Minufiya J. Agric. Res. Vol.38 No. 2(1): 327-336 (2013) "http://www.mujar.net"

BIOCHEMICAL STUDIES ON THE INFLUENCE OF POTASSIUM FERTILIZER AND FOLIAR APPLICATION OF MICRONUTRIENTS (BORON-MOLYBDENUM) ON CARBOHYDRATE FRACTIONS OF WHEAT PLANTS AND GRAINS

M.A. Hammam[(1)], A.A. Sakr[(1)]; A.A. Darwish[(2)] and Hanan M. Abu Elfotoh[(2)]
[(1)] Agric. Biochemistry Dept., Fac. of Agric., Minufiya Univ.
[(2)] Soil, Water and Emvironment Res. Inst., Agric. Res. Center.

(Received: Dec. 29, 2012)

ABSTRACT: *Two field experiments were carried out using wheat plants (Cultivar Gemmeiza-9) at the experimental farm of Gemmeiza Agriculture Research Station, during two successive winter seasons 2008-2009 and 2009-2010. The effect of three levels of potassium fertilizer (0, 24 and 48 kg potassium/fed) and foliar application of the micronutrients (boron-molybdenum) at concentrations (0, 100 and 200 ppm) on carbohydrate fraction of wheat plants was studied.*
The obtained data indicated that increasing potassium fertilizer levels, increased carbohydrate fractions significantly. Carbohydrate fractions increased significantly with increasing micronutrients concentrations (boron and molybdenum) from 0 up to 200 ppm.

Key words: *Wheat, Potassium fertilizer, Micronutrients (boron-molybdenum), Carbohydrate fractions.*

INTRODUCTION

Wheat represents one of the major sources of food all over the world and the most important cereal crop in Egypt. Potassium (K) is one of essential nutrients required for plant growth and reproduction. It is classified as a macronutrients.

potassium is not a constituent of any plant structures or compounds, it plays apart in many important regulatory roles in the plant. It is essential in nearly all processes needed to sustain plant growth and reproduction. Potassium plays a vital role in : Increasing photosynthesis and carbohydrates synthesis and translocation of photosynthates and carbohydrates, protein synthesis, activation of plant enzymes, control of ionic balance regulation of plant stomata and water use, improve the tolerance of plants to stress and suitable amount of K can improve crop quality.

Micronutrients play on important role in plant metabolism, as activators co-factor in all vital processes of plant life.

Boron and Molybdenum are anecessary micronutrients because plants require it in smaller amounts than the macronutrients.

Boron; essential for germination, sugar metabolism and transport of carbohydrates through cell membrane.

Molybdenum has several functions in plant growth, plants require aconstant and continuous supply of Mo for normal assimilation of N, important for nitrate reductase activity in all plants, Mo is also acomponent of the enzyme nitrogenase, Mo required in N fixation N_2 to NH_3, play role in P utilization and Mo is required in the synthesis of ascorbic acid.

Many investigators reported that increasing potassium fertilization levels significantly increased carbohydrate fractions of wheat plants. Rui *et al*., (2003) indicated that potassium application to wheat plants increased soluble sugar content of wheat plants (Wang *et al*., 2003, Al-Moshileh and Errebi, 2004; Amal *et al*., 2006 and Mazvila *et al*., 2007) and Maqsood *et al*., 2008; applied potassium fertilizer on maize at rates of zero and 200 kg/ha, increased total soluble sugars on maize compared to the control, (Laila and Elbordiny, 2009) soaked seeds of wheat (cv. Sakha 68) in two concentrations 50 and 100 ppm potassium humate for different periods 12, 24 and 36 hours, they observed that there were significant increase carbohydrate content of treated plants, (Heidari and Jamshid, 2010; Banerjee *et al.,* 2012 and Liu *et al.,* 2012) fertilized sweet potato (Beijing 553) by potassium fertilizer at rates of zero and 24 g K_2O, application of potassium increase the content of soluble sugars and its components, at the harvest, the contents of soluble sugar increased by 13.52% compared with the control. (Gao and Chen, 1990; Picchioni *et al.,* 1991; Rao and Sahu, 1991 and Sharma *et al.,* 1991) sprayed durum wheat cv. DWL-5023 with 5, 10, 20 or 40 ppm boric acid at anthesis and one week after anthesis, grain sugar contents increased by boric acid sprays compared with the control. (Droba, 1993 and Yan *et al.,* 2003), investigated the effect of boron at rates (0, 0.3, 1 and 10 micro mol/L) on wheat plants in a solution culture experiment. The resulted showed that the soluble sugar content in stems was higher in 0.3 micro mol B/L treatments. (Dwivedi *et al.,* 1993 and Chengxiao *et al.*, 1998; Liwenxue *et al.,* 2001) in a pot experiment studied the effect of Mo on winter wheat in yellow brown soil, the soil was treated with 0.00, 0.01, 0.02, 0.04, 0.08, 0.16, 0.32, 0.64, 1.28 and 2.56 mg Mo/kg to make available Mo content of soils, content of soluble sugars increased with increasing content of Mo on soil.

