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Response of Night-Blooming Jessamine (*Cestrum nocturnum* L.) Plants to Phosphorus-Zinc relation.
II. Phosphorus and micronutrients concentration in leaf tissue.

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Abstract

Night blooming jessamine (*Cestrum nocturnum* L.) plants were grown in pots to study P-Zn interactionwhich influence on their accumulations and other micronutrients in leaf tissue. Phosphorus fertilization was applied to soil at rates of 0 to 580 ppm with concomitant addition of Zn at rates of 0 to 48 ppm.

Concentrations of Zn, Fe and Mn in leaf tissue indicated that P and Zn fertilization had altered the accumulation of these micronutrients in the plant. Although P and Zn application decreased the concentration of each other, increasing either P or Zn applied increased leaf Mn. Concentrations of P, Zn and Mn were varied opposite to that of Fe. Zinc-deficient plants accumulated a large excess of Fe. Interference from excess Fe is suggested as contributing to physiological malfunction within Zn-deficient night-blooming jessamine plants. High concentration of P in leaf tissue resulting in high P/Zn concentration ratios appear to offer a better explanation for the metabolic upset. Healthy plants tended to have P/Zn concentration ratios < 100, where in deficient plants the ratio was generally > 100.

Some of the resulting observations help to explain why starter fertilizers containing P may on occasions cause depressions in plant growth, especially when soil P is high, would seem to portend Zn deficiency problems as the behavior of both P and Zn in affecting translocation of each other.

Keywords: *Night-blooming jessamine, P applied, Zn applied, P-Zn interaction, leaf P/Zn ratio, Fe-Zn interaction, micronutrients.*

Introduction

Zinc is an essential micronutrient for normal healthy growth in plants, it is playing principal metabolically role in plants. Plant growth and quality are reduced by Zn inadequate in soil. Zinc has a chemical and biological interaction with some other elements. Phosphorus is the most important element which interferes on Zn uptake by plants. Zinc absorption capacity is reduced by high P utilization but Zn in plant and soil has an antagonism state with phosphorus. About the interaction of P and Zn, numerous studies have been done and most of them demonstrated that high P applications increase the severity of Zn-deficiency symptoms in plants (Stukenholts *et al*., 1966;; Sharma *et al*., 1968; Khan and Zende, 1977, Cakmak and Marschner, 1987; Zhu *et al.,* 2001; Bukvicl *et al*., 2003; Das *et al*., 2005; Barben *et al*., 2010 and Mousavi, 2011).

Evaluating interactions of phosphorous with Zn, Fe and Mn micronutrients are very important to maintain a balanced nutrient supply for improving plant growth. Addition

heavy P fertilization, an effect that raises the ratios of P/Zn (Loneragan *et al*., 1982) and P/Fe (Dekoock and Wallace, 1965 and Elliot and Lauchli, 1985) and has often been associated with deficiency symptoms of the two micronutrients (Racz and Haluschak, 1974; Murphy *et al*., 1981). Some workers found better agreement between Zn deficiency and the ratio of P/Zn than with either P or Zn content of tissue. They proposed that a critical ratio of P/Zn existed within plant tissue (Boawn and Leggett, 1964; Warnock, 1970 and El-Sallami, 2001).

Foy *et al.* (1978) reported that increased soil Zn greatly increased translocation of Mn to soybean tops. They explained that Zn and Mn interfere with Fe utilization in the leaves for chlorophyll synthesis. Fageria (2001) concluded that Zn and Fe were precipitated within the tissues of plants, indicating that formation of insoluble Zn and Fe phosphates limited their mobility within plants. Positive interaction between P and Mn has been reported by Smilde (1973) and is assumed to be attributed to the soil-acidifying effect of P which increases the Mn uptake (Jackson and Carter, 1976).

Negative interactions between Fe and Mn have been widely reported in crop plants; Chinnery and Harding (1980); Moraghan (1985) and Zaharieva (1986). They found higher concentration of iron in leaves at lower Mn concentration.

