Improving the Growth and Productivity of Barley (*Hordeum Vulgare*, L) As Affected by Foliar Application of Phosphorous and Micronutrients Grown in Calcareous Soil

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ABSTRACT

Field experiment was carried out during winter season 2018 / 2019 in Mareyout, the agriculture experiment station of the Desert Research Center, south west Alexandria, Egypt to study the influence of foliar application of phosphorous at rates of 0, 1, 2 and 4 kg P/ fed. And the mixture of some microelements (Fe, Mn and Zn) at rates of 0, 150, 300 and 600 ppm / fed. On the growth and productivity of barley grown in calcareous soil under surface irrigation system. Foliar spraying of the treatments were added through three doses, i.e. in tailoring, elongation and budding stages, of barley plants (Giza 123 c.v).

Results showed that spraying barley by 4 kg P /fed, combined with 600 ppm /fed of mixture (Fe, Mn and Zn), which were very effective in improving grain, straw and biological yields, which recorded 2.2 , 5.3 and 7.5 ton/fed, respectively. And gave the highest increases yield parameters (plant height, No. of tillers/ m^2, No. of spikes/m^2 and spike length. Also, this treatment recoded the highest values of nitrogen, potassium, phosphorus, Fe, Mn and Zn as concentration and uptake in both grain and straw of barley plants. It is noticed that, increasing application of P and microelements mixture lead to a significant increases of the studied parameters.

Keywords: Barley, productivity, concentration of elements and uptake of N, P, K, Fe, Mn and Zn.

INTRODUCTION

Barley (*Hordeum vulgare*, L) is widely grown in the rain fed areas of the arid and semi-arid Mediterranean regions like North-Coastal Egyptian calcareous soil. Barley could be grown in a wide range of environmental conditions. It is the fourth most important crop in the world. Its grains are used as food, feed, and malting purposes, while straws provide an important source of roughage for feeding animals, Asal et al. (2018).

Phosphorous and micronutrients play a direct role in plant production. Some cultivated areas in Egypt have inadequate nutrients supply such as the lime rich soil of the newly developed areas.

Currently, foliar sprays are fast acting and effective for treat in nutrient deficiencies. Foliar uptake of nutrients is much faster than root uptake. Therefore foliar feeding is the method of choice when deficiency symptoms are noted, and prompt correction of deficiencies is required nutrients rapidly absorbed through the foliage, providing the plant with the missing nutrients, and strengthening it.

Adequate phosphorous nutrition enhances many aspects of plant physiology including the fundamental processes of photosynthesis, nitrogen fixation, flowering, fruiting (including seed or grain production) and maturation. Root growth, particularly development of lateral roots and fibrous rootles, is encouraged by phosphorous. In cereal crop, good phosphorous nutrition strengthens structural tissues such as those found in straw or stalks, thus helping to prevent lodging (falling over). It is also the important structural component of nucleic acids, coenzymes, phospholipids, and nucleotides, Nyle and Ray (1996).

Increased yields of barley were obtained using dilute solutions of foliar P, Qaseem et al. (1978). Jagadeesh et al. (2006) studied the effect of foliar applications of P on winter wheat grain yields, P uptake and use efficiency by using twelve treatments containing varying foliar P rates (0, 1, 2, and 4 kg P/ha with and without pre-plant rates of 30 kgP_2O_5/ha. Foliar applications of P increased grain yields and P uptake versus no foliar, P use efficiency was higher when P was applied.

Micronutrients are required in relatively smaller quantities for plant growth, they are as important as macronutrients. If any element is lacking in the soil or not adequately balanced with the other nutrients, growth suppression or even complete inhibition may result (Mengel et al., 2001). Micronutrients often act as co-factors in enzyme systems and participate in redox reactions, in addition have several other vital functions in plants. Most importantly, micronutrients are involved in the key physiological processes of photosynthesis and respiration (Marschner, 1995 and Mengel et al., 2001). The positive effects of Fe and Zn on barley plant may be due to their effects as a metal component of some enzymes or regulatory for the others. Moreover, they have essential roles in plant metabolism and increase growth and nutrient uptake of Barley Abd El-Hady (2007). In another study, Abd El-Wahab (2008) stated that micronutrients such as iron, manganese and zinc

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have important roles in plant growth and yield of aromatic and medicinal plants. Sary et al. (2014) Showed that, foliar spraying with micro-nutrients positively affected all growth, yield and yield components characters as compared with control treatment with superiority to combined treatments (Zn + Fe + B + Mn) which recorded the highest values for all the studied characters in both the studied seasons. Mirvat et al. (2015) indicated that, foliar application of some micro-nutrients (Tap water, 260 ppm Zn, 260 ppm Mn and 260 ppm Zn + 260 ppm Mn) significantly increased the yield and yield components as well as chemical composition of barley grains over control treatment when applied single or in combination.

Amal et al. (2017) showed that foliar spraying with Nitrophoska foliar 20/19/19/TE spraying with 300 cm Nitrophoska foliar/ 100 l water produced the highest significant values of growth characters at 80 and 100 days from sowing, also increased the barley yield and its components compared with other foliar treatments under study. Anjum et al. (2017) found that application of micronutrients, improved yield and yield components of barley.

