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EFFECT OF NITROGEN, PHOSPHORUS AND IRON FERTILIZATION ON PRODUCTVITY AND MINERAL CONTENTS OF WHEAT

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ABSTRACT: Wheat fields in Egypt are spatially variable as to soil fertility and crop productivity. The general objective of this study is to determine the relationships between yield, mineral content of wheat with N, P and iron foliar spray rates using the regression analysis of yield data. The study was carried out using N application (190, 285 and 380 Kg N ha^{-1}), P application (0, 15, 31 and 47 Kg P ha^{-1}) and iron foliar spray (without, mineral iron and chelated iron at 0.2 gl^{-1}). Wheat (*Triticum aestivum*, Giza 168 cultivar) was grown at research station of the Desert Research Center, El Quntra Sharq, Eastren North Sinai, Egypt in the 2015-2016 season. The highest grain and straw yields were obtained under 285 Kg N + chelated iron and 31 Kg P ha^{-1}. The highest wheat grain nitrogen uptake was obtained under 285 Kg N + chelated iron and 31 Kg P ha^{-1}. The highest N uptake by wheat straw was obtained under 285 Kg N + chelated iron and 47 Kg P ha^{-1}. The highest P uptake in grains was obtained under 380 kg N ha^{-1} + mineral iron and 31 Kg P ha^{-1}. The highest P uptake in straw was obtained under 285 Kg N ha^{-1} + chelated iron and 31 Kg P ha^{-1}. The highest Fe uptake in grains was obtained under 285 Kg N ha^{-1} + mineral iron and 47 Kg P ha^{-1}. The highest Fe uptake in straw was obtained under 285 Kg N ha^{-1} + mineral iron and 47 Kg P ha^{-1}.

Key words: Grain yield, N and P fertilization, iron foliar, wheat.

INTRODUCTION

Wheat is the first strategic food crop in Egypt. It has maintained its position during that time as the basic staple food for Egyptians. Wheat straw is an important fodder for animals in Egypt. Wheat plants are sometimes exposed to drought stress at different periods of growth. A possible approach to minimize drought stress that induces crop losses, is foliar application with some chemical desiccant on wheat plants.

Nitrogen is a constituent of proteins, enzymes, coenzymes, nucleic acids, phytochromes and chlorophyll. It plays an important role in the biochemical processes of the plant (Grundon *et al.,* 1987). Therefore, it is one of the most required nutrients for wheat. Phosphorus is an essential nutrient required for the growth of wheat with a key role in the structure of cell membranes, DNA and RNA, photosynthesis and respiration (Grant *et al.,* 2001). Plants during their initial stage of growth, need adequate P due to its role in cell division. Thus symptoms of P deficiency are particularly evident during plant early growth stages (Grundon *et al.,* 1987). Mild P deficiency causes stunting while severe deficiency darkens leaves, causes older leaves to brown and die off and reduces tillering, head and grain numbers (Grundon *et al.,* 1987).

Iron is most important for respiration and photosynthesis processes. It plays a vital role in many plant processes such as chlorophyll development, energy transfer, enzymes, proteins synthesis, and nitrogen fixation as well as nucleic acid metabolism (Havlin *et al.,* 2014). The main objective of the current study is to

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asse and evaluate the effect of nitrogen, phosphorus and Fe on soil and wheat plant regarding plant growth and contents of elements especially N, P, K and Fe.

MATERIALS AND METHODS

A field experiment was conducted during season of 2015/2016 at Desert Research Station, El Quntra Sharq, Eastern North Sinai, Egypt. Table 1 shows the properties of the soil where the experiment was conducted. The objective was to study the effect of N, P and Fe fertilization on the yield of wheat (*Triticum aestivum*, Giza 168 cultivar) as well as uptake of nutrients and their content in soil. The treatments were conducted in three replicates using split- split design.

Three rates of N were used as ammonium sulphate (20%N), *i.e.,* 190 (N_1), 285 (N_2) and 380 Kg N ha^{-1} (N_3) added in 3 splits 25, 50 and 25% after 30, 60 and 90 days from sowing, respectively. Four rates of P as ordinary superphosphate (6.8%P), *i.e.,* 0(P_0), 15 (P_1), 31 (P_2) and 47 Kg P. ha^{-1}. (P_3) were added 15 days before cultivation during soil preparates. Two sources of iron were used as foliar spray (Fe sulphat and Fe chelate) $FeSO_4.7H_2O$ (20%Fe) and chelated Fe-IDHA (13% Fe) spray solution was 2 g l^{-1} spray was done three times , *i.e.,* 30, 60 and 90 days after seeding. Irrigation was done weekly. Plant samples were taken at five stages after 30, 60, 90, 120 and 150 days maturity stage (at harvesting time) and the end of the experiment samples of plant materials were ground and wet digested with a mixture of concentrated sulphoric and perchloric acids for nutrient determination according to Thomas *et al.* (1967) and Brennar and Mulvaey (1982). Samples of soil from the depths of 0-30 and 30-60 cm were taken at harvest to determine soil available N, P and K. Determination of the physical and chemical properties of the investigated soil samples prior to at the end of the experiment were performed according to the standard methods outlined by Black *et al.* (1965). Available N was extracted by 2MKCl and determined by microkjeldahl according to Chapman and Pratt (1961). Available K was extracted by 1N NH_4OAC and available P was extracted by 0.5M $NaHCO_3$ solution at pH 8.5 (Olsen *et al*., 1954) and determined using ascorbic acid and ammonium molybdate according to Holman and Elliott (1983). Iron in plant was determined using Atomic Absorption Spectrophotometer.