The purpose of this study was to establish an optimum ratio of P/Zn in leaf tissue of night-blooming jessamine plants and to determine leaf concentrations of Zn, Fe and Mn as this ratio responsible for varying the three micro-elements concentrations. This information may improve the understanding of nutrient balance for adequate plant growth and flowering.

Materials and Methods

Night-blooming jessamine (*Cestrum nocturnum*, L.) plants were grown under saran house conditions (30% light) at the Experimental Farm of Assiut University, Egypt, during two successive seasons of 2012 and 2013.

On March 20th of both seasons, healthy and vigorous plants (one-year-old) were carefully selected as being uniform in their size (30-32 cm in height). Plants were grown singly in plastic pots, each pot (4.5 *l*) contained 4.2 kg air-dried clay soil, sieved through a 0.6 cm screen. Soil analysis showed; pH= 7.9 (1:1 soil to water suspension), $CaCO_3$= 3.86%, O.M.= 1.43%, C.E.C.= 56.4 mg/100 g, Olsen-P= 28.6 ppm, and DTPA-extractable Zn, Fe and Mn were 1.1, 11.7 and 23.2 ppm, respectively.

Phosphorus was added as $NH_4H_2PO_4$ at 0, 70, 140, 280 or 560 ppm and thoroughly mixed into the soil. Zinc was applied as $ZnSO_4$ at 0, 6, 12, 24 or 48 ppm. All pots received the same application of 300 ppm nitrogen as NH_4NO_3 and 200 ppm potassium as K_2SO_4. Potassium was mixed uniformly with the soil and the N and Zn were placed in a layer of 5 cm below its surface. Pots were irrigated with sufficient water

The experiment had 25 treatments (5 P x 5 Zn) consisting of a factorial combination. Treatments were arranged in a randomized complete block design with four replications.

On October 20th of both seasons, leaf samples were taken and

washed immediately with distilled water and dried at 70°C for 24 hr. The dried leaf tissue was grounded with steel Wiley mill preparatory to wet ashing with nitric-perchloric acid procedure. Phosphorus was determined colorimetrically as phosphomolybdate according to Jackson (1978). Zinc, iron and manganese were estimated by atomic absorption spectrophotometer system (Perkin-Elmer Model 3100). Data were statistically analyzed using SAS software and means were compared using a least significant difference test according to Dawdy and Stanley (1983).

Results and Discussion

P content in leaf tissue

There was a significant increase in leaf P content as the level of applied P raised (Table 1). Phosphorus accumulated in the tissue at high level was much greater, however, averaging 44% more than that found at maximum growth P_{280} Zn $_{24}$. Since it has been shown by others (Kato and Takel, 1989; Mohamed, 1992; El-Sallami, 1997 & 2001; Mirvat *et al*., 2006; Khorgamy and Farnia, 2009 and Balal *et al*., 2011). They revealed that application of phosphatic fertilizers at a high dose increased P content in plant tissue. The adverse effect of Zn fertilization on P content was observed, whereas, P concentration in leaves gradually decreased with increasing Zn level. However, P concentration in the maximum growth was 21% higher than that obtained at high Zn level, indicating that effects of high Zn level were less than high P level which doubled P content. Leaf P was not reduced significantly by low Zn but increasing concentration levels from 12 to 48 ppm markedly reduced P content. The reduction percentage of P from these treatments were ranged from 9 to 24% below plants grown in the absence of added Zn. Since low P level with high Zn level were accompanied by P deficiency in plants from both the P_0Zn_{48} and $P_{70}Zn_{48}$. These observations were expected by others (Mohamed, 1992; Fageria, 2001 and Mohamed *et al*., 2011). They concluded that application of large amounts of Zn markedly reduced P concentration in leaves and luxury content of Zn was occurred. The fact that a high rate of Zn resulted in such a reduction in P concentration would indicate that the interaction of Zn and P was physiologicaly due to root surface absorption or reduced its translocation within the plant. This would agree with conclusions reached by others (Dell and Wilson, 1985; Cakmak and Marschner, 1987; Moraghan and Grafton, 2003 and Barben *et al*., 2010).

