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EFFECT OF NITRIC AND PHOSPHORIC ACID ON THE PRODUCTIVITY OF WHEAT AND BARLEY UNDER DRIP IRRIGATION SYSTEM

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ABSTRACT

The study was conducted at El –Maghara Research Station of Desert Research Center (North Sinai).Two field experiments of wheat and barley crops were conducted under drip irrigation system. In the first experiment treatments were 6 rates of nitric acid (0 , 30 , 60 , 90 , 120, and 150 kg N / fed) and 6 rates of phosphoric acid (0 , 10 , 20 , 30 , 40 , 50 kg P_2O_5 / fed) added together each four weeks . The other experiment used nitric acid, ammonium sulphate, ammonium nitrate and urea as a source of nitrogen fertilizer. Phosphoric acid and superphosphate were used as a source of P fertilizer.

Yield of wheat and barley, N and P content in grain and straw were increased significantly with increasing the rate of both nitric and phosphoric acids together. The most pronounced response was obtained from the treatment of 120 kg N / fed + 40 kg P_2O_5 / fed. The productivity of wheat and barley by using different source of N followed this order: nitric acid > ammonium sulphate > ammonium nitrate > urea, while being phosphoric acid > superphosphate for P source.

INTRODUCTION

The marked increase in yield has been documented due to rapid advances in technology. One of the improvement in technology may include the correct fertilizer application rates, source of fertilizer and placement techniques to provide high efficiency and optimum growth levels.

The response of wheat and barley to different fertilizer application .rates of N,P,K and micronutrients have been documented (salem, 1984 ;Abed EL-Gawad et al.1986 ; Omran et al ,1988 ; Gaber ,1988 ; El-Sayed and Mohamed ,1992 ; Mohamed, 1992 ; El-Bawab,1994 ;Abd-Alla and Bassiouny ,1994 ; Moselhy,1995 ; Hatem et al, 1996 and Gomaa, 1997).

The most common techniques to add fertilizers are broadcast and side dressed or banded .The use of liquid fertilizers to soil and foliar application increased the available techniques of fertilizers applications .The application of plant nutrients through the irrigation system (fertigation) has recently expanded due to efficiency and convenience.(Gascho et al.,1984 ; Kamh et al .,1991 ; Kamh et al .,.1996 and El-kased et al.,1996, Hussein and El- Melegy.,2006).

Through drip irrigation system ,fertilizer use efficiency can be improved than broadcast addition .Plant nutrients are applied directly into the wetted volume of soil below the dripper where activity of roots can be concentrated (Bar-yousef et al ,1989; Hasanein,2002) Wheat as the most important cereal crop in Egypt, is considered moderately salted tolerants crop which and can be grown under many adverse conditions (EL-shall et al.,1987;Kamh et al.,1991;El-Bawab, 994;Wassif et al.,1995 and Kamh et al.,1996).

The expansion of wheat and barley cultivation under desert conditions and saline under groundwater is a strategic goal to provide with increased demand of local needs .So the effect of nitric and phosphoric acid application rates as well as addition of different sources of N and P fertilizers on wheat and barley productivity and their nutrients content were investigated.

MATERIALS AND METHODS

Two field experiments of wheat and barley crops were carried out at El-Maghara Research Station of Desert Research Center at North Sinai and planted in November 2006. The studied soil was characterized by sandy texture, 7.7 pH ,1.6 dS/m EC, 16.5 % $CaCO_3$, o.6 %O.M , 0.02% total N and 3.5ppm available P .Available Fe , Mn, Zn and Cu were 5.9 ,3.0,0.80and 0.20 ppm ,respectively .The total soluble salts cotent of irrigation water from well was about 2500 ppm .

The drip irrigation system was prepared as a main line source and divided to a single line sources placed parallel with a 50 cm lateral spacing .Drip emitters were placed on each 30cm of line as each emitter per group of plants(the area of each treatment 3×3.5 and 60 emitter for each treatment) .Water was supplied from emitters at rate of 2L/h .Irrigation water with fertilization treatments were applied to each line from a containers connected directly to drip lines (Fig.1).

Fig.1 The field experiment under drip irrigation system .

The first experiment, included the addition of both nitric and phosphoric acid together to wheat (Sakha,69) and barley (Giza,124) .Nitric acid (15.5%N)and phosphoric acid (54%P_2O_5) were applied once each 4weeks through drip irrigation system using 6 rates of both acids, ie, 0, 30, 60, 90, 120, 150 Kg N /fed ,and 0, 10 20 30 ,40, and 50 Kg P_2O_5/ fed ,respectively .The second experiment included addition of different N and P fertilizers at rates of 90 Kg N and 30 Kg P_2O_5 /fed .