RESULTS AND DISCUSSION

Wheat Yield

Wheat yield at different stages under nitrogen, Phosphorus fertilization and foliar spray of iron is recorded in Fig. 1. There were positive effects of nitrogen; phosphorus fertilization and iron spray addition on yield of wheat ranged between 547 and 9229 Kg.ha^{-1} at tillring and ripening stages, respectively. The lowest yield of wheat plant was obtained at tillering. The highest wheat yield was obtained at ripening. The indicated results that nitrogen, phosphorus and iron addition increased yield at all growth stages valued as 261, 1037, 1107and 1588% at tillering, jointing, booting, heading and ripening, respectively.

At harvest, wheat yield under nitrogen, phosphorus and iron recorded in Table 2. There were positive effects of nitrogen; phosphorus fertilization and iron spray. The grain yield of wheat ranged between 1.76 and 4.81 Mg ha^{-1}. The lowest grain yield of wheat was obtained by 190 Kg N ha^{-1}. The highest wheat grain yield was obtained under 285Kg N + 31Kg P ha^{-1} and chelated iron spray.

Increasing nitrogen addition from 190 to 285 and 380 Kg N ha^{-1} increased grain yield by 32.4 and 32.8%, respectively. For phosphorus addition, the results indicated that increasing phosphorus addition from 0 to 15, 31 or 47Kg P ha^{-1} increased grain yield 24.4, 55.8 and 33.5%, respectively. For iron sprays, the results indicated that mineral iron and chelated iron increased grain yield by 29.21 and 33.33%, respectively.

The straw yield of wheat ranged between 3.32 and 9.15 Mg ha^{-1}. The lowest straw yield of wheat plant was obtained by 190Kg N ha^{-1} which did not receive phosphorus or iron spray. The highest wheat straw yield was obtained under 285Kg N + 31Kg P ha^{-1} and chelated iron. For nitrogen addition, the results indicated that increasing nitrogen addition from 190 to 285 or 380Kg N ha^{-1}, increased straw yield by 31.7 and 36.6%, respectively. For phosphorus addition,

Table 1. Some physical and chemical characteristics of the experimental site before cultivation

Properties	Value
Physical properties	
Coarse sand	64.1
Fine sand	26.4
Silt	2.7
Clay	6.8
Texture	Sand
Chemical properties	
pH (1:5) Suspension.	8.6
EC (1:5) $dS.m^{-1}$ soil extract	0.61
Avilable mg kg^{-1}	
N	42
P	3.45
K	95
Soluble ions mmole kg^{-1} soil	
Mg^{++}	0.605
Ca^{++}	0.876
Na^{+}	4.340
K^{+}	0.230
SO_4^{--}	0.281
CO_3^{--}	-
HCO_3^{-}	1.77
Cl^{-}	4.00

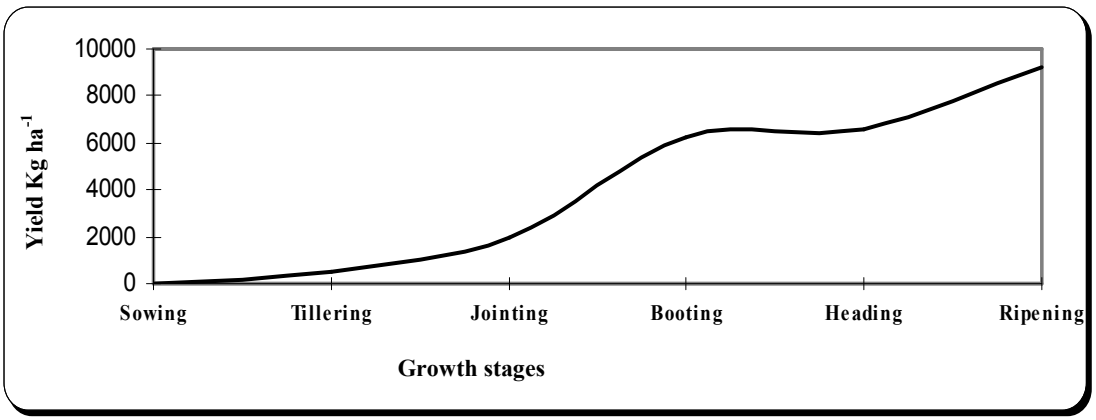

Fig. 1. Yield (Kg ha^{-1}) at different growth stages

Table 2. Grain and straw yields (Mg ha^{-1}) as influenced by application of nitrogen, phosphorus fertilization and iron foliar spray