It is evident that appearance of Zn deficiency symptoms is closely associated with application of P and can be prevented by application of Zn. Similarly, there was a progressive decrease in the effect of P rates on P concentration in leaves as the Zn level was increased from 0 to 48 ppm. Thus, P and Zn would seem to be mutually antagonistic whenever either element exceeds some threshold level. This antagonism between P and Zn has previously been noted by others (Stukenholts *et al*., 1966; Bukvicl *et al*., 2003; Das *et al*., 2005 and Mousavi, 2011).

For the various P levels as the status of plants was changed from severely deficient to normal as a result of increased rates of Zn, there was no consistent increase in concentration

of Zn in leaf tissue. Thus, there would seem to be considerable evidence in these data that Zn concentration in leaves is not the direct cause of the growth disorder observed.

Applying the low levels of Zn were needed to prevent deficiency symptoms from developing resulted in a rather consistent decrease in P concentration of leaves. Consequently, elimination of the deficiency as a result of applying Zn appears to be associated with both a decrease in P accumulation by the plants and undoubtedly some increase in Zn accumulation.

Zinc content

As the rate of P was increased, Zn content in leaves was gradually decreased with significant differences compared to control in both seasons (Table 2). Since high level of P fertilization was accompanied by Zn deficiency, whereas leaf Zn concentration must drop to about 35 ppm with high level of P. Leaf Zn concentration resulted from the maximum growth was averaged 18 ppm more than that occurred at high level of P in 1st and 2nd seasons, respectively. The results of these experiment are in agreement with those of previous workers (Khan and Zende, 1977; Cakmak and Marschner, 1987; Fageria, 2001; Barban*et al*., 2010; Balal, 2011; Mohamed *et al*., 2011and Mousavi, 2011). They demonstrated that high phosphate applications increase the severity of Zn deficiency symptoms in plants.

It is evident that increasing the rate of applied Zn progressively increased Zn concentration in leaves with significant differences compared to plants grown in the absence of added P (Table 2). Greatest accumulation of Zn in leaf tissue was obtained in the presence of 48 ppm Zn treatment, the increment was approximately 71 ppm more than control. Zinc accumulation increased in plants fertilized with Zn but limited in growth by lack of P, reaching to 130 ppm Zn, in average, in the leaf tissue at P_0Zn_{48}. No evidence of Zn toxicity was observed and it was doubtful that the Zn levels attained were injurious to the plants. A similar trend was also observed by numerous investigator (Dell and Wilson 1985; El-Sallami, 1997; Hashemimajd and Somarin, 2011). Reductions in leaf Zn content were occurred in the maximum growth were much greater, however, averaging 44 ppm below plants grown in high level of Zn.

Zinc deficiency was evident on plants from both the $P_{280}Zn_0$ and $P_{560}Zn_0$ levels of fertilization. Leaf Zn from these treatments generally contained almost 32 ppm less than $P_{280}Zn_{24}$ level which produced the maximum growth indicating that Zn concentration must drop to about 32 ppm to induce visual symptoms of deficiency. Webb and Loneagon (1988) have shown that visual symptoms need not be present for wheat to be deficient in Zn. Growth may be restricted by lack of Zn before plants show other symptoms of deficiency. Although no symptoms were apparent on plants from the $P_{280}Zn_{24}$ treatment, Zn concentration in leaf tissue was essentially the same as found in plants definitely Zn deficient. This indicates that these plants were marginal in Zn even though they made the best growth.

As a result, excessive accumulation of phosphorus, causing zinc imposed deficiency. Various studies

have been suggested to explain the main reasons for this effect, which include (i) Zinc transmission of plant roots to shoot is reduced by high concentration of P, so Zn accumulated in roots or its uptake decreases by roots (Sharma *et al*., 1968; Khan and Zende, 1977; Das *et al*., 2005; Khorgamy and Farnia, 2009), (ii) Zinc concentration in shoots of plants decreases by effect of induced growth response (dilution effect); means that amount of Zn uptake in plant increases by increasing plant growth but its concentration decreases in plant tissues(El-Gharably and Rushdi, 1975; Cakmak and Marschner, 1987; El-Sallami, 2001 and Barben *et al*., 2010), (iii) Metabolism effect in plant cells is related to Zn and P imbalance. So by increasing the phosphorus concentration, zinc tasks is impaired at specific positions in the cells (Stukenholts *et al*., 1966; Fageria, 2001; Morghan and Grafton, 2003; Mirvat *et al*., 2006 and Mousavi, 2011).