Accordingly, this study aims to study the effect of foliar spray application of phosphorous and mixture of some micronutrients (Fe + Mn + Zn) on the growth, productivity and chemical contents of barley plant (Giza 123 cultivar) grown in calcareous soil.

MATERIAL AND METHODS

Field experiment was carried out during the season 2018 / 2019 in the Agricultural Experimental Station of the Desert Research Center at Mareyout station, 40 km south –west Alexandria city, Egypt.

The experiment was planned in a split plot design with three replicates. The main plots were applied by four levels of phosphorous as foliar application in the form of phosphoric acid **(**H_3PO_4**)** containing 54% P_2O_5 at rates of (0, 1, 2 and 4 kg P / fed.), The subplots included the foliar spraying of four levels of the mixture of some micronutrients (Fe +Mn + Zn) as chelated form at rates of (0, 150, 300, and 600 ppm /fed.). Foliar spraying of the studied treatments were done three times at tailoring, elongation and budding stages of barley plants (Giza 123 cultivar), which were directly sown by 60 kg seeds/ fed at November 20th.

All plots were fertilized with the recommended rates of nitrogen (45 kg N/fed.) as ammonium sulphat, phosphorous (15 kg p_2O_5/fed.) as superphosphate and K sulphate, (50 kg K_2O/ fed.). Nitrogen, P and K were added before sowing and after 45 days from planting. Also organic manure (farmyard manure) at a rate of 30 m^3/fed. Was added to soil 15 days before cultivation. The experiment included 16 experimental treatment, includes 4 phosphorous treatments and 4 rates of mixture micronutrients. The plot area was (10.5 m^2), 3.5 x 3 m long and wide (1/400 of fed.). Barley seeds treated with bio- fertilizer containing symbiotic N-Fixing bacteria of *Rhizobium legume-nosarum* which provided by Soil Microbiology Unit at Soils Fertility and Microbiology Department, Desert Research Center, Cairo, Egypt. The soil and irrigation water were analyzed at the laboratories of Desert Research Center, and the obtained results are shown in Tables 1 (a & b) and 2.

Table 1a. Some physical and chemical properties of the experimental soil (Mareyut)

Soil depth (cm)	pH	EC dSm^{-1}	$CaCO_3$ %	OM %	Soluble Cations (me/l)				Soluble Anions (me/l)		
0-30	7.7	4.6	29	0.64	Ca^{++}	Mg++	Na^{+}	K^{+}	HCO_3^{-}	$SO4^{=}$	Cl^{-}
					19.89	14.92	9.13	2.10	6.0	20.71	19.3
Available nutrients (ppm)	N		P		K		Fe		Mn	Zn	Zn
	32		8.87		10.86		1.6		4.01	0.97	0.97

pH: Acidity, soil extract (1:2.5), EC: Electrical conductivity, me/ l: mille equivalent per liter; OM = organic matter

Table 1 b. Some physical properties of the studied soil

Site	Particle size distribution				Texture class
	Coarse sand %	Fine sand %	Silt %	Clay %	
Mareyout	5	41.8	35.0	18.2	SCL

SCL = Sandy clay loam

Table 2. Chemical analysis of the applied irrigation water

Parameters	pH	EC dSm^{-1}	Soluble Cations (me/l)				Soluble Anions (me/l)		
			Ca^{++}	Mg++	Na^{+}	K^{+}	HCO_3^{-}	$SO4^{=}$	Cl^{-}
Values	7.5	2.8	8.59	10.43	8.7	0.42	6.83	5.58	15.6

pH: Acidity, EC: Electrical conductivity, me/ l: mille equivalent per liter

Barley Yield and Yield Components:

At maturity of plants, 1 m^2 from the center of each plot was harvested and estimating the No. of tillers /m^2 and No. of spikes / m^2. Sub samples of twenty barley plants were taken randomly to determine the yield Components, i.e., Plant height (cm), Spike length (cm). All barely plants for each plot were harvested to determine: (i) Grain yield (ton/fed.), (ii) Straw yield (ton/fed.) and (iii) Biological yield (ton/fed.).

Chemical contents of grains and straw:

Nitrogen, phosphorus, potassium and micronutrients (Fe, Mn and Zn) were determined in the digested dry matter of barley grains and straw of barley. Plant samples washed by tap water then distilled water and then were oven dried at 70^0 for 72 hours then fine ground wet digested according to Peterburgski (1968) to determine N, P and K% according to Chapman and Pratte (1982). Also micro-nutrients (Fe, Mn and Zn) were using atomic absorption spectrophotometer.

Total nitrogen was determined using Microkjeldahl method, Phosphorus content was determined by spectrophotometer, Potassium percentage was determined by using Flame photometer, protein % calculated by multiplying (N%) of grains × 5.75.

Statistical Analysis:

The obtained were statistically analyzed according to Snedecor and Cochran (1982), where treatment means was compared using LSD, test at 0.05 probability level.

RESULTS AND DISCUSSION

Growth parameters of Barley:

Table (3) showed significant effects of P foliar application on the growth parameters of barley. The highest percentage increases are associated with application of the highest P rate (4 kg P /fed), which reached to about 29.47, 18.37, 33.1, and 13.27% for Plant height, No. of tillers, No. of spikes and Spike length, respectively compared to control treatment. Also there are significant effect of mix microelements foliar application on the growth parameters of barley where the highest percentage increases are associated with the high rate addition of mix microelements (600 ppm / fed.). Such increases reached to about 14.86, 10.19, 15.29 and 6.25% for Plant height, No. of tillers, No. of spikes and Spike length, respectively compared with the control treatment.

