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EFFECT OF MANGANESE ON GROWTH AND SOME METABOLIC ASPECTS OF MUNG BEAN PLANT, GROWING UNDER FERTILIZATION WITH SLOW- RELEASE UREA

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ABSTRACT

A semi field experiment was conducted to investigate the effect of foliar spraying with manganese at different concentrations (5, 10, 15, 20, 25, 30, 35 ppm) on mung bean (Vigna radiate L., Wilczek) fertilized with slow release urea (urea coated with either sulfur or cement or dolomite). The data recorded at vegetative and flowering stages of mung bean growth indicated that, the determined growth parameters (shoot length/,no. of nodes/, leaf area, fresh weight of shoot, dry weight of shoot/plant, relative water content, relative growth rate, net assimilation rate) and photosynthetic pigments (chlorophyll a, chlorophyll b, carotenoids and consequently total pigments) as well as carbohydrates content (glucose, sucrose, total soluble sugars, polysaccharides and total carbohydrates) showed a stimulation, in general non-significantly and significantly at 5&10 ppm Mn respectively after which there was a progressive decrease by increasing Mn concentrations. In contrast, saturated water deficit and leaf area ratio increased by increasing Mn concentrations from 5 to 35ppm. At flowering stage, indol acetic acid, gibberellin and cytokinin content increased non-significantly with 5 ppm Mn and significantly with 10 ppm Mn and decreased progressively by increasing Mn concentrations. Meanwhile a reverse situation was observed in abscisic acid content. These trends were more obvious in response to fertilization with uncoated urea then sulfur coating followed with cement coating then dolomite coating urea except for these parameters of mung bean spraying with the higher Mn concentrations (25,30&35ppm) treated with cement-coating urea as the cement contain silicon which more or less alter Mn absorbance and also for the plants treated with dolomite-coating urea where pigments and carbohydrates were slightly increased, which could be explained as dolomite contains Mg.

Keywords: *Mung bean (Vigna radiata L.) Mn, slow release urea, growth, metabolism.*

INTRODUCTION

With increasing clinical evidence suggesting that plant-derived foods have various potential health benefits, their consumption has been growing at a rate of 5%-10% per year (Tham *et al.,* 1998). Moreover, many health organizations have recommended an increase in the intake of plant-derived foods to improve

health status and prevent chronic diseases (Espin *et al.,* 2007). Mung bean (Vigna radiata L. Wilczek) also called green gram, is an important summer annual leafy legume crop grown widely especially in South East Asia. It is a short duration (60-90 days), therefore, it has less water requirement as compared to other summer crops. Moreover, it is drought tolerant that can withstand adverse environmental conditions and hence successfully be grown in rain fed areas (Anjum *et al,* 2006).

Nutrient elements are needed in relatively small quantities for adequate plant growth and production, their deficiency may cause great disturbance in the physiological and metabolic processes in the plant (Babaeian *et al.,* 2011). During the last decade, foliar application of nutrients has become an established procedure in crop production to increase yield and improve the quality of crop products. (Pradeep and Elamathi, 2007). The foliar application of mineral nutrients by means of spray offers a method of supplying nutrients to higher plants more efficiently than methods involving root application when soil conditions are not suitable for ions availability (Darwesh, 2011).

Manganese (Mn) is an essential element for plants, intervening in several metabolic processes, mainly in photosynthesis and as an enzyme - cofactor. Nevertheless, an excess of this micronutrient is toxic for plants, Mn phytotoxicity is manifested in a reduction of biomass and photosynthesis, and biochemical disorders such as oxidative stress. When Mn is inside the cells, mechanisms that can tolerate this toxicity are also observed being important the compartmentalization of this metal in different organ, death of shoot and leaves. A key role of antioxidative systems in plants in relation to high Mn amounts has also been reported as a defense mechanism (Ducic and Polle, 2005).

Urea as a nitrogenous fertilizer widely used in agriculture because of its high nitrogen content (45%). However, about 20-70% of the supplied urea fertilizer is lost to the environment increasing costs and causing serious pollution. The losses are due to leaching, decomposition and ammonium volatilization in soil (Shaviv and Mikkelsen, 1993).

A controlled-release fertilizer (CRF) is a granulated fertilizer that releases nutrients gradually into the soil (i.e., with a controlled release period).The slowness of the release is determined by the low solubility of the chemical compounds in the soil moisture (Edward; *et al.,* 2001).

The controlled release technology, by coating, can be utilized to increase the efficiency of urea fertilizer. The coating of urea has been studied by many investigators, with different techniques and materials such as sulfur, cement and dolomite (Suherman and Anggoro, 2011).

Sulfur-coated urea contains about 22-38% nitrogen and 12-22% sulfur. It contains a coat of sulfur that surrounds a urea granule and controls its release. Urea is only released after the sulfur coat is oxidized by microorganisms. Coating of urea granules with sulfur may provide an effective controlled-release nitrogen fertilizer at relatively low cost (Rindt *et al.,* 1968). Cement-coated urea contain urea

and Aerosols R-972 which is a highly dispersed fumed silica consisting of 99.8% SiO_2 + (--CH_3) and having an average particle size of approximately 20 * 10^{-7} cm. (Foulkes and Mc Grath, 1999). Dolomite is an anhydrous carbonate mineral composed of calcium magnesium carbonate, ideally $CaMg(CO_3)_2$. Dolomite, on the other hand has 22% Ca and 12% Mg. Thus dolomite-coating urea, in addition to raising the pH, also is a source of calcium and magnesium (AL-Humaid, 2003).

This study was conducted to investigate the effect of foliar spraying with manganese at different concentrations (5,10,15,20,25,30,35 ppm) on mung bean (*Vigna radiata* L., Wilczek) plant fertilized with normal (uncoated) urea and slow release urea (coated with sulfur or cement or dolomite).