In absence or low concentration of zinc, phosphorus uptake and transport increased in the shoot and its concentration increased in the leaves, as a result can cause toxicity in the plant. This increase only occurred with Zn deficiency, means that Zn deficiency increases the permeability of plasma membrane in root compared to P (Webb and Loneagan, 1988; Hu *et al*., 1996 and Bukvicl *et al*., 2003). The high levels of P were mostly appar in leaf tissue and accompanied by some rather marked changes in concentration and mobility of other nutrients (Kato and Takel, 1989; Fageria, 2001; Khorgamy and Farina, 2009 and Mousavi, 2011).

Iron content

Both P and Zn fertilization had some rather distinct effects on Fe within night-blooming jessamine (Table 3). Increasing of either P or Zn level caused a significant reduction in leaf Fe concentration. Iron deficiency induced by heavy application of P has been reported (Tisdale *et al*., 2003). They concluded that P addition reduced the uptake-transport of Fe. The high rates of phosphorus-iron indicates a lake of Fe or excess of P, and low ratio indicates Fe toxicity or a possible P deficiency. Interaction of P and Fe leading to Fe chlorosis appears to be caused by an internal immobilization of Fe probably due to formation of Fe phosphate (Warnock, 1970).

Other mechanisms of Fe reduction by P application may be inhibition of Fe absorption by roots and of Fe transport from roots to shoots, and inactivation of plant Fe (Balal *et al*., 2011; Hashemimajd and Somarin, 2011). Rengel and Romheld (2000) have also reported an abnormally high concentration of Fe in Zn-deficient wheat. They pointed out that Fe accumulation occurred only on those plants which were deficient in Zn, and that "there was no tendency for P to increase the Fe content except where a Zn deficiency was created or accentuated". From this they postulate that Zn deficiency removes a "Zn factor" inhibiting the uptake of Fe. The excessively high Fe concentration found in this study conform to that concept. In view of the known antagonism between Zn and Fe in plant tissue (Fageria, 2001; Balal *et al*., 2011; Hashemimajd and Somarin, 2011 and Mousavi, 2011), the increase of Fe concentration in Zn-

deficient tissue might be contribute to physiological malfunction.

Manganese content

Manganese concentration in leaf tissue was significantly increased with increasing P level (Table 4). Positive interaction between P and Mn has been reported in the literature (Warnock, 1970 and Fageria, 2001). For the various Zn levels, adverse trend was observed in P levels where leaf Mn was significantly increased with increasing Zn level. Manganese concentration was greater in the presence of 560 ppm P (approximately 91%) than in the absence of added Zn. Leaf Mn in the presence of Zn_{48} was greater than in the absence of added P (approximately 141%). These results indicated that high Zn level was more effective in accumulating Mn in leaf tissue than high P level, where high Zn rate increased leaf Mn to one-half than in high P rate. Similar observations were found by others (Warnock, 1970; Fageria, 2001 and Balal *et al*., 2011). They reported that high levels of applied P or Zn greatly increased translocation of Mn. The maximum growth of $P_{560}Zn_{48}$ treatment resulted in appreciably change in leaf Mn from that at $P_{\mathbf{0}}Zn_{\mathbf{48}}$ and $P_{560}Zn_0$. It was noticed antagonism between Fe and Mn in leaf tissue. Hashemimajd and Somarin (2011) found that the concentration of Mn in peach leaves was decreased with increasing Fe concentration in root medium due to an oxidation of Fe by Mn.

Nutrient Ratios in Leaf Tissue

The average ratios of P/Zn in leaf tissue is reported in Table (5). At maximum growth ($P_{280}Zn_{24}$ treatment) the ratio was 81 (in average). With P-induced Zn deficiency ($P_{560}Zn_0$), this ratio increased to 268-well above the values usually reported as "critical". In the absence of P but with 48 ppm Zn added to the soil, the P/Zn ratio dropped to 21. Thus, the P/Zn ratio in leaf tissue increased to 13 times in this test.