The aim of this work was to investigate the effect of different rates of K and different concentrations of micronutrients (boron and molybdenum) on carbohydrate content in wheat plants .

MATERIALS AND METHODS

The field experiments were carried out during the two successive seasons 2008-2009 and 2009-2010 at the experimental farm of Gimmeiza, Agricultural Research Station (Middle Delta, Egypt).

The mechanical and chemical analysis of the used soil are presented in Table (1). Particle size distribution was carried out using the method of Piper (1950). Calcium carbonate was determined using collin's calcimeter according to Wright (1939). Organic matter was assayed according to Walkley Method (1947). Total available nitrogen was determined using the micro-kjeldahl method as described by Chapman and Pratt (1961).

Table (1): Mechanical and chemical analysis of the experimental soil.

Parameter	Value	
	First season	Second season
1- Mechanical analysis:		
Coars sand	1.60%	1.50%
Fine sand	12.91%	14.4%
Silt	37.23%	35.9%
Clay	40.82%	43.0%
$CaCo_3$	3.90%	3.2%
Organic matter	1.57%	1.98%
Texture class	Silty clay loam	
2- Chemical analysis:		
Available nitrogen	33 ppm	35 ppm
Available phosphorous	8 ppm	8.8 ppm
Available potassium	420 ppm	440 ppm
Available Boron	0.10 ppm	0.12 ppm
Available molybdenum	0.08 ppm	0.07 ppm
Soil reaction (pH) (in:2.5 soil suspention)	8	8

Potassium was determined using flam photometric method described by Piper (1938). Phosphorus was determined according to Chapman and Pratt (1961). Avilable B was determine Bingham (1982). Available Mo was determine using Inductively Coupled Spectrometry Plasma (ICP) Modle Ultima 2- Jobin Yvon. pH value was measured in the soil past using Bechman pH meter.

Wheat seeds (cultivar Gimmeiza-9) used in this study was obtained from the wheat Research Department, Agricultural Research Center, Ministry of Agriculture, Egypt.

The wheat seeds were sown on December 1st in the two seasons under study. Split plot design was used with three replicates. The area of each experimental plot was 10.5 m^2 (3 x 3.5 m). The experimental included three treatments at mean plots occupied by different potassium fertilization rates as follow: 0, 24 and 48 kg potassium /fed. The potassium fertilizer form was potassium sulphate (48% K_2O). Sub plots occupied by micronutrients (boron and Molybdenum) as follow: 0 ppm micronutrients, 100 ppm boron, 200 ppm boron, 100 ppm molybdenum and 200 ppm molybdenum by Katyal and Randhawa (FAO, 1983). The micronutrients, boron as boric acid H_3BO_3 and molybdenum as ammonium molybdate $(NH_4)_6$ MO_7 O_{24} $_4H_2O$. The amounts of potassium fertilizer were added in the first irrigation, the amounts of phosphorus and nitrogen fertilizer were added with recommended doses. The micronutrients were applied twice as afoliar spray the first one was applied at 49 days after sowing, the second spray was applied one week from the first one.

Samples of wheat plants were taken from each treatment at two different stages of growth. The first sample was taken after 2 weeks from the final micronutrients spray. The second one was taken after one month from the first sample.

Determination of carbohydrate fractions: Reducing and total soluble sugars as well as total carbohydrates were determined in shoots, grains and straw using picric acid method according to Thomes and Dutcher (1924).

All collective data were statistically analysed according to the procedure described by Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

Data concerning the effect of different levels of potassium fertilizer on carbohydrate fractions in wheat plants in the two seasons of study are illustrated in Tables (2, 3, 4, 5, 6 and 7). Data showed that all fractions were significantly affected by the potassium fertilizer levels added to wheat plants, where the effect was clear in both seasons. Generally, increasing potassium fertilizer levels to plants, increased the content of carbohydrate fractions in wheat. Total hydrolysable carbohydrates (T.H.C) in shoots, grains and straw are recorded in Table (1 and 4). Data showed that highest level of potassium fertilizer (48 kg potassium/fed) gave the highest T.H.C percentage, while the zero kg potassium/fed (control plants) gave the lowest T.H.C percentage.

Results of total soluble carbohydrates, (T.S.C) presented in Tables (1 and 4) indicate that T.S.C were significantly affected by potassium fertilizer levels in the two seasons of the study. Non-soluble carbohydrates (N.S.C) percentage increased with increasing potassium fertilizer levels Tables (1 and 4).