The N sources were :ammonium sulfate (20.5%) , ammonium nitrate 32.5% N,urea (46.5%N) and nitric acid (15.5%),The P sources were super- phosphate (15.5% P_2O_5)and phosphoric acid (54%P_2O_5) . Potassium fertilizer was added at a rat of 50 kg K_2O / fed for all treatments throughout the studied two experiments .The experimental design was randomize block design with four replications.

Wheat was sown at rate of 60 kg /fed in 50cm between lines and 30cm beside each dripper in groups as shown in Fig (1). Also, barley was sown at rate of 50 kg / fed .The plots were harvested by hand at maturity. Data collected from each plot including total dry weight, grain yield and straw weight .Samples of both grain and straw were wet digested for determing total N and P (Chapman and Pratt, 1961).

RESULTS AND DISCUSSION

Wheat Crop:

The biological yield ,straw and grain yields were considered as the yield parameters (Table 1). The treatments of nitric and phosphoric acids together produced significant differences between the yield parameters as compared to control treatment. The treatment of 120 kg N+ 40 kg P_2O_5 / fed obtained the highest biological yield , straw and grain yields (3.9, 2.56, 1.34 kg/fed, respectively). Increasing the treatment to higher rate reduced the yield parameters by about 20 %.

Generally, the increase of nitric and phosphoric acids clear that the rate of grains increase is higher than the rate of straw increase, indicating the importance of the addition of both acids on the productivity of wheat grains.

Table 1: Effect of nitric and phosphoric acids addition on some yield parameters of wheat.

Treatments	Biological yield (T/fed)	Straw yield (T/fed)	Grain yield (T/fed)
N0* P0**	1.64	1.10	0.54
N30 P10	2.68	1.69	0.99
N60 P20	3.25	2.17	1.08
N90 P30	3.66	2.39	1.27
N120 P40	4.15	2.81	1.59
N150 P50	3.10	2.10	1.09
LSD0.05%	1.07	NS	NS

* added in nitric acid form and equivalent to kg N / fed.

** added in phosphoric acid form and equivalent to kg P_2O_5 / fed.

Barley crop:

The yield parameters of barley crop were indicated in Table(2) as affected by nitric and phosphoric acids added together .Increasing nitric acid

rate from 0 to 120 kg N/fed and phosphoric acid rate from0 to 40 kg P_2O_5 /fed increased significantly and gradually the biological yield ,straw and grain yields. Addition of 120 kg N /fed and 40 kg P_2O_5 /fed, produced the highest biological, straw and grain yields.

Table 2: Effect of nitric and phosphoric acids addition on some yield parameters of barley.

Treatments	Biological yield(T/fed)	Straw yield (T/fed)	Grain yield (T/fed)
N0*P0**	2.34	1.33	1.01
N30P10	2.80	1.67	1.12
N60P20	3.47	1.85	1.62
N90P30	3.66	1.98	1.67
N120P40	4.08	2.3	2.02
N150P50	3.84	2.09	1.75
LSD 0.05%	1.18	NS	NS

Wheat and Barley Content of N and P:

Increasing the level of treatments of acids added on wheat and barley tissues of mineral content of N and P% were indicated Table (3). The increase of N content is significant. It is ranged from 1 to 3 % in wheat tissue and from about 2 to 5% in barley tissue .Also, the content of P was significant as indicated from the the treatments effect on P content in tissue of wheat, but not significant in barley .In general, the treatment of 150 kg N /fed and 50 kg P_2O_5 / fed produced the highest level of N and P content in grain and tissue of wheat and barley.

Generally, the range of 2.6 to 3 % of N in tissue of both crops is considered adequate. A higher than this level is considered high or toxic. Also, the range of 0.21to 0.50% of P is adequate in tissue of both crops. Higher values is classified as high or toxic.

In conclusion, the chemical analysis of tissue of wheat and barley indicated that the means of nutrients of N and P as added through drip irrigation system in acidic form were improved with different levels , where the adequate chemical composition enhancing the nutritional values of grain for human and animal diet.