Nitrogen rate (kg ha^{-1}) (A)	Iron sources (C)	Phosphorus rate (kg ha^{-1}) (B)									
		0	15	31	47	Mean	0	15	31	47	Mean
		Grain yield					Straw yield				
	Without	1.76	2.44	2.77	2.49	2.37	3.32	4.25	5.29	5.20	4.52
190	Min.Fe	2.01	2.78	3.42	2.84	2.76	3.70	4.61	6.10	5.56	4.99
	Chel.Fe	2.06	2.87	3.38	2.99	2.83	3.81	4.88	6.17	5.75	5.15
Mean		1.94	2.70	3.19	2.77	2.65	3.61	4.58	5.85	5.50	4.89
	Without	2.15	2.49	3.41	2.61	2.67	4.08	4.46	5.83	5.39	4.94
285	Min.Fe	2.97	3.77	4.69	3.95	3.85	5.66	6.11	9.14	7.41	7.08
	Chel.Fe	3.24	3.89	4.81	4.08	4.01	6.07	6.28	9.15	7.73	7.31
Mean		2.79	3.38	4.30	3.55	3.51	5.27	5.62	8.04	6.84	6.44
	Without	2.68	2.68	3.77	2.74	2.97	4.24	5.25	7.49	6.68	5.92
380	Min.Fe	2.71	3.57	4.44	4.21	3.73	5.57	6.32	8.79	7.55	7.06
	Chel.Fe	3.04	3.65	4.46	4.27	3.86	5.34	6.45	8.79	7.69	7.07
Mean		2.81	3.30	4.22	3.74	3.52	5.05	6.01	8.36	7.31	6.68
		Mean of Fe treatment									
	Without	2.20	2.54	3.32	2.61	2.67	3.88	4.65	6.20	5.76	5.12
	Min.Fe	2.56	3.37	4.18	3.67	3.45	4.98	5.68	8.01	6.84	6.38
	Chel.Fe	2.78	3.47	4.22	3.78	3.56	5.07	5.87	8.04	7.06	6.51
Mean		2.51	3.13	3.91	3.35	3.22	4.64	5.40	7.42	6.55	6.00
LSD (0.05)		A=0.086		AB= 0.089			A= 0.104		AB=0.208		
		B= 0.052		BC= 0.161			B = 0.121		BC= 0.195		
		C= 0.81		AC= 0.139			C= 0.098		AC= 0.169		
		ABC= 0.279					ABC= 0.338				

the results indicated that increasing phosphorus addition from 0 to 15, 31 or 47Kg P.ha^{-1}, increased straw yield by 16.4, 59.9 and 41.2%, respectively. For iron spray, mineral iron and chelated iron increased straw yield by 24.61 and 27.15%, respectively. The above results are in agreement with those obtained by Jamal and Chaudhary (2007), Silwana *et al*. (2007), Khan *et al*. (2009) and Betric *et al*. (2006).

Nitrogen Uptake by Wheat

The wheat nitrogen uptake at different stages under nitrogen, phosphorus fertilization and Fe foliar spray are shown in Fig. 2. There were positive effects of nitrogen; phosphorus fertilization and iron spray. The nitrogen uptake by wheat ranged between 7.57 and 131.83 Kg ha^{-1} at tillring and ripening stages, respectively. The lowest nitrogen uptake was obtained at tillering

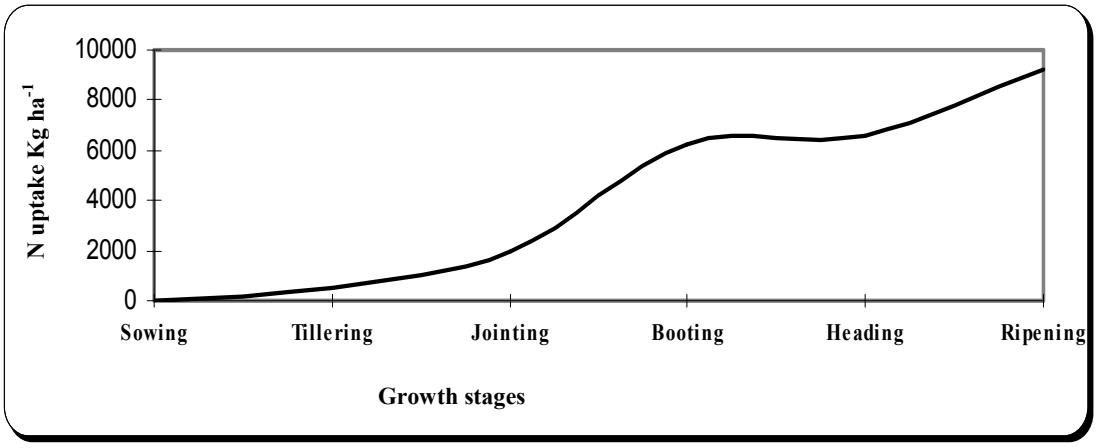

Fig. 2. Nitrogen uptake (Kg ha^{-1}) at different growth stages

stage. The highest wheat nitrogen uptake was obtained at ripening stage. The results indicated that increasing nitrogen, phosphorus and iron increased nitrogen uptake at tillering, jointing, booting, heading and ripening as averaged 337, 731, 1239 and 1641%, respectively.

N uptake at ripening stages is shown in Fig. 2. There were positive effects of applying nitrogen; phosphorus and iron. The N uptake in grains ranged between 48.13 and 125.79 Kg ha^{-1} (Table 3). The lowest was obtained by 190Kg N ha^{-1} and the highest was obtained by 285Kg N + 31 Kg P ha^{-1} + chelated iron spray.

For nitrogen addition, the results indicated that increasing nitrogen addition from 190 to 285 or 380kg N ha^{-1} increased grain nitrogen uptake by averages of 44.4 and 35.1%, respectively. For phosphorus addition, the results indicated that increasing phosphorus addition from 0 to 15, 31 or 47Kg P ha^{-1} increased grain nitrogen uptake by an average of 25.8, 49.4 and 39.9%, respectively. For iron sprays either mineral iron spray or chelated iron spray; the results indicated that mineral iron or chelated iron increased grain nitrogen uptake by 34.35 and 35.28, respectively.