Other nutrients ratios within the leaf are also shown in Table (5). The P/Fe ratio varied from 75.2 to 6.1, reflecting the effect of high P in reducing Fe content of tissue. High P has been shown to precipitate insoluble Fe phosphates within tissues (Fageria, 2001), but in this study increases of both Fe and P were greatest in the leaf tissue. Iron to Zn ratio follows a similar pattern that of P/Zn. At optimum growth, Fe content was about 4.2 times of Zn but increased to 9.2 times in tissue of plant severely Zn-deficient ($P_{560}Zn_0$). This further emphasizes the probability of Fe-Zn antagonism within the plant in P-induced Zn deficiency. The Zn/Mn ratio was reduced by increasing P level but it increased with increasing Zn level, reflecting the effect of high P in reducing Zn and increasing Mn content in leaf tissue. The Fe/Mn ratio follows a parallel effect to that of Fe/Zn ratio.

In general, although these ratios reflected the behavior of individual nutrients under various treatments, they pointed out the differential influences of such treatments on the nutrient balance inside night-blooming jessamine plants.

Table 1. Phosphorus concentration in leaves of night-blooming jessamine in relation to P and Zn fertilization in 2012 and 2013 seasons.

P applied, ppm in soil	P in leaves, ppm											
	Zn applied, ppm in soil											
	0	6	12	24	48	Mean	0	6	12	24	48	Mean
	2012						2013					
0	3442	3284	3025	3098	2750	**3120**	3322	3186	3064	2885	2673	**3048**
70	4560	4032	3721	3505	3078	**3779**	4433	3950	3765	3465	2867	**3696**
140	5201	4876	4575	4410	3708	**4554**	5153	4677	4508	4520	3447	**4461**
280	5206	5247	5054	4760	4645	**4982**	5466	5375	5109	4908	3887	**4949**
560	7289	7105	7079	6983	6495	**6990**	7272	7106	6880	6816	6515	**6918**
Mean	**5140**	**4909**	**4691**	**4551**	**4135**		**5129**	**4859**	**4665**	**4519**	**3900**	
LSD5%	P=**421**		Zn= **421**		PxZn= **940**		P=**456**		Zn= **456**		PxZn= **1086**	

Table 2. Zinc concentration in leaves of night-blooming jessamine in relation to P and Zn fertilization in 2012 and 2013 seasons.

P applied, ppm in soil	Zn in leaves, ppm											
	Zn applied, ppm in soil											
	0	6	12	24	48	Mean	0	6	12	24	48	Mean
	2012						2013					
0	35.7	59.5	75.0	83.1	135.0	**77.7**	37.3	61.3	73.0	84.9	124.3	**76.2**
70	35.2	44.8	57.3	81.9	124.0	**68.6**	34.8	46.0	58.6	78.3	130.5	**69.6**
140	33.1	39.6	43.0	61.3	105.7	**56.5**	33.6	36.7	44.6	65.4	111.5	**58.4**
280	28.7	32.0	36.2	58.7	89.3	**49.0**	29.5	32.2	35.6	61.2	77.8	**47.3**
560	27.3	32.2	39.3	43.0	70.0	**42.4**	27.5	30.1	38.9	41.7	67.0	**41.0**
Mean	**32.0**	**41.6**	**50.2**	**65.6**	**104.8**		**32.5**	**41.3**	**50.1**	**66.3**	**102.2**	
LSD5%	P=**5.4**		Zn= **5.4**		PxZn= **12.1**		P=**6.1**		Zn= **6.1**		PxZn= **13.6**	

Table 3. Iron concentration in leaves of night-blooming jessamine in relation to P and Znfertilization in 2012 and 2013 seasons.