Table (3) Effect of treatment on wheat and barley content of N and P (%)

treatment	wheat				Barley			
	Grain		Straw		Grain		Straw	
	N	P	N	P	N	P	N	P
N0P0	1.9	0.15	1.0	0.1	1.5	0.18	0.80	0.09
N30P10	2.5	0.27	1.2	0.15	1.4	0.23	1.0	0.11
N60P20	3.5	0.26	1.5	0.16	1.9	0.20	1.1	0.10
N90P30	3.2	0.36	1.4	0.22	2.5	0.24	1.2	0.18
N120P40	3.7	0.45	3.1	0.25	2.9	0.27	1.5	0.21
N150P50	5.6	0.55	3.0	0.30	3.1	0.29	1.9	0.21
LSD0.05%	1.04	0.16	0.77	0.11	0.97	NS	0.57	NS

Effect of Nitrogen Fertilizer Sources:

The influence of N added to the soil from drip emitters is varied markedly depending on the source of N fertilizer added. Accordingly a significant difference in grain and straw of wheat and barley were produced (Table 4).

The addition of nitric acid produced a marked increase in grain and straw yield of wheat (1.36 and 2.5) T/fed respectively) , but the increase in barley is not significant. The lowest yields were recorded with urea application in comparison with other N sources. In general, grain and straw yields followed this order: nitric acid > ammonium sulphate >ammonium nitrate >urea.

Nitric acid (15.5% N) is in liquid form which can be mixed with water and applied through irrigation system. The nitrate (NO_3) form is usually considered the most readily available and the easiest to utilize by plant .The most important advantage is the mobility of the nitrate ion in the soil .The ion is negatively charged as in soil.

The significant increase in yield of wheat and barley due to N sources fertilizers is indicated in Table (4).

Table4 : Grain and straw yields (T / fed) of wheat and barley as affected by different sources of N fertilizers .

Source of fertilizer	wheat		Barley	
	Grain	Straw	Grain	Straw
Nitric acid	1.36	2.5	1.62	1.85
Ammonium sulphat	1.22	2.38	1.49	1.65
Ammonium nitrate	0.94	2.10	1.31	1.38
Urea	0.89	1.83	1.12	1.37
Control	0.54	1.10	1.01	1.33
LSD0.05%	0.53	0.55	NS	NS

Ammonium sulphate (20.5%) is a highly soluble, where it can be added trough drip irrigation system .It is positively charged from ($NH4^+$) which held on the negatively charged soil to remain until either plant or bacteria use them. Sulphat ions (SO4) produce an acidic effect in soil which reduce soil pH and increase the availability of some micronutrients. Under drip system ammonium volatilization loss is expected to be reduced .The superiority of ammonium sulphat over ammonium nitrate and a urea source was observed in Table 4.

Ammonium nitrate (33.5% N) is water soluble which can be easily used through drip irrigation system .It divided equally to ammonic form and nitrate form. Ammonic ion is held by the negatively charged soil, where nitrate form remains mobile in soil solution which become available to plant. It produce a natural effect in losses through leaching and denitrefication.

Generally, the application of ammonium nitrate produces about 10 to 20 % less yield than ammonium sulphat (Table 4). Urea (46 % N), is water soluble, but it dose not react with water to form ions unless the water contains enzyme urea's which cause hydrolysis of urea to ammonium ion. Ammonium ions react with soil as describe before. As the transit time through the drip

irrigation system is fast, urea is not expected to be hydrolyzed to ammonium to significant degree in the irrigation system even if the enzyme is present. In general, the productivity of urea addition to the grown plants was the less, when compared with the other N sources (Table 4).

In conclusion , several sources of N such as nitric acid , ammonium sulphat,ammonium nitrate and urea can be added through the drip irrigation system .Reactions are differ with soils ,depending on sources of N fertilizer added , which should be carefully considered in selecting the most suitable N source to be added .

To meet plant needs and growth, a more efficient way is to added fertilizer throughout the growing season.

Effect of P fertilizers Sources:

Ordinary superphosphate (15.5%)and phosphoric acid (54 %P_2O_5) affect yield of wheat and barley is indicated in Table 5 .Data showed that the acid is a better source of P than the ordinary superphosphate.The acid increased significantly the yield of wheat (grain and straw) and barley (straw only) compared to the other source. The increase ranged from about 25 to 40 % for acid treatment .The P acid 75% contains 54% P_2O_5 liquid high soluble in water . It appears to be the most suitable from of P for use in drip irrigation system .It has an acidic effect in irrigation water. Ordinary superphosphate is not recommend to be used through drip irrigation system due to its effect on blocking the drippers.

Table 5: Grain and straw yields (T / fed) of wheat and barley as affected by different sources of P fertilizers .