Reducing and non-reducing sugars, data are shown in Tables (1 and 4). The lowest value resulted from untreated plants with potassium fertilizer, while adding 48 kg potassium/fed produced the maximum percentage of reducing and non-reducing sugars of wheat plants in the two seasons. Generally, increasing potassium fertilizer levels increased the levels of carbohydrate fractions. Similar results were reported by Rui *et al.*, (2003), Wang *et al.*, (2003), Al-Moshileh and Errebi (2004), Amal *et al.*, (2006); Heidari and Jamshid (2010), Banerjee *et al.*, (2012) and Liu *et al.*, (2012).

Table (2): Effect of potassium fertilizer levels on carbohydrate fractions percentage in wheat plants (as glucose gm/100 gm sample)

Seasons	2008-2009									
Days after sowing	70 days					100 days				
Treatments	T.H.C	T.S.C	N.S.C	R.S.	N.R.S	T.H.C	T.S.C	N.S.C	R.S.	N.R.S
0kg K/fed(control)	25.53	12.57	12.96	4.63	7.94	30.47	14.76	15.71	4.84	9.92
24 kg K/fed	26.40	12.94	13.46	4.93	8.02	31.48	15.31	16.17	5.25	10.06
48 kg K/fed	27.16	13.37	13.79	5.22	8.15	32.48	15.76	16.71	5.63	10.14
L.S.D. at 0.05	0.0707	0.0279	0.0618	0.01808	0.0419	0.0643	0.0436	0.0489	0.0489	0.0468
	2009-2010									
0kg K/fed(control)	24.70	11.70	13.00	4.50	7.20	29.48	14.28	15.20	4.71	9.56
24 kg K/fed	25.62	12.02	13.60	4.77	4.25	30.64	14.83	15.81	5.20	9.63
48 kg K/fed	26.57	12.56	14.00	5.08	7.48	31.60	15.35	16.25	5.50	9.85
L.S.D. at 0.05	0.0657	0.0485	0.0928	0.0250	0.0535	0.0233	0.0175	0.0262	0.0264	0.0417

T.H.C = Total hydrolysable carbohydrate   T.S.C = Total soluble carbohydrate
N.R.S = Non-reducing sugars   N.S.C – Non-soluble carbohydrate
k = potassium fertilizer   R.S = Reducing sugars
L.S.D. = Least Significant Difference

Table (3): Effect of micronutrients concentrations on carbohydrate fractions percentage in wheat plants (as glucose gm/100 gm sample).

Seasons	Seasons 2008-2009									
	Days after sowing									
Days after sowing	70 days					100 days				
Treatments	T.H.C	T.S.C	N.S.C	R.S.	N.R.S	T.H.C	T.S.C	N.S.C	R.S.	N.R.S
0 p.p.m(control)	25.31	12.53	12.78	4.63	7.90	30.56	14.73	15.83	4.82	9.91
100 p.p.m (B)	26.62	13.04	13.58	4.98	8.06	31.74	15.36	16.38	5.32	10.04
200 p.p.m (B)	27.45	13.56	13.89	5.32	8.24	32.68	16.06	16.62	5.70	10.36
100 p.p.m (Mo)	26.06	12.73	13.33	4.78	7.95	31.03	15.00	16.03	5.10	9.89
200 p.p.m (Mo)	26.39	12.96	13.44	4.93	8.03	31.37	15.24	16.13	5.25	9.98
L.S.D. at 0.05	0.0367	0.0309	0.0449	0.0229	0.0331	0.0361	0.0522	0.0553	0.0386	0.0575
	Seasons 2009-2010									
0 p.p.m (control)	25.54	11.69	12.85	4.50	7.20	29.55	14.31	15.24	4.77	9.55
100 p.p.m (B)	25.95	12.19	13.76	4.84	7.35	30.88	14.87	16.01	5.18	9.69
200 p.p.m (B)	26.69	12.67	14.02	5.16	7.51	31.75	15.53	16.22	5.61	9.92
100 p.p.m (Mo)	25.29	11.84	13.44	4.63	7.21	30.18	14.59	15.60	5.00	9.58
200 p.p.m (Mo)	25.69	12.08	13.62	4.78	7.29	30.51	14.79	15.72	5.13	9.67
L.S.D. at 0.05	0.0512	0.0422	0.0569	0.0581	0.0518	0.0572	0.0289	0.0603	0.0337	0.0474

T.H.C = Total hydrolysable carbohydrate   B = Boron
T.S.C = Total soluble carbohydrate   Mo = Molybdenum
N.S.C – Non-soluble carbohydrate   L.S.D. = Least Significant Difference

R.S = Reducing sugars N.R.S = Non-reducing sugar

Table (4): The interaction effect between potassium fertilizer levels and micronutrients concentrations on carbohydrate fractions percentage in wheat plants (as glucose gm/100 gm sample).