MATERIALS AND METHODS

Materials

Plants used and growth conditions:

The experiment was run with a homogeneous lot of mung bean (*Vigna radiate* L., Wilczek) seeds. Pure strain of seeds were obtained from the Agricultural Research Center, Ministry of Agriculture, Giza, Egypt and selected for apparent uniformity of size and shape. Moreover, the used uncoated and slow- release urea (sulfur-coated, cement- coated and dolomite-coated) and their dose were obtained from Fertilizer Factory, Talkha, Dakhlia, Egypt.

A pot experiment was carried out in the green house of Botany Department, Faculty of Science, Mansoura University to study the effect of spraying with different concentrations of manganese which applied as manganese nitrate, on growth and metabolism of *Vigna radiata* cultivated in garden soil (clay & sand; 2:1) and under three types of urea-coated fertilizers (sulfur-coated urea, cement-coated urea and dolomite-coated urea) in addition to the normal uncoated urea. Also super phosphate (0.6g/pot)] was added to the soil according to the recommended dose by the announcement of Ministry of Agriculture of Egypt.

After selection of the suitable Mn concentrations according to a preliminary experiment, a homogenously-sized lot of *Vigna radiate* L., Wilczek seeds were selected then surface sterilized with 0.01 % $HgCl_2$ solution for 3 minutes. The seeds were washed thoroughly with tap water, then divided into four equal groups; planted at 20 of June 2013.The first supplied with the normal uncoated urea whereas the other three were fertilized with sulfur-coated, cement-coated and dolomite-coated urea respectively (twice fertilizations; at 11 July and 1 August 2013) were carried out. Each group of these four groups was subdivided into eight subgroups. The first sprayed with water to serve as control, the other seven groups sprayed twice (at 18 July and 8 of August 2013) with the chosen manganous nitrate concentrations as follow: 5, 10, 15, 20, 25, 30& 35 ppm. The pots were kept in the greenhouse under a normal day/ night conditions and irrigated as usual with equal amounts of tap water when required. Super phosphate was added to the soil in all the experimental pots, during the first week of cultivation.

At 2^{nd} of July and 15^{th} of August 2013 sampling from treated and control took place, representing vegetative and flowering stage re-

spectively and were used for assessment of growth parameters (shoot length, number of nodes/, total leaf area/, shoot fresh weight, shoot dry weight/plant, relative water content, leaf area ratio, saturation water deficit, net assimilation rate and relative growth rate), as well as some metabolic activities (pigments, carbohydrate fractions and plant growth substances).

Before cultivation some physical and chemical analysis of the used soil is carried out according to Black (1965) and it was as follow: Moisture (%); 1.9, pH; 8.44, MWC (%); 60, $CaCO_3$ (%); 2, EC(dsm^{-1}); 2.15, Total salts (%); 19.5, T.N (%); 44.9, Sand (%); 22.13, Clay (%); 60.09, Silt (%); 19.79, Soil texture class; clay. (MWC= maximum water capacity, E C= electric conductivity, T.N= total nitrogen).

Statistical analysis and comparison among means of the differently treated groups were carried out by computer programming method (stat graphic- vers-4-2- Display ANOVA), as described by Snedecor and Cochran (1982).

ANALYTICAL METHODS :

The relative water contents was estimated according to method described by Ritchie *et. al.* (1990) and Pardossi *et al.* (1992).

The relative growth rate of shoot (RGRs): was determined according to Jose and Gillespie (1998) over a period of known days by the formula:

RGRs= (Final dry weight- initial dry weight) /period in days

Leaf area ratio (LAR) was calculated as recommended by Poorter and Remkes (1990), it is the ratio between total leaf area and total plant weight.

LAR=total leaf area/total fresh plant weight

Net assimilation rate: calculated as the increase in plant dry weight per increase in leaf area / unit time (Poorter and Remkes, 1990).

NAR = (Final dry weight-initial dry weight)/

(final leaf area-initial leaf area)/period in days.

Saturation water deficit (SWD%): was calculated according to Weatherly and Barrs (1962) from the following equation:

SWD%= 100-RWC%

Estimation of photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids) were determined using the spectrophotometric method as recommended by Arnon (1949) for chlorophylls and Horvath *et al.* (1972) for carotenoids as adopted by Kissimon (1999).

Estimation of carbohydrates: The methods adopted in this investigation for extraction of the different carbohydrate fractions tested were essentially those of Yemm and Willis (1954) and Handel (1968). Glucose content was estimated using O-toluidine (Fetris, 1965) as modified by Riazi *et al.* (1985). Sucrose content was determined using the modified procedures by Handel (1968) by first degrading reactive sugars present in 0.1 ml extract with 0.1 ml 5.4 N KOH at 97° C for 10 minutes. Total soluble sugars (TSS) content was determined using modification of the procedures of Yemm and Willis (1954). The method used for estimation of polysaccharides in the

present study was that of Thayermanavan and Sadasivam (1984).

The estimation of plant growth substances, including extraction and separation which done according to Shindy and Smith (1975). The bioassay of auxin is determined as described by Foda and Radwan (1962). For measuring gibberellin the method adopted by Franklandand Wareing (1960) was followed. The technique used to assay the activity of cytokinins and abscisic acid were that described by Esashi and Leopold (1969) and Wright (1969) respectively.

RESULTS AND DICUSSION

An important feature of the mung bean crop is its ability to produce higher yield depending on the genotypes and the environmental conditions (Ullah *et al.,* 2011).

The data recorded in tables 1-10 cleared that, during the two stages of plant growth (vegetative and flowering), treatment of mung bean with Mn at 5 and 10 ppm in general, increased shoot length/, number of nodes/, leaf area/, shoot fresh& dry weight/plant, relative water content, net assimilation ratio and relative growth rate significantly. On the other hand, a general significant decrease in the above mentioned parameters was detected by the higher Mn concentrations (15,20,25,30,35 ppm). Meanwhile a general significant increase was detected in leaf area ratio and saturation water deficit in response to all used treatments in relation to the control values (Tables 7&9). In this connection, it has been found that, Mn toxicity is intensified when other available elements such as Ca, Mg, K, Fe and Si are in a low quantity (Abou *et al,* 2002).