Source of fertilizer	wheat		Barley	
	Grain	Straw	Grain	Straw
Superphosphate	0.93	1.77	1.31	1.51
Phosphoric acid	1.33	2.25	1.70	2.0
Control	0.54	1.10	1.01	1.33
LSD0.05%	0.43	0.49	NS	0.44

Generally in alkaline soil, P tie up mainly related to calcium reacting with P .Sometimes calcium reacts directly with P forming less soluble calcium phosphate. Also, P may be precipitated directly on free calcium carbonate particles in soil.

In conclusion, P acid appears to be the most suitable from of P for use through drip irrigation system. The addition of P acid keeps the pH of irrigation water low enough for phosphate salts to remain soluble.

CONCLUSION

The application of nitric and phosphoric acid increased grain, straw yield and N and P content of wheat and barley crops .The most positive response was produced from the treatments of 120 kg N / fed + 40 kg P_2O_5 / fed .The productivity of wheat and barley by using different sources of N followed the order: nitric acid >ammonium sulphate >ammonium nitrate >urea and phosphoric acid >superphosphate for P source.

The main nutrients of N and P as added through drip irrigation system in acidic form were improved with different levels, where the adequate chemical composition enhancing the nutritional values of grain for human and animal diet. Several sources of N and P can be added through the using drip irrigation system. Reactions are differing with soil, depending on sources of N and P added, which should be carefully considered in selecting the most suitable source to be added.

A more efficient way is to add fertilizer throughout the growing season, to meet plant needs and growth.

REFERANCES

Abd-Alla,m.m. and A.H.Bassiouny (1994).Response of two wheat cultivars to various planting densities .Egypt .J. Appl. sci .9 (8) : 836-849.

Abd El-Gawad ,A.A.,A.E.El-tabbaakh,A.S .Edrir and A.M.Abou-shetaia .(1986).Potential productivity of wheat in Egypt.VII.Response of wheat cultivar of different nitrogen levels.Annals Agric.sci.,Ain shams Univ. 31(2) : 1159-1177.

Bar-yosef ,B.sagiv and T.Markovitch .(1989). Sweet corn response to surface and subsurface trickle phosphorous fertigation .Agron .J. 81:443-447.

Chapman,H. and P.F. Pratt (1961).Methods of analysis for soil , plants and water , Univ.of Calif. Div. of Agric .sci.

El-Bawab,A.M.O.(1994).Response of some barley cultivars to grow under different environmental conditions .Ph.D. Thesis,Fac.of Agric .Cairo Univ. ,Egypt.

El-kased,F.A.,R.N.kamh and Bouthaina F.Abd El-Ghany .(1996) .wheat response to bio and mineral nitrogen fertigated in newly reclaimed sandy soil .Desert Inst.Bull. Egypt :46 (2) 373-387.

El-Sayed ,A.A.and T.A. Mohamed. (1992) . Selecting drought tolerance barley genotypes under adjusted soil moisture stress Egypt J.Appli. Sci. 7(6):679-690.

El-Shall,A. M.Wassif,M.hilal.and I.El-Bagouri .(1987). Response of barley to sulfur application in a calcareous soil under saline irrigation water . Desert Inst.Bull.,A.R.E.37(1):117-130.

Gaber ,E. M.A.(1988) . Effect of seed rate and nitrogen application on wheat yield .Ph.D.thesis ,Fac.of Agric. Zagazig univ.,Egypt.

Gascho , J.,M.E. Hook and G.A. Mitchell. (1984). Sprinkler applied and side dressed nitrogen for irrigated corn grown on sand .Agron .J.76:77-81.

Gomaa,M.A.(1997).Response of wheat (Triticum Aestivum l.) to seeding rate and nitrogen levels under sandy soils conditions. Egypt.J.Appl.sci. 12(2):88-102.

Gomaa,M.A.and S.A.I.Ghanem.(1985).The response of from wheat cultivations to nitrogen and fetilon combi fertilization .Zagazig J.Agric.Res.12 (2):305-325.

Hasaneine,B.M.(2002). Rate and timing effect of phosphoric acid application on fodder beet yield ,soil P and PH below the emitters .J.Agric.sci.Mansoura. Univ.,27(2):751-757.

Hasaneine,B.M.(2001).Corn production as affected by application of nitric acid through drip irrigation system .Desert Inst. Bull., Egypt .51(2):305-318.