Seasons	2008-2009									
Days after sowing	70 days					100 days				
Treatments	T.H.C	T.S.C	N.S.C	R.S.	N.R.S	T.H.C	T.S.C	N.S.C	R.S.	N.R.S
0 p.p.m (control)	24.35	12.20	12.15	4.33	7.86	29.56	14.36	15.21	4.53	9.82
100 p.p.m (B)	25.95	12.70	13.25	4.73	7.97	30.93	14.86	16.08	4.90	9.96
0 kg K/fed 200 p.p.m (B)	26.65	12.92	13.73	4.92	8.00	31.44	15.14	16.30	5.12	10.02
100 p.p.m (Mo)	25.15	12.42	12.72	4.51	7.90	30.12	14.65	15.47	4.77	9.88
200 p.p.m (Mo)	25.55	12.62	12.93	4.66	7.96	30.28	14.78	15.50	4.87	9.91
0 p.p.m (control)	25.35	12.27	12.78	4.70	7.87	30.70	14.70	15.91	4.89	9.91
100 p.p.m (B)	26.55	12.96	13.59	4.96	7.99	31.60	15.35	16.25	5.28	10.07
24 kg K/fed 200 p.p.m(B)	27.55	13.61	13.94	5.30	8.30	32.66	16.23	16.43	5.83	10.40
100 p.p.m(Mo)	26.13	12.67	13.46	4.74	7.93	31.38	14.99	16.08	5.07	9.92
200 p.p.m (Mo)	26.43	12.91	13.52	4.93	7.98	31.28	15.20	16.18	5.18	10.01
0 p.p.m (control)	26.22	12.82	13.40	4.87	7.95	31.42	15.05	16.37	5.05	10.00
100 p.p.m (B)	27.35	13.45	13.90	5.25	8.20	32.69	15.86	16.82	5.76	10.10
48 kg K/fed 200 p.p.m(B)	28.15	14.15	14.00	5.73	8.42	33.94	16.82	17.12	6.16	10.66
100 p.p.m (Mo)	26.90	13.10	13.80	5.08	8.02	31.90	15.35	16.55	5.48	9.87
200 p.p.m (Mo)	27.19	13.33	13.86	5.19	8.14	32.45	15.74	16.71	5.69	10.05
L.S.D. at 0.05	0.0637	0.0536	0.0778	0.0397	0.0573	0.0885	0.0904	0.0959	0.0669	0.0994

Table (4): Con..

Seasons	2008-2009									
Days after sowing	70 days					100 days				
Treatments	T.H.C	T.S.C	N.S.C	R.S.	N.R.S	T.H.C	T.S.C	N.S.C	R.S.	N.R.S
2009-2010										
0 p.p.m (control)	23.60	11.33	12.27	4.20	7.13	28.20	13.94	14.26	4.5	9.44
100 p.p.m (B)	24.97	11.83	13.14	4.58	7.25	29.88	14.27	15.61	4.67	9.60
0 kg K/fed 200 p.p.m (B)	25.65	12.12	13.53	4.82	7.30	39.69	14.85	15.83	5.15	9.70
100 p.p.m (Mo)	24.45	11.47	12.98	4.34	7.13	29.10	14.09	15.01	4.60	9.49
200 p.p.m (Mo)	24.85	11.76	13.09	4.55	7.21	29.53	14.22	15.31	4.65	9.57
0 p.p.m (control)	24.80	11.77	13.03	4.53	7.24	29.72	14.26	15.46	4.79	9.47
100 p.p.m (B)	25.95	12.07	13.88	4.81	7.26	30.88	14.86	16.02	5.25	9.62
24 kg K/fed 200 p.p.m(B)	26.56	12.48	14.08	5.15	7.33	31.98	15.65	16.32	5.71	9.94
100 p.p.m(Mo)	25.22	11.81	13.41	4.63	7.19	30.17	14.55	15.62	5.04	9.51
200 p.p.m (Mo)	25.55	11.94	13.61	4.72	7.22	30.45	14.82	15.64	5.21	9.61
0 p.p.m (control)	25.23	12.00	13.24	4.78	7.22	30.74	14.74	16.00	5.01	9.73
100 p.p.m (B)	26.91	12.65	14.26	5.12	7.53	31.86	15.46	16.40	5.62	9.84
48 kg K/fed 200 p.p.m(B)	27.85	13.40	14.45	5.50	7.90	32.58	16.08	16.50	5.97	10.11
100 p.p.m (Mo)	26.19	12.25	13.94	4.93	7.32	31.28	15.12	16.16	5.37	9.75
200 p.p.m (Mo)	26.68	12.53	14.15	5.08	7.45	31.54	15.34	16.20	5.53	9.82
L.S.D. at 0.05	0.0885	0.0731	0.0986	0.0450	0.0898	0.0991	0.0450	0.1044	0.0583	0.0821

T.H.C = Total hydrolysable carbohydrate k = potassium fertilizer
T.S.C = Total soluble carbohydrate B = Boron
N.S.C – Non-soluble carbohydrate Mo = Molybdenum

R.S = Reducing sugars
L.S.D. = Least Significant Difference

Table (5): Effect of potassium fertilizer levels on levels on carbohydrate fractions percentage in wheat grains and straws (as glucose gm/100 gm sample).