Table (1) : Effect of different concentrations of manganese on Shoot length/plant (cm) of *Vigna radiata* under fertilization with coated and uncoated urea.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	30.25	27.2	26.75	24
	5 ppm	31.5	27.97	26.84	24.83
	10 ppm	33.27*	29.17*	27.84*	23.34
	15 ppm	26.67*	24.17*	27.5	21.67*
	20 ppm	24.83*	23.33*	25.67*	20.33*
	25 ppm	24.67*	21.83*	25.17*	19.17*
	30 ppm	22.5*	20.17*	23.17*	17.5*
	35 ppm	20.67*	18.33*	21.67*	16.83*
	LSD	1.42	1.33	1.02	0.98
Flowering	0	46.5	44	41.5	40.5
	5 ppm	47.5	44.5	42	41.5
	10 ppm	48	46.5	43.5	42.5
	15 ppm	40.5*	37.5*	41	35.5*
	20 ppm	37.25*	35.5*	39	34.5*
	25 ppm	37*	35.5*	38.5*	34*
	30 ppm	33.5*	30.5*	34.5*	28.5*
	35 ppm	31.25*	29.5*	32.5*	28*
	LSD	2.79	2.75	2.83	2.02

Table (2) : Effect of different concentrations of manganese on number of nodes/plant under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	7	6.33	6	5.67
	5 ppm	7.33	6.67	6.33	6.12*
	10 ppm	7.67*	7.16*	6.67*	6.26*
	15 ppm	5.67*	6.13	6	5.33*
	20 ppm	5.33*	5.16*	5.67	4.67*
	25 ppm	5.16*	4.67*	5.33*	4.33*
	30 ppm	4.55*	4.33*	4.67*	4.16*
	35 ppm	4.27*	4.16*	4.33*	3.67*
	LSD	0.37	0.35	0.39	0.33
Flowering	0	8.67	8.33	8	7.67
	5 ppm	9	8. 5	8.33	8
	10 ppm	9.5*	9.25*	9*	8.67*
	15 ppm	7.5*	7.33*	7.67	7
	20 ppm	6.67*	6.33*	7.5	6.15*
	25 ppm	6.5*	6*	7*	5.5*
	30 ppm	6.33*	5.67*	6. 67*	5.33*
	35 ppm	6*	5.5*	6.5*	5*
	LSD	0.80	0.77	0.81	0.75

Table (3) : Effect of different concentrations of manganese on Shoot fresh weight (gm)/plant under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	15.75	14.55	13.75	13. 25
	5 ppm	15.98	14.65	14.27	14.11
	10 ppm	16.42	15.93*	15.29*	12.46
	15 ppm	13.25*	13.12*	13.32	12.81
	20 ppm	13.01*	12.67*	13. 28	12.56
	25 ppm	12.55*	12.25*	12.76*	12.06*
	30 ppm	11.75*	11.44*	12.25*	11.25*
	35 ppm	11.35*	11.25*	11.67*	10.67*
	LSD	0.96	0.92	0.98	0.89
Flowering	0	56.58	56.12	55.58	55.12
	5 ppm	57.14	56.87	56.16	55.73
	10 ppm	58.22*	57.61*	56.99*	56.05
	15 ppm	53.65*	53.42*	54.5	52.89*
	20 ppm	53.44*	53.22*	53.90*	52.33*
	25 ppm	53.22*	52. 75*	53.79*	52.25*
	30 ppm	52.62*	52.26*	52.74*	51.83*
	35 ppm	50.77*	50.06*	51.89*	50.25*
	LSD	1.19	1.15	1.21	1.12

Table (4) : Effect of different concentrations of manganese on Shoot dry weight (gm)/plant under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	2.06	1.94	1.64	1.52
	5 ppm	2.11	1.98	2.06*	1.63*
	10 ppm	2.41*	2.26*	2.15*	1.96*
	15 ppm	1.90	1.85	1. 97*	1.71*
	20 ppm	1.68*	1.54*	1.73	1.29*
	25 ppm	1.61*	1.49*	1.68	1.15*
	30 ppm	1.46*	1.31*	1. 53	1.05*
	35 ppm	1.3*	1.28*	1.48	.98*
	LSD	0.17	0.11	0.19	0.09
Flowering	0	12.75	12.66	12.48	11.78
	5 ppm	13.19	12.85	12.64	12.18
	10 ppm	13.39	13.26	13.13	12.75*
	15 ppm	11.72*	11.69*	12.24	11.37
	20 ppm	11.14*	11.08*	11.93	10.87*
	25 ppm	11.35*	11.1*	11.84	10.16*
	30 ppm	10.25*	10.15*	10.59*	10.14*
	35 ppm	10.15*	10. 05*	10.28*	9.78*
	LSD	1.02	0.95	0.98	0.90

Table (5) : Effect of different concentrations of manganese on Shoot fresh weight (gm)/plant under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn. concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	70.89	70.38	70.13	69.78
	5 ppm	71.44	70.99	70.89	70.05
	10 ppm	71.83	71.23	71.15	70.88
	15 ppm	69.05*	68.88*	69.26	68.35*
	20 ppm	68.55*	68.29*	68.77	68.03*
	25 ppm	67.75*	67.37*	68.28*	67*
	30 ppm	67.25*	66.88*	67.82*	66.29*
	35 ppm	66.33*	66*	66.85*	65.68*
	LSD	1.33	1.30	1.37	1.27
Flowering	0	90.05	90.80	90.46	90.18
	5 ppm	91.72*	91.55*	91.34*	90.93*
	10 ppm	91.89*	91.66*	91.53*	91*
	15 ppm	89.74	89.65*	89.89	89.31*
	20 ppm	88.84*	88.45*	89.24*	88*
	25 ppm	87.91*	87.61*	88.17*	87.14*
	30 ppm	87.82*	87.39*	88*	86.89*
	35 ppm	86.84*	86.19*	87.28*	86.67*
	LSD	0.75	0.73	0.84	0.70