P applied, ppm in soil	Fe in leaves, ppm											
	Zn applied, ppm in soil											
	0	6	12	24	48	Mean	0	6	12	24	48	Mean
	2012						2013					
0	572	523	405	398	315	**443**	549	455	416	372	301	**419**
70	479	411	352	307	286	**367**	442	397	368	304	272	**357**
140	378	347	320	278	236	**312**	391	366	334	265	249	**321**
280	335	302	275	249	213	**275**	326	305	283	256	228	**280**
560	278	208	197	136	109	**186**	256	229	177	115	88	**173**
Mean	**408**	**358**	**310**	**274**	**232**		**393**	**350**	**316**	**262**	**228**	
LSD5%	P=**35**		Zn= **35**		PxZn= **78**		P=**32**		Zn= **32**		PxZn= **71**	

Table 4. Manganese concentration in leaves of night-blooming jessamine in relation to P and Zn fertilization in 2012 and 2013 seasons.

P applied, ppm in soil	Mn in leaves, ppm											
	Zn applied, ppm in soil											
	0	6	12	24	48	Mean	0	6	12	24	48	Mean
	2012						2013					
0	42	49	54	63	77	**57**	45	49	52	56	68	**54**
70	70	77	82	96	105	**86**	63	66	73	89	98	**78**
140	79	96	114	122	135	**109**	68	87	105	116	129	**101**
280	106	114	146	167	183	**143**	95	127	136	151	176	**137**
560	139	151	167	172	192	**165**	128	144	152	165	181	**154**
Mean	**87**	**97**	**113**	**125**	**138**		**80**	**95**	**104**	**115**	**130**	
LSD5%	P=**10**		Zn= **10**		PxZn= **22**		P=**9**		Zn= **9**		PxZn= **20**	

Table 5. Nutrient ratios in leaves of night-blooming jessamine in relation to P and Zn fertilization in 2012 and 2013 seasons.

P applied, ppm in soil	Zn applied, ppm in soil	Ratios									
		P/Zn		P/Fe		Fe/Zn		Zn/Mn		Fe/Mn	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
0	0	96.9	90,.3	6.10	6.05	16.12	14.92	0.85	0.84	13.70	12.55
	6	55.3	52.0	6.32	7.01	8.82	7.45	1.23	1.28	10.68	9.44
	12	40.5	42.0	7.48	7.37	5.42	5.70	1.42	1.43	7.64	8.11
	24	37.4	34.0	7.79	7.76	4.79	4.39	1.33	1.52	6.35	6.67
	48	20.4	22.5	9.27	9.24	2.35	2.43	1.76	1.84	4.08	4.48
	Mean	**50.1**	**48.2**	**7.39**	**7.49**	**7.50**	**6.98**	**1.32**	**1.38**	**8.49**	**8.25**
70	0	131.0	127.6	9.54	10.04	13.70	12.82	0.50	0.56	6.87	7.05
	6	90.6	86.9	9.81	9.95	9.25	8.75	0.58	0.70	5.36	6.02
	12	65.2	63.8	10.57	10.26	6.16	6.29	0.70	0.81	4.30	5.05
	24	42.9	44.4	11.45	11.41	3.76	3.89	0.86	0.89	3.21	3.44
	48	24.8	22.0	10.79	10.61	2.31	2.08	1.18	1.34	2.73	2.78
	Mean	**70.9**	**68.9**	**10.43**	**10.45**	**7.04**	**6.77**	**0.76**	**0.86**	**4.49**	**4.87**
140	0	160.0	153.9	13.78	13.19	11.60	11.66	0.42	0.50	4.80	5.80
	6	168.7	128.9	14.07	12.78	12.08	10.08	0.31	0.43	3.63	4.22
	12	107.0	102.2	14.30	13.50	7.49	7.58	0.38	0.43	2.82	3.19
	24	72.0	69.3	15.87	17.09	4.54	4.07	0.50	0.57	2.28	2.29
	48	35.2	31.1	15.77	13.88	2.24	2.25	0.78	0.87	1.75	1.94
	Mean	**108.6**	**97.1**	**14.76**	**14.09**	**7.59**	**7.13**	**0.48**	**0.56**	**3.06**	**3.49**
280	0	184.4	188.5	15.64	16.78	11.83	11.25	0.27	0.31	3.16	3.44
	6	164.6	168.0	17.46	17.61	9.46	9.53	0.29	0.25	2.68	2.41
	12	140.7	145.3	18.42	18.25	7.67	8.14	0.25	0.26	1.89	2.10
	24	81.4	80.3	19.16	19.18	4.25	4.19	0.35	0.41	1.49	1.70
	48	52.2	50.1	21.83	17.11	2.39	2.94	0.49	0.45	1.17	1.30
	Mean	**124.7**	**126.4**	**18.40**	**17.79**	**7.12**	**7.21**	**0.33**	**0.34**	**2.08**	**2.19**
560	0	269.4	266.0	26.24	28.62	10.27	9.36	0.20	0.22	2.01	2.02
	6	221.8	236.9	34.18	31.09	6.52	7.65	0.22	0.21	1.38	1.59
	12	181.2	177.7	35.99	38.96	5.04	4.57	0.24	0.26	1.18	1.17
	24	164.7	164.3	51.44	59.48	3.20	2.77	0.25	0.25	0.78	0.70
	48	93.2	98.2	59.76	75.22	1.56	1.31	0.37	0.38	0.57	0.50
	Mean	**186.1**	**188.6**	**41.52**	**46.67**	**5.32**	**5.13**	**0.26**	**0.26**	**1.18**	**1.20**
Mean for Zn effect											
0		168.3	165.3	14.26	14.94	12.70	12.00	0.45	0.49	6.11	6.17
6		140.2	134.5	16.37	15.69	9.23	8.69	0.53	0.57	4.75	4.74
12		106.9	106.2	17.35	17.67	6.36	6.46	0.60	0.64	3.57	3.92
24		79.7	78.5	21.14	22.98	4.11	3.86	0.66	0.73	2.82	2.96
48		45.2	44.8	23.48	25.21	2.17	2.20	0.92	0.98	2.06	2.20
LSD at 0.05											
P		**79**	**82**	**6.82**	**7.23**	**2.13**	**1.96**	**0.42**	**0.39**	**2.11**	**2.16**
Zn		**79**	**82**	**6.82**	**7.23**	**2.13**	**1.96**	**0.42**	**0.39**	**2.11**	**2.16**
PxZn		**176**	**183**	**15.24**	**16.15**	**4.76**	**4.38**	**0.94**	**0.87**	**4.71**	**4.83**