It was noticed that, the highest percentage increase of growth parameters are associated with the addition of both the highest rates of foliar P and mixture micronutrients indicating increases reached to 38.18, 27.9, 40.3, and 16.73 for Plant height, No. of tillers, No. of spikes and Spike length, respectively compared to the control. Moreover, increasing addition of P and mixture micronutrients are a reflection of the favorable effect of p and micro due to their deficiency in soil. These results are in agreement with they found by Jagadeesh et al. (2006), Amanullah et al. (2016) and Amal et al. (2017).

Yield and Yield Components:

Table (4) clearly indicated that foliar spray of phosphorous and mixture micronutrients showed significant effect on grain, straw and biological yields of Barley. The results indicated that adding the higher rate 4 kg P/fed. Recorded the highest mean values which were 1.9 for grain yield, 4.08 for straw yield and 6.8 ton / fed, for the biological yield. The percentage increase were 26.67, 37.14 and 36.73%, respectively, compared to the control. These increases may be due to the role of phosphorous nutrition which has the ability to enhance many aspects of plant physiology including the fundamental processes of photosynthesis, nitrogen fixation, flowering, fruiting (including seed or grain production) and maturation. Root growth, particularly development of lateral roots and fibrous rootles, are encouraged by phosphorous.

Concerning the effect of mix micro, data showed that the highest percentage increase of yields were obtained with the application of the highest rate of micronutrients, and reached to about 12.26, 23.43, and 20 % for grain, straw, and biological yields of barley relative to 0 rate respectively. The yield increased significantly by increasing mix micronutrients Fe, Mn and Zn application this may be due to the low content of these elements in soil as shown in Table (1), therefore applying it to the increased the growth of the cultivated plants.

Table 3. Effect of the studied treatments on the growth parameters of barley

P Kg /fed (A)		Micro. (ppm) (B)	Plant height (cm)	Tillers No./ m^2	Spikes No./ m^2	Spike length (cm)
0		0	70.27	161.0	139.7	5.20
		150	77.43	164.3	145.3	5.37
		300	**78.53**	165.0	147.3	5.50
		600	79.47	166.3	153.3	5.53
	Means		76.43	164.17	146.42	5.40
1		0	80.04	165.0	155.3	5.30
		150	85.30	167.0	166.7	5.42
		300	87.43	168.7	170.3	5.55
		600	90.33	172.3	175.3	5.66
	Means		85.78	168.25	166.92	5.48
2		0	81.50	166.3	158.0	5.61
		150	89.53	176.7	177.7	5.65
		300	90.67	181.3	179.0	5.70
		600	92.77	187.3	183.7	5.85
	Means		88.62	177.92	174.58	5.70
4		0	81.37	172.0	170.0	5.63
		150	91.53	188.0	186.7	5.89
		300	93.90	196.3	191.0	5.98
		600	97.10	206.0	196.0	6.07
	Means		90.98	190.58	185.92	5.89
			Mean of treatments			
Mean of treatments		0	78.29	166.08	155.75	5.44
		150	85.95	174.00	169.08	5.58
		300	87.63	177.83	171.92	5.68
		600	89.92	183.00	177.08	5.78
	Means		85.45	175.23	168.46	5.62
$LSD_{0.05}$		A	0.323	0.943	2.78	0.048
		B	0.321	0.768	2.68	0.036
		AB	0.641	1.54	5.36	0.073

With respect to the interaction effect between (P× mix micro.), data showed that spraying with the highest rates of both was the best treatment and recorded the highest values: 2.34, 5.26 and 7.60 ton/fed, of grain, straw and biological yields, respectively. Such increases reached 65, 54 and 57 % relative to control treatment, respectively. The favorable effect of the interaction between elements may be attributed to each nutrient lead increase plant growth or maintaining favorable balance between these elements. Similar results agreed with many researchers, Amanullah et al. (2016), Anjum et al. (2017) and Amal et al. (2017).

Chemical contents of grain and straw:

Data presented in Tables (5 and 6) showed the effect of the applied foliar P and mix micronutrients on the concentration of N, P, K, Fe, Mn and Zn in grain and straw of barley.

a) Chemical contents of grain:

Concerning the effect of P on barley grain, data showed that the highest mean concentration values of N, P, K %, Fe, Mn, Zn (ppm) and protein % were 2.06, 0.30, 0.43 %, 64.90, 3.17, 13.36 (ppm) and 11.85 %, respectively, with applied the highest rate of P (4 kg P/fed.). These increases in studied nutrients concentration due to role of phosphorous nutrition which enhances many aspects of plant physiology including the fundamental processes of photosynthesis, nitrogen fixation, flowering, fruiting (including seed or grain production) and maturation. Root growth, particularly development of lateral roots and fibrous rootles, is encouraged by phosphorous. It is also the important structural component of nucleic acids, coenzymes, phospholipids, and nucleotides, Nyle and Ray (1996).