Table (6) : Effect of different concentrations of manganese on Leaf Area/Plant (cm^2) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	130.42	129.64	128.25	127.62
	5 ppm	133. 56*	130.47	129.75	129.45
	10 ppm	135.92*	133.53	131.14	130.28
	15 ppm	130.14	126.96	131.78	124.39
	20 ppm	126.94*	124.34*	127.84	122.73*
	25 ppm	124.81*	123.42*	125.6	121.72*
	30 ppm	122.56*	120.53*	123.34	118.5*
	35 ppm	119.08*	118.89*	120.78*	117.6*
	LSD	3.14	3.92	5.21	4.83
Flowering	0	318.34	318	317.25	316. 75
	5 ppm	328.83*	324.82*	323.47*	322.75*
	10 ppm	330.125*	328.55*	326.5*	325.625*
	15 ppm	315.21	314.375	316.5	313.92
	20 ppm	314.29	313.84	314.67	313. 25
	25 ppm	314.08*	313.59	314.42	313.17
	30 ppm	313.15*	312.21*	313.25	312.84
	35 ppm	312.55*	311.75*	312.96	311.21*
	LSD	4.25	4.72	4.41	4.49

Table (7) : Effect of different concentrations of manganese on leaf area ratio (cm^2/g) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	8.47	8.90	9.32	9.63
	5 ppm	8.35	8.90	9.09	9.17
	10 ppm	8.27	8.38*	8.57*	10.45*
	15 ppm	9.82*	9.67*	9.89*	9.71
	20 ppm	9.75*	9.81*	9.62	9.77
	25 ppm	9.94*	10.07*	9.84	10.09
	30 ppm	10.43*	10.53*	10.06*	10.53*
	35 ppm	10.49*	10.56*	10.34*	11.02*
	LSD	0.32	0.42	0.53	0.54
Flowering	0	6.15	6.12	6.17	6.20
	5 ppm	6.01	6.06	6.11	6.15
	10 ppm	6.03	6.05	6.08	6.16
	15 ppm	6.43*	6.40*	6.35*	6.42*
	20 ppm	6.42*	6.44*	6.39*	6.47*
	25 ppm	6.40*	6.41*	6.36*	6.46*
	30 ppm	6.43*	6.47*	6.45*	6.42*
	35 ppm	6.63*	6.64*	6.55*	6.59*
	LSD	0.15	0.18	0.16	0.20

Table (8) : Effect of different concentrations of manganese on net assimilation rate ($g/cm^2/day$) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	0.44	0.39	0.51	0.54
	5 ppm	0.51	0.66*	0.53*	0.57*
	10 ppm	0.72*	0.71*	0.69*	0.74*
	15 ppm	0.58*	0.55*	0.46*	0.49*
	20 ppm	0.31*	0.45*	0.26*	0.31*
	25 ppm	0.21*	0.43*	0.23*	0.27*
	30 ppm	0.15*	0.33*	0.11*	0.17*
	35 ppm	0.10*	0.31*	0.09*	0.07*
	LSD	0.023	0.02	0.021	0.018
Flowering	0	3.07	3.03	3.15	3.54
	5 ppm	3.24*	3.05	3.42*	3.71*
	10 ppm	3.43*	3.58*	3.58*	3.97*
	15 ppm	2.98*	3.42*	2.94*	3.19*
	20 ppm	2.83*	3.36*	2.81*	3.09*
	25 ppm	2.64*	3.37*	2.83*	2.88*
	30 ppm	2.67*	3.01	2.58*	2.86*
	35 ppm	2.55*	2.93*	2.53*	2.74*
	LSD	0.082	0.079	0. 080	0.0 77

Table (9) : Effect of different concentrations of manganese on saturated water deficit (%) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	29.11	29.62	29.87	30.22
	5 ppm	28.56	29.01	29.11	29.95
	10 ppm	28.17	28.77	28.85*	29.12*
	15 ppm	30.95*	31.12*	30.74	31.65*
	20 ppm	31.45*	31.71*	31.23*	31.97*
	25 ppm	32.25*	32.63*	31.72*	33*
	30 ppm	32.75*	33.12*	32.18*	33.71*
	35 ppm	33.67*	34*	33.15*	34.32*
	LSD	1.03	1.02	1.01	1.05
Flowering	0	9.95	9.2	9.54	9.82
	5 ppm	8.28*	8.45*	8.66*	9.07*
	10 ppm	8.11*	8.34*	8.47*	9*
	15 ppm	10.26	10.35*	10.11	10.69*
	20 ppm	11.16*	11.55*	10.76*	12*
	25 ppm	12.09*	12.39*	11.83*	12.86*
	30 ppm	12.18*	12.61*	12*	13.11*
	35 ppm	13.16*	13.81*	12.72*	13.33*
	LSD	0.53	0.57	0.59	0.511

Table (10) : Effect of different concentrations of manganese on relative growth rate (mg/g /day) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	57.08	50.83	65.83	71.67
	5 ppm	66.25*	85.83*	69.17*	75.83*
	10 ppm	93.75*	93.33*	92.5*	100.83*
	15 ppm	72.97*	72.5*	58.33*	58.33*
	20 ppm	37.97*	58.33*	32.5*	40*
	25 ppm	26.25*	54.17*	28.33*	34.17*
	30 ppm	17.97*	41.67*	13.33*	21.67*
	35 ppm	12.08*	37.5*	10.83*	8.33*
	LSD	2.22	2.11	2.98	3.34
Flowering	0	420.96	440.38	442.69	444.23
	5 ppm	436.34	446.53	450	461.15
	10 ppm	458.26*	465.38*	465.76*	468.84*
	15 ppm	405.19	470.76*	405.38*	404.61*
	20 ppm	385.96*	419.23*	381.92*	382.30*
	25 ppm	358.65*	415.76*	382.69*	390.38*
	30 ppm	357.88*	367.69*	346.15*	348.07*
	35 ppm	344.03*	355.76*	342.30*	344.23*
	LSD	15.85	17.42857	16.50	18.71

Regarding the effect of the used treatments on the photosynthetic pigments of mung bean, a general non-significant and significant increase in chlorophyll a, chlorophyll b, carotenoids, total chlorophylls and total pigments by application of 5&10 ppm Mn were detected respectively. In contrast, a general decrease in these pigments was observed in response to the higher Mn concentrations. But a non-significant response was showed in chlorophyll a/chlorophyll b ratio, during the two stages of plant growth and development (Tables 11-15). In this respect, manganese is considered as essential element for the biosynthesis of chlorophyll through the activation of specific enzymes (Lidon *et al.,* 2004). Hence, Mn is involved in metabolic processes such as respiration, photosynthesis, synthesis of amino acids and hormone inactivation throughout indol acetic acid oxidases (Burnell, 1988).