Seasons	2008-2009									
wheat	Grains					Straw				
Treatments	T.H.C	T.S.C	N.S.C	R.S.	N.R.S	T.H.C	T.S.C	N.S.C	R.S.	N.R.S
0 kg K/fed (control)	66.41	2.54	63.86	0.393	2.15	9.31	1.44	7.87	0.334	1.10
24 kg K/fed	67.50	2.87	64.63	0.424	2.45	9.80	1.64	8.16	0.361	1.28
48 kg K/fed	68.58	3.17	65.42	0.454	2.71	10.71	1.83	8.88	0.389	1.44
L.S.D. at 0.05	0.0343	0.0257	0.0525	0.00132	0.0255	0.0727	0.0222	0.0649	0.00167	0.0226
	2009-2010									
0 kg K/fed (control)	65.49	2.38	63.11	0.376	2.00	8.91	1.33	7.58	0.327	1.01
24 kg K/fed	66.50	2.63	63.87	0.396	2.23	9.45	1.53	7.92	0.350	1.18
48 kg K/fed	67.61	2.86	64.75	0.418	2.44	10.33	1.72	8.60	2.381	1.34
L.S.D. at 0.05	0.0719	0.0172	0.0838	0.00173	0.0164	0.0591	0.00953	0.0786	0.00210	0.00911

T.H.C = Total hydrolysable carbohydrate
T.S.C = Total soluble carbohydrate
N.S.C – Non-soluble carbohydrate
R.S = Reducing sugars
N.R.S = Non-reducing sugars
k = potassium fertilizer
L.S.D. = Least Significant Difference

Table (6): Effect of micronutrients concentrations on carbohydrate fractions percentage in wheat grains and straws (as glucose gm/100 gm sample).

Seasons	2008-2009									
wheat	Grains					Straw				
Treatments	T.H.C	T.S.C	N.S.C	R.S.	N.R.S	T.H.C	T.S.C	N.S.C	R.S.	N.R.S
0 p.p.m (control)	66.50	2.60	63.90	0.395	2.21	9.05	1.47	7.58	0.339	1.13
100 p.p.m (B)	67.87	2.94	64.94	0.426	2.51	10.27	1.69	8.58	0.368	1.32
200 p.p.m (B)	68.49	3.18	65.31	0.464	2.71	10.79	1.89	8.90	0.394	1.50
100 p.p.m (Mo)	67.17	2.73	64.44	0.410	2.32	9.60	1.52	8.09	0.347	1.17
200 p.p.m (Mo)	67.45	2.85	64.60	0.421	2.43	9.98	1.61	8.36	0.360	1.25
L.S.D. at 0.05	0.0392	0.0378	0.0529	0.00185	0.0372	0.0699	0.0208	0.0723	0.0285	0.0203
	2009-2010									
0 p.p.m (control)	65.29	2.39	62.90	0.377	2.02	8.71	1.35	7.36	0.328	1.02
100 p.p.m (B)	66.87	2.70	64.17	0.399	2.30	9.96	1.57	8.40	0.358	1.21
200 p.p.m (B)	67.74	2.94	64.80	0.425	2.52	10.32	1.78	8.54	0.387	1.39
100 p.p.m (Mo)	66.24	2.45	63.78	0.386	2.07	9.27	1.42	7.82	0.337	1.08
200 p.p.m (Mo)	66.51	2.62	63.90	0.395	2.22	9.56	1.52	8.04	0.351	1.17
L.S.D. at 0.05	0.0691	0.0186	0.0769	0.00157	0.01865	0.0468	0.0217	0.0665	0.00248	0.0212

T.H.C = Total hydrolysable carbohydrate
T.S.C = Total soluble carbohydrate
N.S.C – Non-soluble carbohydrate
R.S = Reducing sugars
B = Boron
Mo = Molybdenum
L.S.D. = Least Significant Difference

N.R.S = Non-reducing sugars

Table (7): The interaction effect between potassium fertilizer levels and micronutrients concentration on carbohydrate fractions percentage in wheat grains and straw (as glucose gm/100 gm sample).