Table 4. Effect of the studied treatments on grain and straw yields (ton/fed) of barley plants

P Kg/fed- (A)	Micro. (ppm) (B)	Grain yield	Straw yield	Biological yield
		(ton/ fed)		
0	0	1.418	3.414	4.832
	150	1.445	3.452	4.897
	300	1.480	3.466	4.947
	600	1.485	3.482	4.967
Mean		1.5	3.5	4.9
1	0	1.467	3.763	5.230
	150	1.530	3.454	3.454
	300	1.540	3.461	5.001
	600	1.548	3.47	5.018
Mean		1.5	3.5	5.0
2	0	1.466	3.462	4.928
	150	1.624	3.482	5.106
	300	1.703	4.652	6.356
	600	1.732	4.783	6.515
Mean		1.6	4.1	5.7
4	0	1.622	3.689	5.311
	150	2.106	5.089	7.195
	300	2.225	5.163	7.388
	600	2.340	5.256	7.596
Mean		1.9	4.8	6.7
		Means of treatments		
0		1.55	3.50	5.05
150		1.50	3.87	5.37
300		1.68	4.19	5.87
600		1.74	4.32	6.06
	A	0.0061	0.137	0.139
$LSD_{0.05}$	B	0.0066	0.121	0.122
	AB	0.0131	0.243	0.244

As regard to the effect of foliar spray with mix micronutrients application at 600 ppm gave the highest concentration mean values were 1.98 %, 0.26 %, 0.43 %, 64.65 (ppm), 3.18 (ppm), 12.95 (ppm) and 11.39 % for N %, P %, K %, Fe (ppm), Mn (ppm), Zn (ppm) and protein %, respectively.

With respect to the interaction between P and the mix. of micro. The results indicated that addition of (4 kg P + 600 ppm mix Micro. /fed.) was the best treatment and gave the highest mean values 2.39, 0.34, 0.46 %, 71.0, 3.34, 14.5 (ppm) and 13.74 % of concentrations for N, P, K, Fe, Mn, Zn and protein of barley grains.

a) Chemical contents of straw:

As the effect of P on barley straw (Table 6) data showed that the highest concentration mean values of N, P, K %, Fe, Mn and Zn (ppm) were 0.66, 0.21, 0.77%, 118.75, 46.75 and 41.48 (ppm) with application the highest rate of P (4 kg P/fed.), respectively.

The effect of foliar spray with mix micronutrients at a rate 600 ppm gave the highest mean values: 0.65, 0.19, 0.75 %, 118.5, 45.15 and 40.83 (ppm) for N, P, K, Fe, Mn and Zn in barley straw, respectively.

Table 5. Effect of the studied treatments on the content of some nutrients in barley grains

P Kg /fed. (A)	Micro. (ppm) (B)	N	protein	P	K	Fe	Mn	Zn
		(%)				(ppm)		
0	0	1.41	8.11	0.15	0.35	45.7	2.82	11.2
	150	1.42	8.17	0.17	0.37	49.5	2.85	11.5
	300	1.43	8.22	0.18	0.38	51.3	2.89	11.7
	600	1.48	8.51	0.19	0.40	52.2	2.94	11.8
Means		1.43	8.22	0.17	0.37	49.68	2.88	11.55
1	0	1.45	8.34	0.18	0.37	47.1	2.86	11.3
	150	1.78	10.24	0.20	0.38	56.0	2.88	11.7
	300	1.83	10.52	0.22	0.39	60.2	3.11	12.0
	600	1.88	10.81	0.23	0.43	65.3	3.21	12.3
Means		1.74	10.01	0.21	0.39	57.15	3.01	11.83
2	0	1.55	8.91	0.20	0.38	47.4	2.89	11.4
	150	1.86	10.70	0.24	0.40	59.0	2.94	12.1
	300	1.96	11.27	0.25	0.42	68.1	3.11	12.5
	600	2.16	12.42	0.27	0.44	70.1	3.24	13.1
Means		1.88	10.81	0.24	0.41	61.16	3.05	12.27
4	0	1.70	9.78	0.23	0.38	58.7	2.93	11.6
	150	1.96	11.27	0.28	0.43	61.2	3.12	13.1
	300	2.18	12.54	0.32	0.45	68.8	3.28	14.2
	600	2.39	13.74	0.34	0.46	71.0	3.34	14.5
Means		2.06	11.85	0.30	0.43	64.90	3.17	13.36
		Mean of treatments						
0		1.53	8.80	0.19	0.37	49.71	2.87	11.38
150		1.75	10.06	0.22	0.40	56.43	2.95	12.09
300		1.85	10.64	0.24	0.41	62.10	3.10	12.60
600		1.98	11.39	0.26	0.43	64.65	3.18	12.95
Means		1.78	10.24	0.23	0.40	58.22	3.03	12.25

This effect by micronutrients, due to they often act as co-factors in enzyme systems and participate in redox reactions, in addition, have several other vital functions in plants. Most importantly, micronutrients are involved in the key physiological processes of photosynthesis and respiration (Marschner, 1995 and Mengel et al., 2001).

Concerning the duple interaction between P and the mix of micronutrients, the results indicated that addition of (4 kg P + 600 ppm mix Micro. / fed) was the most effective treatment and gave the highest mean values of the concentration of the studied nutrients in barley straw. The increase of the concentration nutrients under the studied treatment of foliar application of P and mix micro may be due to role of these nutrients and the balance between them and the other nutrients. Similar results were reported by Mengel *et al.* (2001), Abd El-Hady (2007), Mirvat & Gobarah (2015) and Asal et. al. (2018), they indicated that foliar application of some micronutrients significantly increased chemical composition of barley grains over control treatment when applied single or in combination.