Moreover the detected decrease in the determined growth parameters and pigments by increasing Mn level may be due to the inhibition of pigment synthesis. This is supported by Macfie and Taylor (1992) who stated that, increased Mn concentrations (0 - 1,000 and 10,000 μM) in wheat plants inhibited the biosynthesis of chlorophyll and carotenoids, inducing a decrease in photosynthetic electron transport rates and therefore a decrease in the rate of photosynthesis. Also, it was reported that, in addition to a decrease in growth rate, symptoms of Mn toxicity such as chlorosis in leaves (intervenial and marginal) and necrotic leaf spots are very common and have been reported in the whole plants; of canola

(Moroni *et al,* 2003), clover (Rosas *et al.,* 2007), ryegrass (Mora *et al.,* 2009) as well as in leaves of barley and cowpea (Demirevska-Kepova *et al.,* 2004) and this is in harmony with the present results.

The determined carbohydrates in mung bean shoot as cleared in tables 17-21, showed non-significant increase in glucose and sucrose by 5 and 10 ppm Mn where significant decrease in them was detected by the higher used Mn doses. On the other hand, a non-significant response in general was observed in polysaccharides and total soluble sugars in mung bean by all the used treatments as compared to the control values (Tables 16-19). Thus the foliar application of mineral nutrients by means of spray offers a method of supplying nutrients to higher plants more efficient than methods involving root application when soil conditions are not suitable for ions availability (Darwesh, 2011).

Table (11) : Effect of different concentrations of manganese on Chlorophyll a (mg/g dry weight) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	4.94	4.72	4.5	5.13
	5 ppm	5.42*	5.15*	4. 82*	5.65*
	10 ppm	5.77*	5.56*	5.16*	6.25*
	15 ppm	4.55*	4.25*	4.56	4. 74*
	20 ppm	4. 15*	3.95*	4.25	4.35*
	25 ppm	3. 44*	3.22*	3.46*	3. 92*
	30 ppm	3.24*	3.17*	3.75*	3.75*
	35 ppm	2.75*	2. 57*	3.14*	2.82*
	LSD	0.25	0.22	0. 28	0.31
Flowering	0	9.14	8. 94	8.57	9.53
	5 ppm	9.49	9.36*	9. 02	9.65
	10 ppm	9.56	9.33	9.06*	9.95
	15 ppm	8.45*	8.27*	8.52	8. 74*
	20 ppm	7. 82*	7.92**	8.02*	8.27*
	25 ppm	7. 64*	6.87*	7.72*	7. 82*
	30 ppm	6.54*	6.46*	7.67*	7.55*
	35 ppm	6.25*	6.15*	7.44*	7.12*
	LSD	0.43	0.40	0.48	0.51

Table (12) : Effect of different concentrations of manganese on Chlorophyll b (mg/g dry weight) under fertilization with coated and uncoated urea of *Vigna radiata.*

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	2. 04	1.84	1.73	2.14
	5 ppm	2.16	1.89	1.82	2. 25
	10 ppm	2.31*	1.98*	1.88*	2.54*
	15 ppm	1.95	1.72	1.96*	2.05
	20 ppm	1.75*	1.62*	1.86*	1.91*
	25 ppm	1.67*	1.46*	1.69	1.72*
	30 ppm	1.27*	1.16*	1.62*	1.57*
	35 ppm	1.22*	1.06*	1.57*	1.49*
	LSD	0.19	0.13	0.10	0.15
Flowering	0	4. 14	3.97	3.93	4.34
	5 ppm	4.33	4.26	4.02	4. 55
	10 ppm	4.61*	4.55*	4.17	4.74*
	15 ppm	3.55*	3.47*	3.78	3.85*
	20 ppm	3.35*	3.32*	3.66	3.71*
	25 ppm	3.27*	3.26*	3.34*	3.42*
	30 ppm	2.77*	2.66*	2.99*	2.87*
	35 ppm	2.62*	2.54*	2.87*	2.75*
	LSD	0.43	0.40	0.49	0.32

Table (13): Effect of different concentrations of manganese on chlorophyll a + chlorophyll b (mg/g dry weight) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	7.27	6.23	6.56	8.98
	5 ppm	7.9*	6.64*	7.04*	7.58*
	10 ppm	8.79*	7.04*	7.54*	8.08*
	15 ppm	6.79*	6.52	5.97*	6.5*
	20 ppm	6.26*	6.11	5.57*	5.9*
	25 ppm	5.64*	5.15*	4.68*	5.11*
	30 ppm	5.32*	5.37*	4.33*	4.51*
	35 ppm	4.31*	4.71*	3.63*	3.97*
	LSD	0.46	0.38	0.35	0.44
Flowering	0	13.87	12.5	12.5	13.28
	5 ppm	14.2	13.04	13.62*	13.82
	10 ppm	14.69	13.23	13.88*	14.17*
	15 ppm	12.59*	12.3	11.74*	12*
	20 ppm	11.98*	11.68	11.24*	11.17*
	25 ppm	11.24*	11.06*	10.13*	10.91*
	30 ppm	10.42*	10.66*	9.12*	9.31*
	35 ppm	9.87*	10.31*	8.69*	8.87*
	LSD	0.83	0.97	0.8	0.86