Seasons	2008-2009									
wheat	Grains					Straw				
Treatments	T.H.C	T.S.C	N.S.C	R.S.	N.R.S	T.H.C	T.S.C	N.S.C	R.S.	N.R.S
0 p.p.m (control)	65.33	2.25	63.08	0.372	1.88	8.50	1.24	7.26	0.312	0.928
100 p.p.m (B)	66.85	2.64	64.21	0.397	2.24	9.55	1.50	8.04	0.337	1.17
0 kg K/fed 200p.p.m (B)	67.44	2.88	64.56	0.422	2.46	9.90	1.72	8.18	0.373	1.35
100 p.p.m (Mo)	66.07	2.41	63.66	0.380	2.03	9.15	1.31	7.84	0.319	0.991
200 p.p.m (Mo)	66.34	2.53	63.81	0.391	2.14	9.44	1.41	8.03	0.329	1.081
0 p.p.m (control)	66.63	2.62	64.01	0.396	2.22	8.89	1.48	7.41	0.333	1.15
100 p.p.m (B)	67.88	2.95	64.93	0.420	2.53	10.18	1.69	8.49	0.372	1.32
24kg K/fed 200 p.p.m (B)	68.35	3.14	65.21	0.472	2.67	10.75	1.91	8.84	0.395	1.52
100p.p.m(Mo)	67.18	2.76	64.43	0.410	2.35	9.38	1.52	7.86	0.344	1.17
200 p.p.m (Mo)	67.47	2.88	64.57	0.418	2.46	9.80	1.62	8.18	0.360	1.26
0 p.p.m (control)	67.55	2.94	64.60	0.417	2.53	9.75	1.69	8.06	0.371	1.32
100 p.p.m (B)	68.90	3.22	65.68	0.462	2.76	11.08	1.87	9.22	0.395	1.47
48 kg K/fed 200p.p.m(B)	69.67	3.52	66.15	0.498	3.02	11.73	2.04	9.69	0.413	1.63
100 p.p.m (Mo)	68.25	3.01	65.23	0.439	2.57	10.28	1.72	8.56	0.377	1.35
200 p.p.m (Mo)	68.56	3.14	65.41	0.453	2.69	10.70	1.82	8.88	0.390	1.43
L.S.D. at 0.05	0.0679	N.S	0.0917	0.00319	0.0645	0.121	0.0361	0.1253	N.S	0.0352
2009-2010										
0 p.p.m (control)	64.08	2.12	61.96	0.355	1.77	8.12	1.09	7.03	0.306	0.784
100 p.p.m (B)	65.88	2.44	63.44	0.384	2.06	9.22	1.41	7.82	0.327	1.08
0 kg K/fed 200p.p.m (B)	66.78	2.72	64.05	0.395	2.32	9.60	1.62	7.98	0.363	1.25
100 p.p.m (Mo)	65.21	2.22	62.99	0.366	1.86	8.64	1.22	7.42	0.313	0.907
200 p.p.m (Mo)	65.50	2.37	63.13	0.375	1.99	8.98	1.33	7.65	0.324	1.01
0 p.p.m (control)	65.30	2.40	62.90	0.380	2.02	8.65	1.34	7.31	0.324	1.01
100 p.p.m (B)	66.85	2.72	64.13	0.398	2.32	9.82	1.58	8.24	0.356	1.22
24 kg K/fed 200 p.p.m(B)	67.80	2.95	64.85	0.422	2.53	10.18	1.80	8.38	0.390	1.41
100p.p.m(Mo)	66.15	2.44	63.71	0.386	2.10	9.15	1.40	7.75	0.333	1.07
200 p.p.m (Mo)	66.40	2.64	63.76	0.394	2.25	9.45	1.52	7.93	0.345	1.18
0 p.p.m (control)	66.49	2.66	63.83	0.396	2.26	9.35	1.61	7.74	0.355	1.26
100 p.p.m (B)	67.88	2.95	64.94	0.418	2.53	10.85	1.72	9.13	0.391	1.33
48 kg K/fed 200p.p.m(B)	68.65	3.15	65.51	0.455	2.69	11.18	1.91	9.27	0.408	1.50
100 p.p.m (Mo)	67.35	2.70	64.65	0.407	2.30	10.01	1.64	8.29	0.366	1.28
200 p.p.m (Mo)	67.65	2.84	64.81	0.415	2.43	10.25	1.70	8.55	0.384	1.31
L.S.D. at 0.05	0.120	0.0322	0.1332	0.00272	0.03230	0.0811	0.0376	0.1152	0.00430	0.0367

T.H.C = Total hydrolysable carbohydrate
T.S.C = Total soluble carbohydrate
N.S.C – Non-soluble carbohydrate
R.S = Reducing sugars

k = potassium fertilizer
B = Boron
Mo = Molybdenum
L.S.D. = Least Significant Difference

N.R.S = Non-reducing sugars

N.S = Non- significant

The effect of all concentrations of micronutrients (boron-molybdenum) on carbohydrate fractions percentage indicate that it's applications, significantly increased carbohydrate fractions of wheat plants in the two seasons of study Tables (2 and 5). Generally, it seems that increasing concentrations of boron increased carbohydrate fractions of wheat plants. These results are in agreement with those obtained by Gao and Chen (1990), and Yan *et al*., (2003). It is obvious from the data, increasing concentrations of molybdenum increased carbohydrate fractions of wheat plants. Similar results were reported by Dwivedi *et al*., (1993) and Chengxiao *et al*., (1998).