Table 6. Effect of the studied treatments on the content of some nutrients in barley straw

P Kg/fed (A)	Micro. (ppm) (B)	N	P	K	Fe	Mn	Zn
			(%)			(ppm)	
	0	0.61	0.07	0.71	103.00	23.00	27.70
	150	0.62	0.09	0.72	106.00	26.00	31.70
0	300	0.62	0.11	0.72	107.00	31.00	31.00
	600	0.63	0.12	0.72	109.00	30.30	31.30
Mean		0.62	0.09	0.72	106.25	27.58	30.43
	0	0.63	0.11	0.72	105.00	28.00	30.30
	150	0.64	0.14	0.73	108.30	32.30	34.30
1	300	0.64	0.16	0.74	114.00	41.30	36.70
	600	0.64	0.17	0.74	117.00	44.30	41.00
Mean		0.64	0.15	0.73	111.08	36.48	35.58
	0	0.64	0.14	0.74	106.70	30.70	31.70
	150	0.65	0.17	0.75	112.00	40.70	36.30
2	300	0.65	0.21	0.76	116.00	45.70	41.00
	600	0.65	0.23	0.76	122.00	51.00	43.70
Mean		0.65	0.19	0.75	114.18	42.03	38.18
	0	0.65	0.16	0.76	108.00	34.00	32.00
4	150	0.66	0.21	0.76	118.70	46.00	42.30
	300	0.67	0.23	0.77	122.30	52.00	44.30
	600	0.67	0.25	0.78	126.00	55.00	47.30
Mean		0.66	0.21	0.77	118.75	46.75	41.48
			Means of treatments				
	0	0.63	0.12	0.73	105.68	28.93	30.43
	150	0.64	0.15	0.74	111.25	36.25	36.15
	300	0.64	0.18	0.75	114.83	42.50	38.25
	600	0.65	0.19	0.75	118.50	45.15	40.83

Uptake by grain and straw:

Data shown in Tables (7and 8) and figs. (1 - 4) clearly indicated that foliar application P and mix micro. Showed significant effect on N, P, K, Fe, Mn, and Zn uptake (kg/fed.) in both barley grain and straw.

a) Uptake by grain:

As regard to the effect of P, the results showed significant effect on N, P, K, Fe, Mn, and Zn uptake by grain as compared to the control treatment. The highest mean values of N, P, K, Fe, Mn, and Zn uptake by grain were 43.26, 6.24, 9.03, 0.14, 0.01 and 0.03 kg / fed with application the higher rate of P, respectively. This increase of nutrients uptake leads to the role of foliar spray phosphorous, Nyle and Ray (1996). Also low content of P in soil and inadequate nutrient supply because its soil lime rich as showed in (Table 1).

With respect to the effect of foliar spray with the mix of micro nutrients the spray with rate 600 ppm gave the highest mean values of the uptake which reached for grains to about 36.06, 4.79 ,7.73, 0.12, 0.01, 0.02 for N, P, K, Fe, Mn, and Zn kg /fed.

Concerning the duple interaction between P and the mix of micro the results indicated that addition of (4 kg P + 600 ppm mix micro / fed) were the best treatment and gave the highest mean values of the uptake nutrients under study in barley grains.

b) Uptake by straw:

With respect to the effect of P data showed that (Table 8) significant effects on N, P, K, Fe, Mn, and Zn uptake kg / fed of straw as compared to control treatment. The highest mean values of N, P, K, Fe, Mn, and Zn uptake kg / fed of straw were 31.83, 10.45, 36.85, 0.57, 0.23 and 0.21 kg/fed, with highest rate of P, respectively.

Table 7. Effect of the studied treatments on the uptake of some macro and micronutrients by barley grains

P Kg/fed. (A)	Micro. (ppm)- (B)	N	P	K	Fe	Mn	Zn
		Uptake (kg/fed)					
0	0	19.9	2.13	5.01	0.065	0.004	0.016
	150	20.5	2.41	5.30	0.072	0.004	0.017
	300	21.2	2.62	5.58	0.076	0.004	0.017
	600	21.9	2.87	5.89	0.078	0.004	0.018
Mean		20.89	2.50	5.44	0.07	0.00	0.02
1	0	21.3	2.59	5.48	0.069	0.004	0.017
	150	27.2	3.11	5.86	0.086	0.004	0.018
	300	28.2	3.39	5.95	0.093	0.005	0.018
	600	29.1	3.51	6.60	0.101	0.005	0.019
Mean		26.46	3.15	5.97	0.09	0.00	0.02
2	0	22.7	2.98	5.52	0.069	0.004	0.017
	150	30.2	3.84	6.44	0.096	0.005	0.020
	300	33.4	4.26	7.21	0.116	0.005	0.021
	600	37.4	4.74	7.68	0.121	0.006	0.023
Mean		30.93	3.95	6.71	0.10	0.00	0.02
4	0	27.6	3.78	6.22	0.095	0.005	0.019
	150	41.2	5.97	9.13	0.129	0.007	0.028
	300	48.4	7.19	10.01	0.153	0.007	0.032
	600	55.8	8.03	10.76	0.166	0.008	0.034
Mean		43.26	6.24	9.03	0.14	0.01	0.03
		Mean of treatment					
	0	22.89	2.87	5.56	0.07	0.00	0.02
	150	29.77	3.83	6.68	0.10	0.00	0.02
	300	32.83	4.36	7.19	0.11	0.01	0.02
	600	36.06	4.79	7.73	0.12	0.01	0.02
Mean		30.39	3.96	6.79	0.10	0.01	0.02
	A	0.956	0.174	0.191	0.0006	0.00002	0.00007
$LSD_{0.05}$	B	0.557	0.103	0.150	0.0013	0.00003	0.00008
	AB	1.12	0.206	0.300	0.0026	0.0001	0.0002