The straw nitrogen uptake of wheat ranged between 27.92 and 89.23Kg ha^{-1}. The lowest was obtained by 190Kg N ha^{-1} without addition both of phosphorus and iron and the highest was obtained under 285Kg N + 47Kg P ha^{-1} + chelated iron. For nitrogen addition, the results indicated that increasing nitrogen addition from 190 to 285 or 380Kg N ha^{-1} increased straw nitrogen uptake by averages of 48.5 and 48.8%, respectively. For phosphorus addition, the results indicated that increasing phosphorus addition from 0 to 15, 31 or 47Kg P ha^{-1}, increased straw nitrogen uptake by averages of 12.7, 30.3 and 38.02%, respectively. For iron sprays results indicated that mineral iron and chelated iron increased straw nitrogen uptake by 26.70 and 37.49, respectively. The above results agree with those obtained by Betric *et al*. (2006), Kegang (2005), Jamal and Chaudhary (2007) and Khan *et al.* (2009).

Phosphorus Uptake by Wheat

Values of phosphorus uptake are recorded in Fig. 3. There were positive effects of nitrogen; phosphorus fertilization and iron spray. The phosphorus uptake of wheat ranged between 1.28 and 16.49 Kg ha^{-1}. The lowest phosphorus uptake of wheat plant was obtained at tillering stage. The highest wheat phosphorus uptake was obtained at ripening stage. Increasing nitrogen, phosphorus and iron addition increased phosphorus uptake by advancing growth stages at tillering, jointing, booting, heading and ripening by averages of 176.56, 358.59, 528.91 and 1188.28%, respectively.

Table 3. Grain and straw nitrogen uptake (Kg ha^{-1}) as influenced by application of nitrogen, phosphorus fertilization and iron foliar spray

Nitrogen rate (kg ha^{-1}) (A)	Iron sources (C)	Phosphorus rate (kg ha^{-1}) (B)									
		0	15	31	47	Mean	0	15	31	47	Mean
		Grain					Straw				
190	Without	48.52	63.94	58.07	72.72	60.81	27.92	31.72	33.96	40.69	33.57
	Min.Fe	58.27	67.46	88.28	78.78	73.20	30.25	39.77	35.59	41.56	36.79
	Chel.Fe	48.13	72.38	85.82	73.00	69.83	33.75	46.73	49.69	40.24	42.60
Mean		51.64	67.93	77.39	74.83	67.95	30.64	39.41	39.74	40.83	37.66
285	Without	54.65	60.78	74.00	66.02	63.86	42.85	37.45	37.44	52.91	42.66
	Min.Fe	72.31	92.33	114.79	104.71	96.03	48.82	49.18	68.24	63.14	57.34
	Chel.Fe	80.86	88.00	125.79	99.11	98.44	49.58	51.27	81.13	89.23	67.80
Mean		69.27	80.37	104.86	89.95	86.11	47.08	45.97	62.27	68.42	55.93
380	Without	66.99	65.96	92.30	74.24	74.87	36.60	41.05	68.16	42.21	47.01
	Min.Fe	66.96	96.97	106.51	125.07	98.87	47.46	55.26	74.85	70.48	62.01
	Chel.Fe	76.17	112.53	110.45	107.59	101.69	46.09	57.19	71.85	60.99	59.03
Mean		70.04	91.82	103.09	102.30	91.81	43.39	51.17	71.62	57.89	56.02
		Mean of Fe treatment									
	Without	56.72	63.56	74.79	71.00	66.52	35.79	36.74	46.52	45.27	41.08
	Min.Fe	65.84	85.58	103.19	102.85	89.37	42.17	48.07	59.56	58.39	52.05
	Chel.Fe	68.39	90.97	107.35	93.23	89.99	43.14	51.73	67.56	63.48	56.48
Mean		63.65	80.04	95.11	89.03	81.96	40.37	45.51	57.88	55.72	49.87
LSD (0.05)		A= 3.31		AB= 3.96			A= 4.45		AB= 6.35		
		B= 2.29		BC= 7.10			B= 3.67		BC= ns		
		C= 3.55		AC= 6.15			C= 4.63		AC= 8.03		
		ABC= 12.30					ABC= ns				