The interaction effect between the potassium fertilizer levels and micronutrients (boron-molybdenum) application on carbohydrate fractions percentage in wheat plants are shown in Table (3 and 6). It is clear from the data that the highest value of carbohydrate fractions percentage was obtained when wheat plants were fertilized with 48 kg potassium/fed and spray with 200 p.p.m boron. On the other hand, the lowest value of carbohydrate fractions percentage was obtained when plants untreated with potassium fertilizer and without application any micronutrients..

REFERENCES

Al-Moshileh, A.M. and M.A. Errebi (2004). Effect of various potassium sulfate rates on growth yield and quality of potato grown under sandy soil and aird conditions. IPI regional workshop on potassium and fertigation development in west Asia and North Africa. Rabat, Morocco, 24-28 November.

Amal, G.A., M.S. Hassanein and M.M. El-Gazzar (2006). Growth and yield response of two wheat cultivars to complete foliar fertilizer compound Dogoplus. Journal of Applied Sciences Research. 2 (1): 20-26.

Banerjee, A., J.K. Datta and N.K. Mondal (2012). Biochemical changes in leaves of mustard under the influence of different fertilizer and cycocol. Journal of Agricultural Technology. 8 (4): 1397-1411.

Bingham, F.T. (1982). Boron in A.L. Page R.H. Miller and D.R. Keeny (eds). Methods of Soil Analysis, Part 2, Agron. Monogr. 9 Am. Soc. Agron., Madison, WIP. 431-446.

Chapman, H.D. and P.F. Pratt (1961). Method of Analysis for Soils, Plant and Water Univ. Cal. Div. Agric. Science, USA. pp. 150-152.

Chengxiao, H., Y.H. Wang, W. Wei and H. Chen (1998). Influence of available Mo levels of yellow brown earth on yield, chlorophyll and soluble sugar content of winter wheat. Soil and Fertilizers (Bijing). (1): 19-22.

Droba, O. (1993). Fertilizing effect of boron in different formulations. Agro chemia (Bratislava) 33 (8):204-205 [c.f. Micronutrients News and Information. 14 (3): 0707].

Dwivedi, M., R.M. Upadhayay and G.K. Dwived (1993). Effect of inorganic, organic and biofertilizers on yield and nutritional quality of block gram and wheat grown in sequence. Indian Journal of Agricultural Chemistry. 26 (2/3): 111-122.

Gao, D. and Z. Chen (1990). N-P-K fertilizer containing trace elements and phytohormone, for watermelon. (c.f. Micronutrients News and Informations, 12 (1): 0276).

Heidari, M. and P. Jamshid (2010). Interaction between salinity and potassium on grain yield, carbohydrate content and nutrient uptake in pearl millet. ARPN Journal of Agricultural and Biological Science. 5 (6): 39-46.

Katyal, J.C. and N.S. Randhawa (1983). Micronutrients. FAO fertilizer and Plant Nutrition Bulletin 7.India Council of Agricultural Research, India, Fertilizer and Plant Nutrition Service Land and Water Development Division.

Laila, K.M.A. and M.M. Elbordiny (2009). Response of wheat plants to potassium Humate application. Journal of Applied

Sciences Research. 5 (9): 1202-1209.

Liu, H.J., C.Y. SHI, L.M. Zhang, H.F. Zhang, Z.Z. Wang and S.S. Chai (2012). Effect of potassium on related enzyme activities in sugar metabolism of edible sweet potato. Plant Nutrition and Fertilizer Science. 18 (3): 724-732.

Liwenxue, Z.Y. Wang, G.H. Mi, X. Ri Han and F.S. Zhang (2001). Molybdenum deficiency in winter wheat seedlings as enhanced by freezing temperature. Journal of Plant Nutrition. 24 (8): 1195-1203.

Maqsood, T., J. Akhtar, M.R. Farooq, M.A. Haq and Z.A. Saqib (2008). Biochemical attributes of salt tolerant and salt sensitive maize cultivars to salinity and potassium nutrition. Pak. J. Agric. Sci., 45 (1): 1-5.

Mazvila, J., Z. Vaisvila, J. Arbaciausks, T. Adomaitis, A. Antanaitis and J. Lubyte (2007). Dependence of agricultural yield and its quality on long-term fertilization on sandy loam soil. Zemdirbyste (Agriculture). 94 (3): 3-17.

Picchioni, G.A., S. Miyamoto and J.B. Storey (1991). Boron uptake and effects on growth and carbohydrate partitioning of pistachio seedlings. J. Amer. Soc. Hort. Sci. 116 (4): 706-711.