With respect to the effect of foliar spray with mix micronutrients at rate 600 ppm, gave the highest mean values of the uptake which were 28.10, 8.58, 32.63, 0.52, 0.20 and 0.18 kg/fed, for N, P, K, Fe, Mn and Zn, respectively. For the interaction between P and mix micro, the results indicated that addition (4 kg P + 600 ppm mix. micro/fed.) was the best treatment and gave the highest mean values of nutrients under study of straw barley. These results agreed with those mentioned by Asal et al. (2018), Jagadeesh. et al. (2006), Abd El-Hady (2007) and Mirvat & Gobarah (2015), who stated that, Phosphorous and micronutrients play a direct role in plant production. Some cultivated areas in Egypt have inadequate nutrients supply such as the lime rich soil of the newly developed areas.

Table 8. Effect of the studied treatments on the uptake (kg/fed.) of some macro and micronutrients of barley straw

P Kg/fed. (A)	Micro. (ppm)- (B)	N	P	K	Fe	Mn	Zn
		uptake of straw (kg/fed)					
0	0	20.8	2.3	24.2	0.35	0.08	0.09
	150	21.3	3.0	24.7	0.37	0.09	0.11
	300	21.6	3.7	25.0	0.37	0.11	0.11
	600	22.0	4.1	25.2	0.38	0.11	0.11
Mean		21.43	3.28	24.78	0.37	0.10	0.11
1	0	21.8	3.9	24.9	0.36	0.10	0.10
	150	22.0	4.7	25.3	0.38	0.11	0.12
	300	22.1	5.3	25.6	0.40	0.14	0.13
	600	24.0	5.9	27.9	0.44	0.17	0.15
Mean		22.48	4.95	25.93	0.40	0.13	0.13
2	0	22.1	4.7	25.6	0.37	0.11	0.11
	150	22.5	5.8	26.2	0.39	0.14	0.13
	300	30.2	9.8	35.2	0.54	0.21	0.19
	600	31.1	11.0	36.4	0.58	0.24	0.21
Mean		26.48	7.83	30.85	0.47	0.18	0.16
4	0	24.0	5.8	27.9	0.40	0.13	0.12
	150	33.6	10.7	38.8	0.60	0.23	0.22
	300	34.4	12.0	39.7	0.63	0.27	0.23
	600	35.3	13.3	41.0	0.66	0.29	0.25
Mean		31.83	10.45	36.85	0.57	0.23	0.21
		Mean of treatments					
0		22.18	4.18	25.65	0.37	0.11	0.11
150		24.85	6.05	28.75	0.44	0.14	0.15
300		27.08	7.70	31.38	0.49	0.18	0.17
600		28.10	8.58	32.63	0.52	0.20	0.18
	A	1.41	0.321	1.49	0.017	0.0068	0.0088
$LSD_{0.05}$	B	1.30	0.323	1.18	0.014	0.0057	0.0052
	AB	2.61	0.645	2.36	0.028	0.0111	0.0104

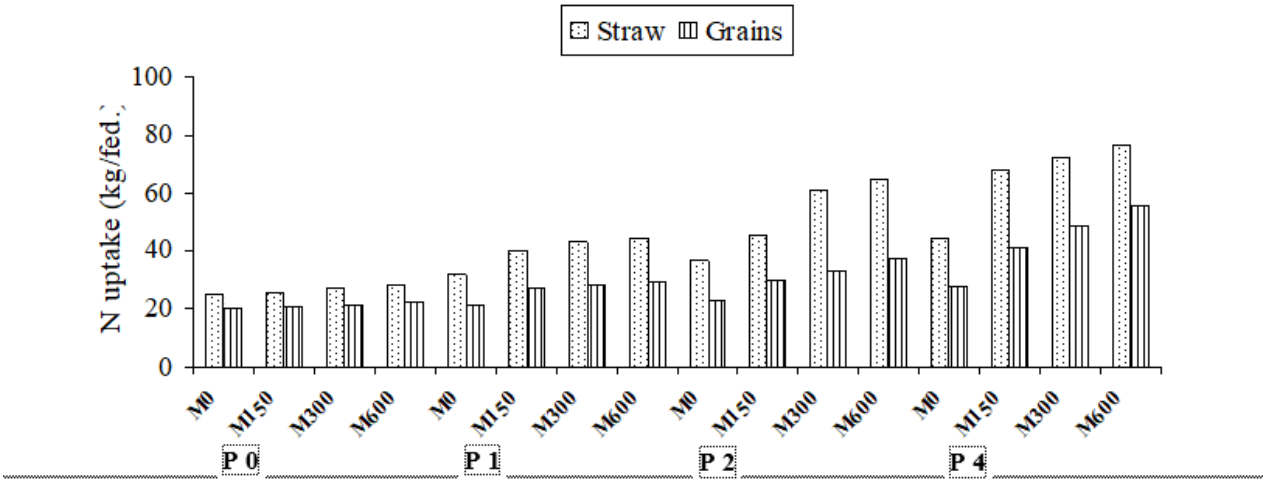

Fig. 1. Effect of the studied treatments on N uptake (kg/fed.) of barley straw and grain