Conclusions

It is evident from the data obtained from these experiments the severe reduction in growth which had received heavy application of P was due mainly to P-induced Zn deficiency. Also, data support the conclusion that the more susceptible plant to take up more Fe and P when grown in a soil low in Zn. The differential absorption of Fe and P was the cause of the differential susceptibility to Zn deficiency.

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استجابة نباتات مسك الليل للعلاقة بين الفوسفور الزنك
II. تركيز الفوسفور والعناصر الصغرى فى نسيج الورقة

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الملخص

أجريت الدراسة بمزرعة نباتات الزينة – كلية الزراعة – جامعة اسيوط لمعرفة تأثير التفاعل بين عنصرى الفوسفور والزنك على محتواهما فى الاوراق وتأثير كل منهما على محتوى بعض العناصر الصغرى (الحديد والمنجنيز).

زرعت النباتات فى اصص واضيف السماد الفوسفاتى بمعدلات صفر، ٧٠، ١٤٠، ٢٨٠، ٥٦٠ جزء/ مليون. كما أضيف الزنك بمعدلات صفر، ٦، ١٢، ٢٤، ٤٨ جزء/ مليون.

وكانت أهم النتائج كما يلى:

- أظهر التحليل الكيماوى أن محتوى الاوراق من عناصر الزنك والحديد يتبادل ارتفاع تركيزاتهم فى الاوراق.
- على الرغم من ان تركيز كل من الفوسفور والزنك نقص بزيادة تركيز الاخر الا ان زيادة تركيز اى منهما ادى الى زيادة تركيز المنجنيز بالاوراق.
- زيادة تركيز الحديد بالاوراق ادى الى نقص الزنك. كما ان زيادة تركيز الفوسفور ادى الى ارتفاع نسبة فوسفور/زنك والتى ارتبطت بتحسن النبات عند نسبة أصغر من ١٠٠ بينما ظهر اعراض نقص الزنك عند نسبة اكبر من ١٠٠.