Piper, C.S. (1938). The occurrence of Reclamation Disease in cereals in south Australia. Australia Council Sci. Ind. Research Pamphlet No. 78: 24-28.

Piper, C.S. (1950). Soil and plant analysis. Inter Sci. Publishers, Inc., New York.

Rao, S.S. and M.P. Sahu (1991). Effect of sulphur and foliar applied chemicals on cold tolerance in chickpea (Cicer arietinum L.). Journal of Agronomy and Crop Science. 167 (5): 320-325. [c.f. Micronutrients News and Information. Vol (13/2) 0406].

Rui, L., X.H. Li, S.X. Yang and Lili (2003). Effects of potassium on physiology of the root system and above– ground part growth of winter wheat soils and fertilizers (Beijing). (4): 16-19.

Sendecor, G.W. and W.G. Cochran (1967). Statistical Method 6th Ed. The low a State Univ. Press, Ames. Lowa State USA.

Sharma, R., S. Gurbaksh and J. Kaur (1991). Effect of boron on physiology of grain filling in wheat (Triticum durum). New trends in plant physiology. Proceeding, national symposium on growth and differentiation in plants. 183-185.

Thomas, M. and R.A. Dutcher (1924). The colorimetric determination of CHO in plants by the picric acid reduction method. J. Amer. Chem Soc., 46: 7-12.

Walkley, A. (1947). Acritical examination of a rapid method for determining organic carbon in soils. Effect of variation in digestion conditions and in organic soil constituents. Soil Sci. 63: 246-251.

Wang, X.D., Y.W. Zheng and D. Wang (2003). Effect of potassium on carbohydrate contents In the stem and the sheath and starch accumulation in the grain of wheat. Plant Nutrition and Fertilizer Science. 9 (1): 57- 62.

Wright, C.H. (1939). Soil analysis Thom as murby and Co., London.

Yan, H., W.X. Li, Y.F. Guo and D.S. Liu (2003). Effect of boron on charbohydrate assimilation and translocation in wheat. Acta pedologica sinica. 40 (3): 440-445.

دراسات كيميائية حيوية على تأثير التسميد البوتاسيومى والرش الورقى للعناصر الصغرى (البورون . المولبيدنيم) على الكربوهيدرات في نبات القمح والحبوب

مصطفى عبد الله همام[١] ، عبد العزيز على صقر[١] ، عبد الهادى عبد الهادى درويش[٢] ، حنان محمد أبو الفتوح[٢]

[١] قسم الكيمياء الحيوية الزراعية . كلية الزراعة . جامعة المنوفية

[٢] معهد بحوث الأراضى والمياه والبيئة . مركز البحوث الزراعية

المُلخص العربي :

أجريت تجربة حقلية بالمزرعة البحثية لمحطة البحوث الزراعية بالجميزة خلال الموسمين الزراعيين الشتويين بين ٢٠٠٨/٢٠٠٩ و ٢٠٠٩/٢٠١٠ لدراسة تأثير تركيزات مختلفة من العناصر الصغرى (البورون . المولبيدنيم) (صفر . ١٠٠ . ٢٠٠ جزء في المليون) لكل عنصر على نبات القمح تحت تأثير مستويات مختلفة من التسميد البوتاسيومى (صفر . ٢٤ . ٤٨ كجم بوتاسيوم للفدان) وتقدير محتوى النباتات والحبوب والقش من الصور المختلفة من المواد الكربوهيدراتية .

وأوضحت النتائج المتحصل عليها أنه بزيادة مستوى التسميد البوتاسيومى يزداد المحتوى الكلى من الكربوهيدرات في العينات بصورة معنوية حيث نجد أن النسبة المئوية للكربوهيدرات تزداد في النبات بزيادة مستوى التسميد البوتاسيومى .

لوحظ عند المعاملة بالعناصر الصغرى (البورون . المولبيدنيم) تزداد النسبة المئوية للكربوهيدرات بزيادة تركيز العناصر الصغرى حيث كانت النسبة المئوية للكربوهيدرات في حالة النباتات المعاملة بتركيزات البورون أعلى من النباتات المعاملة بتركيزات المولبيدنيم .

وبدراسة التداخل بين تأثير كلا من التسميد البوتاسيومى والعناصر الصغرى (البورون . المولبيدنيم) وجد أن أعلى نسبة للكربوهيدرات كانت في حالة استخدام المستوى الأعلى من التسميد البوتاسيومى (٤٨ كجم بوتاسيوم للفدان) مع تركيز ٢٠٠ جزء في المليون من البورون مقارنة بالنباتات الغير معاملة بالتسميد البوتاسيومى (صفر كجم بوتاسيوم للفدان) و (صفر جزء في المليون) من العناصر الصغرى سواء كان بورون أو موليبدنيم