liu, S.J.; Qiu, R.L and Tang, Y.T. (2020):** Phytostabilization of cd and pb in highly polluted farmland soils using ramie and amendments. *Int. J. Environ. Res. Public Health.*, **17**:1661. doi: 10.3390/ijerph17051661.

- **Namvar, A.; Seyed, S. R.; Sedghi, M.; Asghari, Z R.; Khandan, T. and Eskandarpour, B. (2011):** Study on the effects of organic and inorganic nitrogen fertilizer on yield, yield components and nodulation state of chickpea (*Cicer arietinum L.*). *Commun in Soil Sci and Plant Analy.* **42**(9): 1097-1109.

- **Mahler, R.L. (2005):** Lentils. University of Idaho Extension, Idaho Agricultural Experiment Station. *3.3M 1979-91 (formerly CIS 448).*

- **Page, A.; Miller, R.H and Kenney, D.R. (1982):** Methods of Soil Analysis, *Part 1, ASA, SSSA, Madison,Wisconsin, USA.*

- **Qi, X.; Xu, X.; Zhong, C.; Jiang, T.; Wei, W. and Song, X. (2018):** Removal of cadmium and cead from contaminated coils using sophorolipids from sermentation culture of *Starmerella bombicola* CGMCC 1576 fermentation. *Int. J. Environ. Res. Public Health*., **15**:2334. doi: 10.3390/ijerph15112334.

- **Reddy, A.M.; Kumar, S.G.; Jyothsnakumari, G.; Thimmanaik, S. and Sudhakar, C. (2005):** Lead induced changes in antioxidant metabolism of horsegram (*Macrotyloma uniflorum* (Lam.) Verdc.) and bengalgram (*Cicer arietinum L.*) *Chemosphere*., **60**:97. doi: 10.1016/j.chemosphere.2004.11.092.

- **Robinson, R. G. (1973):** Elemental composition and response to nitrogen of sunflower and corn. *Agron. J*., **65**: 318.

- **Salvagiotti, F.; Cassman, K.; pecht, E.J. and Dobermann, A. (2008):** Nitrogen uptake, fixation and response to fertilizer N in soybeans: A Review. *Field Crops Res.,* 108(1):1. doi:10.1016/j.fcr.2008.03.001.

- **SAS Institute (1987):** AS/STATTM Guide for personal computers. *Version 6 edition, SAS Institute Inc, Cary,NY.*

- **Şehirali, S. (1988):** Yemeklik dane baklagiller, Ankara Universitesi Ziraat Fakültesi Yayınları:1089, Ders Kitabı: 314, Ankara, 435 s.

- **Taiz, L. and Zeiger, E. (2013):** Fisiologia vegetal. 5. *ed. Porto Alegre: Artimed, 918p*.

- **Vega, F.A.; Andrade, M.L. and Covelo, E.F. (2010):** Influence of soil properties on the sorption and retention of cadmium, copper and lead, separately and together, by 20 soil horizons: Comparison of linear regression and tree regression analyses. *J. Hazard. Mater.,* 174:522. doi: 10.1016/j.jhazmat.2009.09.083.