Table (14): Effect of different concentrations of manganese on chlorophyll a/chlorophyll b (mg/g dry weight) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	2.39	2.60	2.56	3.75
	5 ppm	2.51	2.64	2.72	3.75
	10 ppm	2.46	2.74	2.80	2.49*
	15 ppm	2.31	2.32	2.47	2.33*
	20 ppm	2.27	2.28	2.43	2.37*
	25 ppm	2.27	2.04	2.20	2.05*
	30 ppm	2.38	2.31	2.73	2.55*
	35 ppm	1.89	2*	2.42	2.25*
	LSD	0.51	0.58	0.39	0.58
Flowering	0	2.19	2.18	2.25	2.20
	5 ppm	2.12	2.24	2.19	2.19
	10 ppm	2.09	2.17	2.05	2.07
	15 ppm	2.27	2.25	2.38	2.38
	20 ppm	2.22	2.19	2.38	2.33
	25 ppm	2.28	2.31	2.10	2.33
	30 ppm	2.63*	2.56	2.42	2.36
	35 ppm	2.58	2.59	2.42	2.38
	LSD	0.42	0.44	0.35	0.23

Table (15) : Effect of different concentrations of manganese on Carotenoids (mg/g dry weight) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	3. 04	2.84	2.73	3.14
	5 ppm	3.16	2.89	2.82	3. 25
	10 ppm	3.21	2.98*	2.88	3.34*
	15 ppm	2.85*	2.72	2.96*	3.05
	20 ppm	2.75*	2.52*	2.86	2.91*
	25 ppm	2.57*	2.46*	2.69	2.72*
	30 ppm	2.27*	2.16*	2.62	2.57*
	35 ppm	2.22*	2.06*	2.57	2.49*
	LSD	0.19	0.13	0.18	0.15
Flowering	0	5. 14	4.97	4.93	5.34
	5 ppm	5.33	5.26	5.02	5. 55
	10 ppm	5.61	5.55*	5.17	5.84
	15 ppm	4.55*	4.37*	4.68	4.75
	20 ppm	4.35*	4.22*	4.66	4.71*
	25 ppm	4.27*	4.16*	4.34*	4.42*
	30 ppm	3.77*	3.66*	3.99*	3.87*
	35 ppm	3.62*	3.44*	3.87*	3.75*
	LSD	0.53	0.50	0.59	0.62

Table (16): Effect of different concentrations of manganese on total pigments(mg/g dry weight) with fertilization with coatedand uncoated ureaof *Vigna radiata*.

Stage	Mn concentration	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	12.02	9.4	8.96	10.41
	5 ppm	10.74*	9.93*	9.46	11.15*
	10 ppm	11.29*	10.52*	9.92*	12.13*
	15 ppm	9.35*	8.69*	9.48	9.84
	20 ppm	8.65*	8.09*	8.97	9.17*
	25 ppm	7.68*	7.14*	7.84*	8.36*
	30 ppm	6.78*	6.49*	7.99*	7.89*
	35 ppm	6.19*	5.69*	7.28*	6.8*
	LSD	0.63	0.48	0.56	0.61
Flowering	0	18.42	17.47	17.43	19.21
	5 ppm	19.15*	18.88*	18.06*	19.75*
	10 ppm	19.78*	19.43*	18.4*	20.53*
	15 ppm	16.55*	16.11*	16.98	17.34*
	20 ppm	15.52*	15.46*	16.34*	16.69*
	25 ppm	15.18*	14.29*	15.4*	15.66*
	30 ppm	13.08*	12.78*	14.65*	14.29*
	35 ppm	12.49*	12.13*	14.18*	13.62*
	LSD	0.39	0.3	0.56	0.45

Table (17) : Effect of different concentrations of manganese on glucose(mg/g dry weight) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	49.3	47.43	47.06	50.06
	5 ppm	49.72	48.21	49.44	50.75
	10 ppm	50.32	49.66	50.08*	51.66
	15 ppm	47.91	47.27	48.43	48.77
	20 ppm	46.71*	45.75	46.75	47.16*
	25 ppm	45.31*	44.44*	46.55	46.86*
	30 ppm	43.02*	42.16*	46.06	45.44*
	35 ppm	41.42*	41.23*	44.69	43.16*
	LSD	2.41	2.24	2.68	2.86
Flowering	0	43.8	42.6	40.98	44.75*
	5 ppm	44.18	43.17	42.15	45.52
	10 ppm	45.04	44.12	43.7*	46.09
	15 ppm	40.48*	39.09*	41.48	42.95
	20 ppm	40.21*	38.8*	40.84	41.1*
	25 ppm	38.75*	37.76*	39.25	39.73*
	30 ppm	38.1*	36.88*	39.14	38.75*
	35 ppm	36.39*	34.47*	38.34*	37.33*
	LSD	1.90	1.88	1.98	2.02

Table (18): Effect of different concentrations of manganese on sucrose (mg/g dry weight) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	23.4	21.69	21.29	23.95
	5 ppm	23.95	22.75*	22.32*	24.35
	10 ppm	24.05	23.5*	23.17*	25.25*
	15 ppm	21.9*	20.44*	22.11	22.75*
	20 ppm	19.45*	18.15*	19.75*	20.27*
	25 ppm	18.83*	17.25*	19.25*	19.75*
	30 ppm	17.26*	16.95*	18.77*	17.92*
	35 ppm	16.87*	14.2*	18.14*	17.3*
	LSD	0.82	0.78	0.85	0.94
Flowering	0	20.25	18.75	18.25	20.65
	5 ppm	20.45	19.25	19.04	21.5
	10 ppm	21.45*	20.35*	20.15*	22.15*
	15 ppm	18.84*	17.75*	19.15*	19.55*
	20 ppm	18.61*	17.25*	18.75	19.04*
	25 ppm	17.55*	16.33*	18.15	18.75*
	30 ppm	16.62*	15.05*	17.95	17.55*
	35 ppm	16.13*	14.21*	17.22*	16.95*
	LSD	0.83	0.81	0.88	0.91