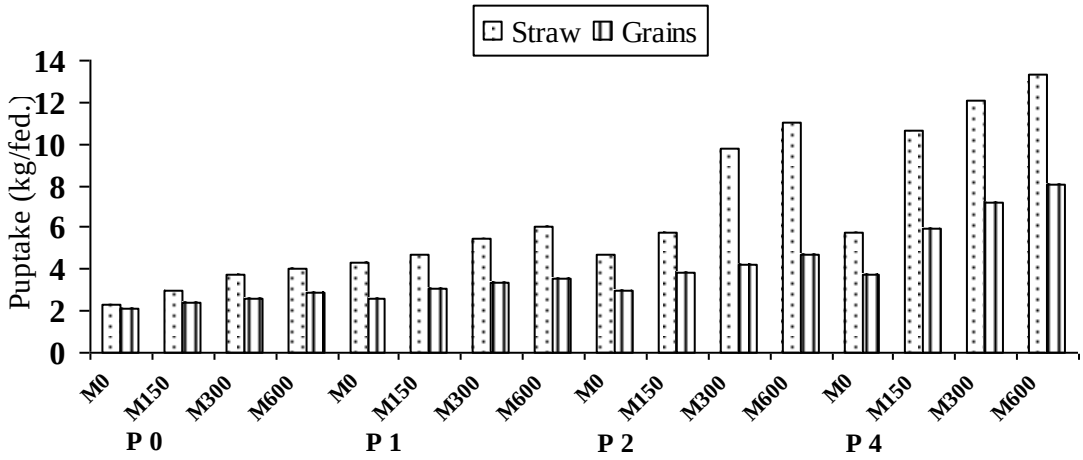

Fig. 2. Effect of the studied treatments on P uptake (kg/fed.) of barley straw and grain

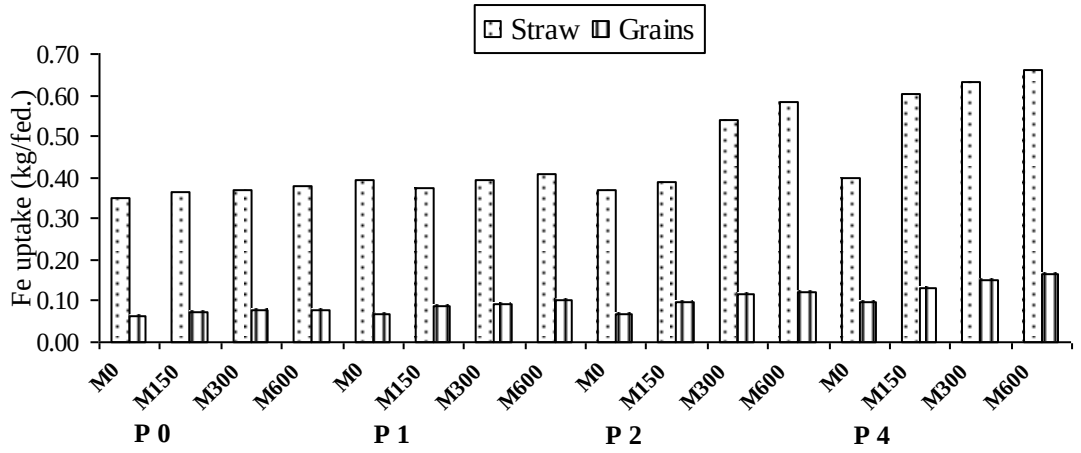

Fig. 3. Effect of the studied treatments on Fe uptake (kg/fed.) of barley straw and grain

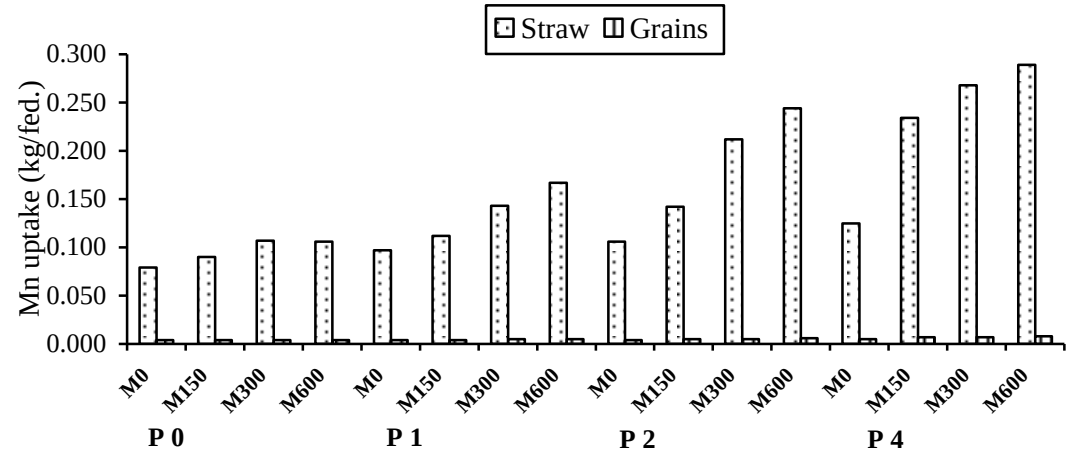

Fig. 4. Effect of the studied treatments on Mn uptake (kg/fed.) of barley straw and grain