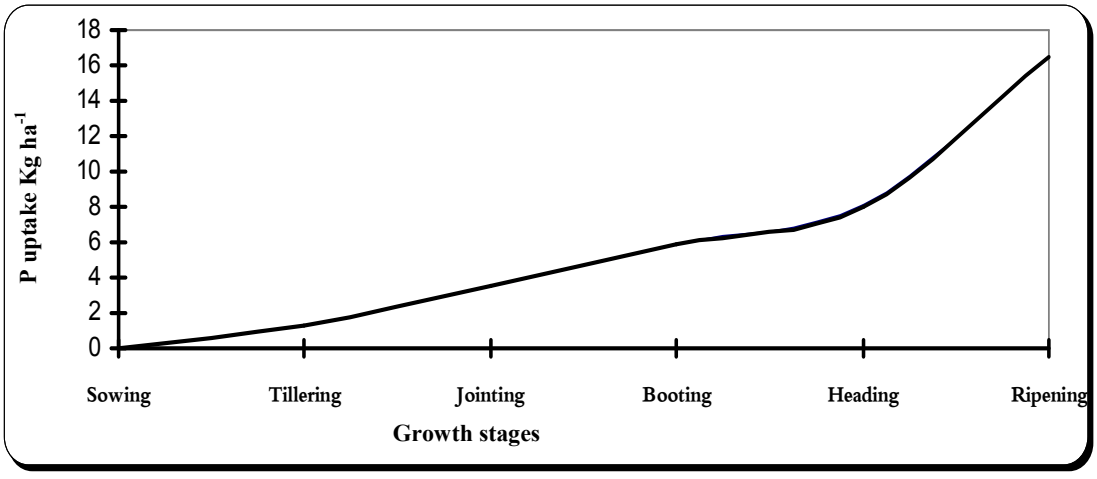

Fig. 3. Phosphorus uptake (Kg ha^{-1}) at different growth stages

P uptake at various stages of wheat growth is shown in Fig. 3 phosphorus uptake in grains and straw is shown in Table 4. Phosphorus uptake in grains ranged between 9.08 and 25.46 Kg ha^{-1}. The lowest was obtained by 190Kg N ha^{-1}. The highest was obtained under 380 Kg N ha^{-1} + 31 Kg P.ha^{-1} + mineral iron. For nitrogen addition, the results indicated that increasing nitrogen addition from 190 to 285 or 380Kg N ha^{-1} increased grain phosphorus uptake by averages of 5.6 and 24.5%, respectively. For phosphorus addition, the results indicated that increasing phosphorus addition from 0 to 15, 31 or 47Kg P.ha^{-1}, increased grain phosphorus uptake by averages of 19.6, 57.4 and 45.7%, respectively. For iron sprays the results indicated that using mineral iron and chelated iron increased grain phosphorus uptake by 36.36 and 33.46%, respectively.

P uptake in straw ranged between 2.76 and 11.64 Kg ha^{-1}. The lowest straw was obtained by 190 Kg N ha^{-1}. The highest was obtained under 285 Kg N ha^{-1} + 31 Kg P ha^{-1} and chelated iron. For nitrogen addition, the results indicated that increasing nitrogen addition from 190 to 285 or 380Kg N ha^{-1} increased straw phosphorus uptake averages of 35.8 and 37.9%, respectively. For phosphorus addition, the results indicated that increasing phosphorus addition from 0 to 15, 31 or 47 Kg P.ha^{-1} increased straw phosphorus uptake by averages of 8.9, 85.2 and 49.6%, respectively. For iron sprays the results indicated that mineral iron and chelated iron increased straw phosphorus uptake by 31.37 and 33.68%, respectively. The above results agreed with those obtained by Betric *et al*. (2006) and Khan *et al. (*2009).

Potassium Uptake by Wheat

The wheat potassium uptake under nitrogen, phosphorus and iron spray recorded in Fig. 4 and Table 5. Potassium uptake ranged between 12.08 and 74.73 Kg ha^{-1}. The lowest was obtained at tillering stage. The highest wheat was obtained at ripening stage. Applying nitrogen, phosphorus and iron increased K uptake at stages of tillering, jointing, booting, heading and ripening by averages of 268.79, 537.75, 1026.49 and 518.63%, respectively. There were positive effects of nitrogen; phosphorus fertilization and iron spray addition. The grain potassium uptake of wheat ranged between 8.53 and 26.00kg.ha^{-1}. The lowest grain potassium uptake of wheat plant was obtained by 380kg N ha^{-1}. The highest wheat grain potassium uptake was obtained under 285 kg N ha^{-1} +31 Kg P ha^{-1} + chelated iron spray. Increasing nitrogen addition from 190 to 285 or 380 kg N ha^{-1} increased grain potassium uptake br averages of 18.7 and 28.4%, respectively.

Increasing phosphorus addition from 0 to 15, 31 or 47kg P ha^{-1} increased grain potassium uptake by averages of 37.7, 89.0 and 69.1%, respectively. Mineral iron and chelated iron increased grain potassium uptake by 33.05 and 22.14%, respectively.

The straw potassium uptake of wheat ranged between 27.69 and 104.72 kg ha^{-1}. The lowest was obtained by 190 kg N ha^{-1}. The highest was obtained under 285 kg N ha^{-1} +31 Kg P ha^{-1}+ chelated iron spray. For Nitrogen addition, the results indicated that increasing nitrogen addition from 190 to 285 and 380 kg N ha^{-1} increased straw potassium uptake by averages of 53.1 and 72.9%, respectively.

For phosphorus addition, the results indicated that increasing phosphorus addition from 0 to 15, 31 or 47Kg P ha^{-1} increased straw potassium uptake by averages of 14.3, 86.7 and 48.5%, respectively. For iron sprays the results indicated that using mineral iron and chelated iron increased straw potassium uptake by 22.21 and 25.11%, respectively.

Iron Uptake by Wheat

The wheat iron uptake is shown in Table 6. There were positive effects of nitrogen phosphorus fertilization and iron spray. The grain iron uptake of wheat ranged between 0.02 and 0.80 Kg.ha^{-1}. The lowest grain iron uptake of wheat plant was obtained by 190 Kg N ha^{-1}. The highest wheat grain iron uptake was obtained under 285 Kg N ha^{-1} + 31 Kg P ha^{-1} and mineral iron. For nitrogen addition, the results indicated that increasing nitrogen addition from 190 to 285 and 380 Kg N.ha^{-1} increased grain iron uptake by averages of 110.5 and 42.11%, respectively. For phosphorus addition, the results indicated that increasing phosphorus addition from 0 to 15, 31 or 47Kg P.ha^{-1} increased grain iron uptake by an average of 56.25, 168.75 and 100.0%, respectively. Using mineral iron and chelated iron increased grain iron uptake by averages of 514 and 424%, respectively.