Table (19) : Effect of different concentrations of manganese on total soluble sugars (mg/g dry weight) under fertilization with coated and uncoated urea of *Vigna radiata.*

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	149.25	148.25	148.13	150.05
	5 ppm	149.75	148.75	148.55	150.95
	10 ppm	150.65	149.73	149.35	151.25
	15 ppm	147.5	146.82	147.95	149.35
	20 ppm	147.15	146.55	148	148.45
	25 ppm	146.75	145.65	147.5	148.35
	30 ppm	146.12	144.55	147.75	147.45
	35 ppm	145.75	143.35	147.15	146.2
	LSD	12.13	12.02	12.31	12.44
Flowering	0	140.05	138.85	138.45	139.09
	5 ppm	140.95	139.75	139.42	139.85
	10 ppm	141.1	140.75	140.16	140.95
	15 ppm	137.5	136.95	138.65	138.75
	20 ppm	136.83	136.75	137.1	138.5
	25 ppm	136.5	136.15	136.84	137.4
	30 ppm	135.45	134.8	136.75	136.16
	35 ppm	134.8	133.75	136.15	135.7
	LSD	11.65	11.55	11.75	11.95

Table (20) : Effect of different concentrations of manganese on polysaccharides(mg/g dry weight) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	60.33	59.75	59.06	61.26
	5 ppm	60.75	60.51	59.54	61.55
	10 ppm	61.75	61.16	60.38	62.63
	15 ppm	58.11	57.77	58.43	60.17
	20 ppm	57.21	56.75	57.75	59.26
	25 ppm	55.81*	55.44*	55.75	57.86
	30 ppm	54.22*	53.66*	54.66*	56.44*
	35 ppm	53.41*	51.83*	53.29*	55.16*
	LSD	3.68	3.63	3.79	3.84
Flowering	0	53.18	53.06	52.28	53.75
	5 ppm	54.48	54.17	52.55	54.52
	10 ppm	54.84	53.72	52.75	55.19
	15 ppm	51.48	51.29	51.68	52.95
	20 ppm	51.21	51.18	51.84	52.15
	25 ppm	50.75	49.75*	51.55	51.73
	30 ppm	49.61*	49.08*	51.44	51.21
	35 ppm	48.19*	47.47*	50.94	50.53*
	LSD	2.94	2.88	2.99	3.07

Table (21) : Effect of different concentrations of manganese on total carbohydrates(mg/g dry weight) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Vegetative	0	285.32	275.54	277.12	282.28
	5 ppm	287.6	279.85	280.22	284.17
	10 ppm	290.79	282.98	284.05	286.77
	15 ppm	281.04	276.92	272.3	275.42
	20 ppm	275.14	272.25	267.2	270.52
	25 ppm	272.82	269.05	262.78	266.7
	30 ppm	267.25	267.24	257.32*	260.62*
	35 ppm	261.82*	263.27	250.61*	257.45*
	LSD	20.08	19.63	18.67	19.04
Flowering	0	258.24	249.96	253.26	257.28
	5 ppm	261.39	253.16	256.34	260.06
	10 ppm	264.38	256.76	258.94	262.43
	15 ppm	254.2	250.96	245.08	248.3
	20 ppm	250.79	248.53	243.98	246.86
	25 ppm	247.61	245.79	239.99	243.55
	30 ppm	243.67	245.28	235.81*	239.78
	35 ppm	240.51*	242.65	229.9*	235.51*
	LSD	15.32	15.54	17.12	18.28

At flowering stage, indol acetic acid, gibberellic acid and cytokinin content increased non-significantly with 5 ppm Mn and significantly with 10 ppm Mn and decreased progressively by increasing Mn concentrations. Meanwhile a reverse situation was observed in abscisic acid (Tables 22-25).

The observed enhancement in mung bean growth in response to uncoated and coated urea was in harmony with those reports that, nitrogen is the most critical element of plant growth, where studies conducted on grain legumes revealed that plant growth is affected differently by various nitrogen sources (Ryle *et al.,* 1978). A comparison of different nitrogen sources showed that, Urea was better than other slow release nitrogen sources (Lahav *et al.,* 1976). Moreover, the stimulated effect of sulfur- coated urea is supported by Shirley and Meline(1975) who stated that, sulfur-coated urea is being tested in 50 states and 54 countries, showing significant advantages with several crops. Meanwhile the inhibition in the determined parameters of mung bean plants by increasing Mn concentrations may be because the sulfur interaction is primarily one-way, as the sulfur content of the plant is diminished so also is the Mn content (Klein, *et al.,* 1975).

On the other hand, the reduction of the harmful effect of the higher Mn level under cement-coated urea could be related to the silicon present in cement and explained on the basic that silicon (Si) applications can alter the Mn distribution in leaf tissue in such a way as to reduce the possibility of Mn toxicity from excess Mn uptake (Foulkes and Mc Grath, 1999). Also the increments in pigments content and carbohydrates of mung bean under fertilization with dolomite-coated urea may be caused by Mg which is a component of dolomite and necessary for chlorophyll synthesis. Thus dolomite-coating urea, in addition to raising the pH, also is a source of calcium and magnesium (AL-Humaid, 2003).

In conclusion, advantages of slow release nitrogen fertilizers are that the nutrients are available gradually over time. This means that, the gardener can fertilize less often, and the nutrients are provided slowly and steadily. This is explaining how most plants prefer to be fed with it and helps them to grow well (Guertal, 2009).

It is evident from this investigation that, maximum growth of mung bean could be achieved by spraying with 10 ppm manganese also by using slow-release N fertilizer with mung bean, we must focus primarily on sulfur coating urea following by using cement-coated, followed by dolomite-coated urea.