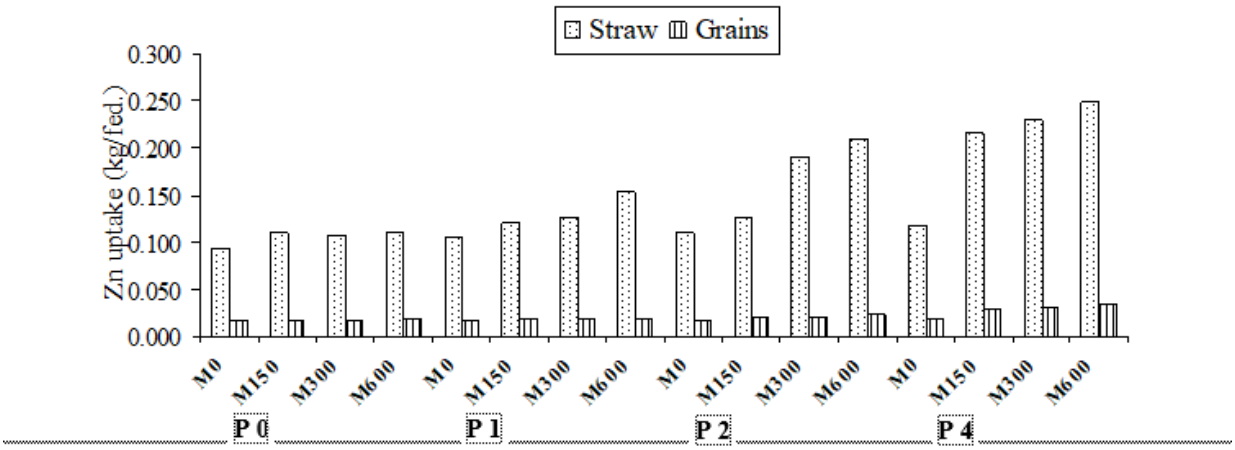

Fig. 5. Effect of the studied treatments on Zn uptake (kg/fed.) of barley straw and grain

CONCLUSIONS

Spraying barley (Giza 123 c.v). by 4 kg P /fed, combined with 600 ppm /fed of mixture (Fe, Mn and Zn), which were very effective in improving grain and straw yields, which recorded 2.2 and 5.3 ton/fed. And gave the highest increases yield parameters (plant height, No. of tillers/ m^2, No. of spikes/m^2 and spike length. Also, this treatment recoded the highest values of nitrogen, potassium, phosphorus, Fe, Mn and Zn as concentration and uptake in both grain and straw of barley plants. It is noticed that, increasing application of P and microelements mixture lead to a significant increases of the studied parameters.

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الملخص العربي

تحسين النمو والانتاجية للشعير المتأثر بالفوسفور والعناصر الصغرى رشا النامى فى أرض جيرية

فتحي عبد الفتاح العزيزي

أقيمت تجربة حقلية خلال الموسم الشتوى ٢٠١٨/٢٠١٩

على محصول الشعير صنف جيزة ١٢٣ فى أرض جيرية تحت نظام الرى السطحى بمحطة بحوث مريوط التابعة لمركز بحوث الصحراء لدراسة تأثير االرش بالفوسفور بمعدل (صفر و ١ و٢ و ٤ كجم فو/ فدان) والرش بمخلوط العناصر الصغرى (الحديد والمجنيز والزنك) بتركيز صفر و ١٥٠ و ٣٠٠ و٦٠٠ جزء فى المليون /فدان) وتم الرش على ثلاث دفعات فى مرحلة التفريع ومرحلة الاستطالة ومرحلة الامتلاء لكل المعاملات.

وكانت أهم النتائج: أن اضافة االفوسفور رشا بمعدل ٤ كجم /فدان والرش بمخلوط العناصر الصغرى بمعدل ٦٠٠ جزء فى المليون أعطت أحسن النتائج وأعلى محصول وهو ٢,٢ و٣,٥ و ٥.٧طن /فدان لكل من محصول الحبوب والقش والمحصول البيولوجى على الترتيب.

كما أعطت أعلى زيادة فى المقاييس المحصولية (ارتفاع النبات وعدد الافرع وعدد السنابل وطول السنبلة)

وأيضا أعطت أعلى قيم لجودة البذر وكانت نسبة البروتين ٦٧,٠ % بالمقارنة بالمعاملات الاخرى.

وكذلك أعطت أعلى قيم للتركيز والممتصن من عناصر النتروجين والفسفور والبوتاسيوم والعناصر الصغرى تحت الدراسة (الحديد والمنجنيز والزنك) فى كل من الحبوب والقش. ولوحظ أن زيادة الاضافة المنفردة لكل من الفوسفورأو مخلوط العناصر الصغرى أدى الى زيادة معنوية فى القياسات التى تمت دراستها وتقديرها.