Table 4. Grain and straw phosphorus uptake (Kg ha^{-1}) as influenced by application of nitrogen, phosphorus fertilization and iron foliar spray

Nitrogen rate (kg ha^{-1}) (A)	Iron sources (C)	Phosphorus rate (Kg ha^{-1}) (B)									
		0	15	31	47	Mean	0	15	31	47	Mean
		Grain					Straw				
190	Without	10.33	13.47	15.87	12.69	13.09	3.05	3.65	5.06	5.05	4.20
	Min.Fe	11.23	13.26	23.39	18.18	16.52	2.76	4.33	6.82	5.93	4.96
	Chel.Fe	9.08	14.44	21.78	12.67	14.49	3.76	4.03	7.30	3.89	4.74
Mean		10.21	13.72	20.35	14.51	14.70	3.19	4.00	6.39	4.95	4.64
285	Without	9.47	11.07	15.35	11.67	11.89	3.80	3.76	5.25	4.91	4.43
	Min.Fe	12.94	15.99	16.40	21.90	16.81	5.60	5.57	9.17	7.23	6.89
	Chel.Fe	14.06	16.40	21.97	19.00	17.86	6.53	4.68	11.64	7.44	7.57
Mean		12.16	14.49	17.90	17.52	15.52	5.31	4.67	8.69	6.53	6.30
380	Without	11.35	14.26	16.74	15.18	14.38	4.19	3.91	8.79	5.51	5.60
	Min.Fe	14.81	16.16	25.46	24.99	20.36	4.12	5.46	8.24	9.64	6.87
	Chel.Fe	16.67	16.55	25.25	22.22	20.17	4.43	6.29	8.53	7.65	6.73
Mean		14.28	15.65	22.48	20.80	18.30	4.25	5.22	8.52	7.60	6.40
Mean of Fe treatment											
	Without	10.38	12.93	15.98	13.18	13.12	3.68	3.77	6.37	5.16	4.75
	Min.Fe	13.00	15.13	21.75	21.69	17.89	4.16	5.12	8.08	7.60	6.24
	Chel.Fe	13.27	15.80	23.00	17.96	17.51	4.91	5.00	9.16	6.33	6.35
Mean		12.22	14.62	20.24	17.61	16.17	4.25	4.63	7.87	6.36	5.78
LSD (0.05)		A= 0.581		AB= 1.09			A= 0.193		AB= 0.429		
		B= 0.632		BC= 1.24			B= 0.248		BC= 0.548		
		C= 0.618		AC= 1.07			C= 0.274		AC= 0.476		
		ABC= 2.143					ABC= 0.950				

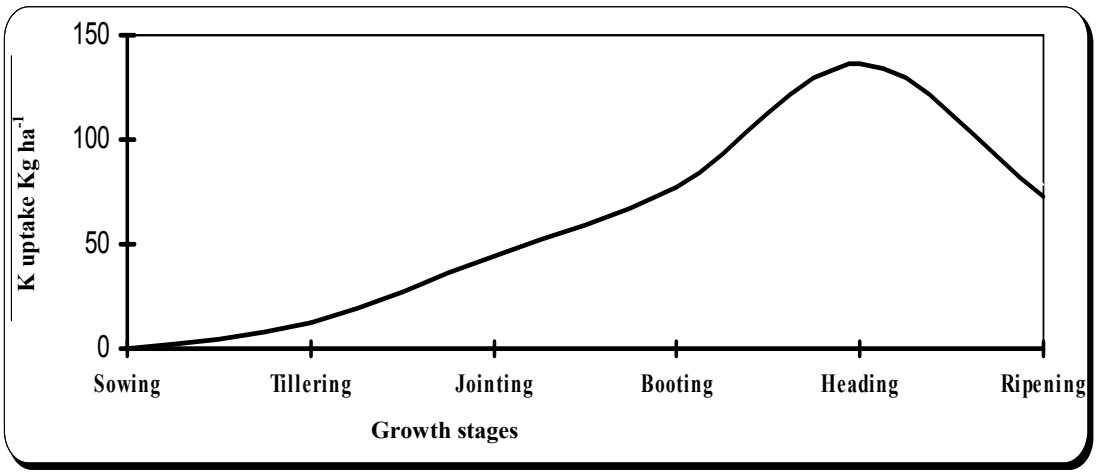

Fig. 4. Potassium uptake (Kg ha^{-1}) at different growth stages

Table 5. Grain and straw potassium uptake (Kg ha^{-1}) as influenced by application of nitrogen, phosphorus fertilization and micronutrients foliar spray