Hatem,H.H.,B.M.Hasanein and H.M.Shehata.(1996). Effect of N,Pand K fertilization on wheat production under desert soil condition of south Sinai. Egypt .J.Appli.sci..11 (9):258-271.

Hussein,S.U.A and A.U.EL-Melegy.(2006) Maize yield and its attributes as affected by cropping squences, water requirements and sources of nitrogen fertilization under drip irrigation system in sandy soils .Zagazig J. Agric . Res.,33 (6) 1043-1062 .

Kamh,R.N.and K.W.Kalil and M.A.El-kadi.(1996). Wheat production under different irrigation systems in the newly reclaimed areas . Desert Inst.Bull., Egypt . 46(2):305-317.

Kamh,R.N.;B.I.Mousa and K.W Kalil.(1991). Wheat response to N,P and K fertilization under sprinkler irrigation . Desert Inst. Blll. 41(2) :275- 288.

Mohamed ,I.R.(1992). Effect of nitrogen rates nitrification inhibitor and splitting nitrogen applications on wheat production in a sandy soil Egypt .J.Appl.sci.7(2):369-376.

Moselhey ,N.M.M.(1995).Raising wheat under desert conditions in Egypt .Ph.D thesis,Fac.ofAgric .Zagazig .Univ.,Egypt.

Omran ,M.S.,El-shinnaauni ,M.M.El-sedry and S.W Barsoom.(1988) .The influence of nitrogen source on plant growth .Egypt .J.soil sci .28(2):967-181.

Salam,U.S.(1984).Interprative study on nitrogen and copper fertilization on wheat. Annals Agric sci., Moshtohor ,17(2):1050-1058.

Wassif,M.M., M.K.,Shabana, ,S.M. Saad, S.E. El-Maghraby, and I.A Ashour ,I.A.(1995). Influence of some soil amendments on calcareous soil properties and its productivity of wheat under high saline irrigation water. Egypt J.soil sci. 35(4):438-451.

تأثير اضافة حمض النيتريك والفوسفوريك على انتاجية القمح والشعير تحت نظام الرى بالتنقيط.

بدران مرسى حسنين – فتحى عبد الفتاح العزيزى و حسين هاشم حاتم
مركز بحوث الصحراء– المطرية – القاهرة .

أجريت تجربتان حقليتان فى محطة بحوث المغارة بشمال سيناء التابعة لمركز بحوث الصحراء بهدف دراسة انتاجية محصولى القمح والشعير ،والمحتوى العنصرى فى النبات نتيجة اضافة حمض النيتريك بمعدل(٠-٣٠-٦٠-٩٠-١٢٠-١٥٠-كجم نتروجين/ فدان) وحمض فوسفوريك بمعدل (٠- ١٠-٢٠-٣٠-٤٠-٥٠-كجم فو٢أ٥/فدان) معا ،كذلك دراسة أثر اضافة مصادر مختلفة من النتروجين والفوسفور والتى تشمل حمض النيتريك وكبريتات الأمونيوم ونترات الأمونيوم واليوريا وحمض الفوسفوريك وسوبر فوسفات بمعدل واحد بمقدار ٩٠كجم نتروجين /فدان ، ٣٠كجم فو٢ أ٥ / فدان على انتاجية محصول القمح والشعير وقد أضيفت المعاملات كل أربعة أسابيع من خلال الرى بالتنقيط بمحطة بحوث المغارة التابعة لمركز بحوث الصحراء بشمال سيناء.

وتشير النتائج الى زيادة معنوية فى انتاجية الحبوب والقش والمحتوى النتروجينى والفوسفاتى للقمح والشعير ، وقد أعطت المعاملة ١٢٠ كجم نتروجين/ فدان ، ٣٠كجم فو٢أ٥ /فدان أعلى انتاجية . كذلك تشير النتائج أيضا الى زيادة معنوية فى انتاجية الحبوب والقش نتيجة استخدام مصادر مختلفة للاسمدة وذلك وفقا للترتيب التالى حمض نيتريك > كبريتات الأمونيوم >نترات الأمونيوم >يوريا ، وبالنسبة لمصدر الفوسفور كان حمض فوسفوريك > سوبر فوسفات.

وتوصى الدراسة باستخدام حمض النيتريك والفوسفوريك تحت ظروف الرى بالتنقيط فى الأراضى الصحراوية كمصدر للاسمدة النتروجينية والفوسفاتية وذلك عن طريق الاضافة التكرارية لاعطاء أعلى كفاءة ممكن للاسمدة خلال موسم النمو.