Table (22) : Effect of different concentrations of manganese on total auxins(ug/g fresh weight) under fertilization with coated and uncoated urea of *Vigna radiata.*

Stage	Mn concentration	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Flowering	0	292.64	297.44	299.77	287.35
	5 ppm	308.02	310.75	309.66	307.5
	10 ppm	313.32*	314.33*	313.83*	312.85*
	15 ppm	288.15	292.34*	296.55	371.32*
	20 ppm	271.33*	281.55*	282.25	341.12*
	25 ppm	250.57*	261.43*	271.75*	229.66*
	30 ppm	229.36*	239.82*	246.08*	219.25*
	35 ppm	200.57*	217.72*	223.75*	196.66*
	LSD	0.66	0.85	1.02	0.45

Table (23) : Effect of different concentrations of manganese on GA3(ug/g fresh weight) under fertilization with coated and uncoated urea of *Vigna radiata.*

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Flowering	0	64	64.32	64.25	63.57
	5 ppm	66.15	66.63	66.45	65.82
	10 ppm	68.22	68.86	68.72	67.92
	15 ppm	61.12	61.94	62.25	60.82
	20 ppm	58.85	59.75	60.05	55.75
	25 ppm	56.76	57.25	57.73	52.37
	30 ppm	55.18*	55.50*	56.55	51.92*
	35 ppm	50.55*	51.84*	52.66*	49.45*
	LSD	2.8	2.11	2.15	2.5

Table (24) : :Effect of different concentrations of manganese on cytokinin (ug/g fresh weight) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Flowering	0	61.84	62.22	62.12	60.25
	5 ppm	62.05	62.65	62.26	60.75
	10 ppm	62.57	63.22	62.75	61.44
	15 ppm	61.32	61.21	61.55	60.12
	20 ppm	60.06	60.25*	60.44	59.66
	25 ppm	59.45*	59.65*	59.82*	59.11
	30 ppm	58.82*	59.50*	59.57*	58.50
	35 ppm	57.63*	57.82*	58.50*	57.30*
	LSD	1.83	1.86	1.88	1.80

Table (25) : : Effect of different concentrations of manganese on ABA (ug/g fresh weight) under fertilization with coated and uncoated urea of *Vigna radiata*.

Stage	Mn concentrations	Uncoated urea	Sulfur-coated urea	Cement-coated urea	Dolomite-coated urea
Flowering	0	86.48	86.75	86.52	85.77
	5 ppm	85.31	85.63	85.43	84.82
	10 ppm	84.14	84.50	84.23	83.25
	15 ppm	88.17	88.4	87.25	87.35
	20 ppm	92.66*	93.21	89.64	89.88
	25 ppm	96.35*	97.25*	95.22*	95.66*
	30 ppm	98.74*	99.45*	96.18*	96.87*
	35 ppm	103.18*	104.12*	101.12*	101.55*
	LSDs	4.33	4.54	4.07	4.12

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الملخص العربى

تأثيرالمنجنيز على نمو و أيض نبات اللوبيا النامى تحت التسميد باليوريا بطيئة التسرب

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معهد بحوث الأراضى والمياه والبيئه – مركز البحوث الزراعيه – الجيزه**

أجريت تجربه نصف حقليه فى صوبة كلية العلوم جامعة المنصوره لدراسة تأثير الرش بتركيزات مختلفه من المنجنيز(٥ – ١٠ – ١٥ – ٢٠ – ٣٠ – ٣٥ جزء فى المليون) على اللوبيا المسمده باليوريا غير المغلفه و بطيئة التسرب و التى هى مغلفه بالكبريت أو الأسمنت أو الرخام وقد أوضحت نتائج المرحلتيين الخضريه و الزهريه لنبات اللوبيا أن دالات النمو المعينه (طول الساق/للنبات–المساحه الورقيه/للنبات – الوزن الرطب والجاف/للنبات–المحتوى المائى الكلى– معدل النمو النسبى– معدل التمثيل الجوهرى) وكذلك محتوى الكربوهيدرات (الجلوكوز– السكروز– المحتوى الكلى الذائب– السكريات العديده و الكليه) ومحتوى الأصباغ النباتيه من كلوروفيل أ و ب ومجموعهما و الكاروتين والأصباغ الكليه قد زادت بصفه عامه غير معنويا ومعنويا مع تكيزى ٥ و١٠ جزء فى المليون على الترتيب. بينما حدث نقص مضطرد فى هذة الدالات مع تدرج الزياده فى تركيز المنجنيز. و على العكس لوحظ تزايد فى المساحه النسبيه للأوراق النباتيه ونسبةالنقص فى محتوى الماء الكلى. كما كان لهذه المعاملات نفس التأثير على الأوكسينات و الجبريلين وكذلك السيتوكينين فى حين انعكس ذلك فى حالة حمض الأبسيسيك وقد أوضحت النتائج أن أعلى المعاملات فى هذه المتغيرات كان تحت التسميد باليوريا غير المغلفه يليه اليوريا المغلفه بالكبريت ثم اليوريا المغلفه بالأسمنت ثم اليوريا المغلفه بالرخام وذلك مع المعامله ب ١٠ جزء فى المليون منجنيز.

ومما هو جدير بالذكر أن التأثير الضار لتركيزات المنجنيز العاليه كان أقل وضوحا فى حالة استخدام اليوريا المغلفه بالأسمنت وقد يكون السبب فى هذا هو احتواء الأسمنت على نسبه من السليكون و الذى يعطل امتصاص المنجنيز و كذلك زادت كمية الأصباغ النباتيه نسبيا مع تركيزات المنجنيز المرتفعه عند استخدام اليوريا المغلفه بالرخام على عكس ما لوحظ مع باقى المعاملات و قد يكون هذا بسبب احتواء الرخام على كميه من الماغنيسيوم و الذى يدخل فى تركيب الكلوروفيل.

JOESE 5

EFFECT OF MANGANESE ON GROWTH AND SOME METABOLIC ASPECTS OF MUNG BEAN PLANT, GROWING UNDER FERTILIZATION WITH SLOW- RELEASE UREA

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