Nitrogen rate (kg ha^{-1}) (A)	Iron sources (C)	Phosphorus rate (Kg ha^{-1}) (B)									
		0	15	31	47	Mean	0	15	31	47	Mean
		Grain					Straw				
190	Without	9.45	12.30	14.74	15.01	12.87	27.69	24.55	47.24	47.82	36.82
	Min.Fe	10.49	13.45	19.14	16.82	14.98	37.69	44.05	51.52	42.62	43.97
	Chel.Fe	8.54	12.84	15.12	12.91	12.35	32.65	18.60	60.67	50.76	40.67
	Mean	9.49	12.86	16.33	14.91	13.40	32.68	29.07	53.14	47.07	40.49
285	Without	10.02	11.47	16.03	12.54	12.51	41.91	43.56	64.43	45.30	48.80
	Min.Fe	10.41	16.96	20.80	21.28	17.36	55.32	58.41	90.35	65.65	67.43
	Chel.Fe	11.98	16.80	26.00	16.70	17.87	55.96	44.81	104.72	73.62	69.78
	Mean	10.80	15.07	20.94	16.84	15.91	51.06	48.92	86.50	61.52	62.00
380	Without	10.71	11.71	21.06	12.12	13.90	42.11	52.08	91.16	68.16	63.38
	Min.Fe	8.53	17.34	22.56	31.42	19.96	52.64	67.26	91.20	71.69	70.70
	Chel.Fe	13.61	16.15	21.70	19.64	17.77	30.77	77.17	102.20	93.76	75.97
	Mean	10.95	15.07	21.77	21.06	17.21	41.84	65.50	94.85	77.87	70.02
		Mean of Fe treatment									
	Without	10.06	11.83	17.28	13.22	13.10	37.24	40.06	67.61	53.76	49.67
	Min.Fe	9.81	15.92	20.84	23.17	17.43	48.55	56.57	77.69	59.99	60.70
	Chel.Fe	11.38	15.26	20.94	16.42	16.00	39.79	46.86	89.20	72.71	62.14
	Mean	10.41	14.33	19.68	17.60	15.51	41.86	47.83	78.16	62.15	57.50
	LSD (0.05)	A= 0.769		AB= 0.836			A= 1.59		AB= 4.70		
		B= 0.483		BC= 0.994			B= 2.71		BC= 3.87		
		C= 0.497		AC= 0.861			C= 1.93		AC= 3.35		
		ABC= 1.72					ABC= 6.69				

Table 6. Grain and straw iron uptake (Kg ha^{-1}) as influenced by application of nitrogen, phosphorus fertilization and micronutrients foliar spray

Nitrogen rate (kg ha^{-1}) (A)	Iron sources (C)	Phosphorus rate (Kg ha^{-1}) (B)									
		0	15	31	47	Mean	0	15	31	47	Mean
		Grain					Straw				
190	Without	0.02	0.04	0.08	0.06	0.05	0.06	0.17	0.30	0.24	0.20
	Min.Fe	0.12	0.24	0.48	0.37	0.30	0.46	0.94	1.34	1.09	0.96
	Chel.Fe	0.07	0.20	0.36	0.27	0.22	0.41	0.73	1.44	1.04	0.90
	Mean	0.07	0.16	0.31	0.24	0.19	0.31	0.61	1.03	0.79	0.69
285	Without	0.04	0.06	0.13	0.09	0.08	0.17	0.20	0.37	0.33	0.27
	Min.Fe	0.35	0.54	0.80	0.60	0.57	1.03	1.62	2.53	1.91	1.77
	Chel.Fe	0.37	0.48	0.79	0.54	0.55	0.97	1.57	2.41	1.95	1.73
	Mean	0.26	0.36	0.57	0.41	0.40	0.72	1.13	1.77	1.40	1.25
380	Without	0.04	0.05	0.11	0.08	0.07	0.10	0.19	0.46	0.32	0.27
	Min.Fe	0.20	0.32	0.64	0.53	0.42	0.81	1.51	2.20	1.84	1.59
	Chel.Fe	0.22	0.29	0.44	0.35	0.33	0.72	1.03	1.68	1.43	1.22
	Mean	0.15	0.22	0.40	0.32	0.27	0.54	0.91	1.45	1.19	1.03
		Mean of Fe treatment									
	Without	0.03	0.05	0.11	0.08	0.07	0.11	0.19	0.38	0.30	0.24
	Min.Fe	0.22	0.37	0.64	0.50	0.43	0.77	1.36	2.02	1.61	1.44
	Chel.Fe	0.22	0.32	0.53	0.39	0.37	0.70	1.11	1.85	1.47	1.28
	Mean	0.16	0.25	0.43	0.32	0.29	0.52	0.89	1.42	1.13	0.99
	LSD (0.05)	A= 0.049		AB= ns			A= 0.088		AB = 0.091		
		B= 0.036		BC= 0.066			B = 0.053		BC= 0.104		
		C= 0.033		AC= 0.057			C= 0.052		AC= 0.090		
		ABC= ns					ABC= 0.181				

The straw iron uptake by wheat ranged between 0.06 and 2.53 Kg ha^{-1}. The lowest was obtained by 190 Kg N ha^{-1}. The highest was obtained by 285 Kg N ha^{-1} + 31 Kg P ha^{-1} + mineral iron. For nitrogen addition, the results indicated that increasing nitrogen addition from 190 to 285 or 380 Kg N ha^{-1} increased straw iron uptake by averages of 81.2 and 49.3%, respectively. For phosphorus addition, the results indicated that increasing phosphorus addition from 0 to 15, 31 or 47 Kg P ha^{-1} increased straw iron uptake by averages of 71, 173 and 117%, respectively.

Iron spray treatments showed that mineral iron spray and chelated iron increased iron uptake by 500 and 533%, respectively. This indicates that iron plays important plant functions. These agree with findings reported by (Pervaiz *et al.,* 2003; Eskandari, 2011; Havlin *et al.,* 2014).

Some Chemical Properties of Soil

Results in Table 7 show that addition of ammonium sulphate decreased soil pH, while increased soil EC. The pH values in the 2nd depth (30-60 cm) were higher than those found in the 1st depth (0-30 cm). Increased application of superphosphate led to decreased soil pH, while increased EC. Increased application of ammonium sulphat and superphosphate increased the extractable amounts of N, P and K. These results agree with Lyamuremye *et al*. (1996),

Table 7. Effect of nitrogen and phosphorus fertilization and iron on some chemical characteristics in soil after harvesting wheat

Nitrogen rates Kg ha^{-1}	Phosphorus rates Kg ha^{-1}	0-30 cm					30-60 cm				
		(1:5) Ext.		Available			(1:5) Ext.		Available		
		pH	EC dSm^{-1}	N	P	K	pH	EC dSm^{-1}	N	P	K
190	0	8.06	0.31	42	6.87	65.6		0.10	28	3.96	46.0
	15	8.05	0.32	42	7.53	211.6	8.41	0.12	28	6.72	48.8
	31	8.04	0.32	42	7.86	131.2	8.35	0.13	35	9.78	50.8
	47	7.83	0.34	49	9.12	131.2	8.37	0.13	42	9.96	51.4
285	0	7.89	0.35	56	9.96	132.4	8.06	0.13	42	3.48	55.4
	15	7.89	0.35	70	10.56	216.8	8.55	0.14	49	8.25	56.6
	31	7.94	0.36	70	11.07	207.0	8.26	0.14	49	9.81	55.8
	47	7.94	0.39	84	13.92	254.6	8.26	0.14	56	10.98	58.4
380	0	7.83	0.44	91	8.88	221.6	8.13	0.18	56	4.11	59.2
	15	7.84	0.44	98	10.83	247.8	7.95	0.21	77	5.85	59.6
	31	7.98	0.52	112	11.43	216.8	7.92	0.20	91	7.14	97.6
	47	7.94	0.44	126	12.09	220.2	7.98	0.24	98	9.39	72.0

Stuart and Sumner (1997), Gaber and Dahdoh (1999), Zebarth *et al.* (1999) and El-Maghraby (2002).

Conclusion

Results indicates that the application of treatment 285 Kg N + 31 P ha^{-1} and chelated iron was giving the highest value for each of grain and straw yields at 4.81 and 9.15 Mg ha^{-1}, respectively.

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تأثير التسميد بالنيتروجين والفوسفور والحديد على الإنتاجية والمحتوى المعدني للقمح

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أجريت هذه الدراسة على محصول القمح بمحطة بحوث القنطرة شرق التابعة لمركز بحوث الصحراء، خلال موسم الزراعة ٢٠١٥-٢٠١٦ وكان الهدف من البحث هو تقييم العلاقة بين تعظيم الانتاجية والمحتوى المعدنى للقمح. وذلك بتسميد القمح بكلا من النيتروجين بمعدلات: ٣٨٠،٢٨٥،١٩٠ كجم ن/هكتاروالتى تم اضافتها بنسب ٢٥:٥٠:٢٥% بعد ٩٠،٦٠،٣٠ يوم من الزراعة على التوالى، والتسميد الفوسفاتى عند تجهيز الارض للزراعة بالمستويات صفر، ١٥ ، ٣١ و٤٧ كجم فو/هكتار، وإضافة الحديد رشا على النباتات فى صورة كبرتات حديدوز أو الحديد المخلبى IDHA-Fe بمعدلات (٠، ٠,٢%) والتى تم رشها ثلاث مرات عقب التسميد النيتروجينى، أكدت النتائج أن أفضل محصول حبوب وقش كان٤,٨١ و٩,١٥ ميجا جرام/هكتار، تم الحصول علية من المعاملة ٢٨٥كجم ن/هكتار+٣١ كجم فو/هكتار+ ٠,٢% IDHA-Fe، أعطت المعاملة ٢٨٥كجم ن/هكتار+٣١ كجم فو/هكتار+ ٠,٢% IDHA-Fe أعلى كمية ممتصة من النيتروجين بالحبوب بينما كانت المعاملة ٢٨٥ كجم ن/هكتار+١٠٧كجم فو/هكتار+ ٠,٢% IDHA-Fe هى الأعلى فى كمية النيتروجين الممتص بالقش، أعطت المعاملة ٣٨٠كجم ن/هكتار+٣١ كجم فو/هكتار+ ٠,٢% Mineral-Fe أعلى كمية ممتصة من الفوسفور بالحبوب، بينما أعطت المعاملة ٢٨٥كجم ن/هكتار+٣١ كجم فو/هكتار+ ٠,٢% IDHA-Fe أعلى كمية ممتصة من الفوسفور بالقش، أعطت المعاملة ٢٨٥كجم ن/هكتار+٤٧ كجم فو/هكتار+ ٠,٢% Mineral-Fe أعلى كمية ممتصة من الحديد بالحبوب بينما أعطت المعاملة ٢٨٥كجم ن/هكتار + ٤٧ كجم فو/هكتار+ ٠,٢% Mineral-Fe أفضل كمية حديد ممتصة بالقش.

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