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RATE AND TIMING EFFECT OF PHOSPHORIC ACID APPLICATION ON FODDER BEET YIELD, SOIL P AND pH BELOW THE EMITTERS

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ABSTRACT

Fodder beet is considered as one of the best fodder crops for livestock under Egyptian conditions. This study investigates the effect of fertilization with phosphoric acid at different both rates and timing of application on fodder beet productivity, soil P and pH below the emitters under drip irrigation system.

The experimental site was located at El-Maghara Research Station of Desert Research Center at North Sinai. Phosphoric acid was applied through drip irrigation system at rates equivalent to 0, 10, 20, 30, 40 and 50 kg P_2O_5/feddan (concentration of acid should not exceed 300 ml/m^3 of water during growth). These treatments were splitted and added each 2 weeks and 4 as timing factor of application.

Fresh yield of roots and leaves beside root length and circuit increased significantly with elevating phosphoric acid rate. The most pronounced response was from 40 Kg P_2O_5/fed. The most effective frequent timing of application was proven to be each 2 weeks. Phosphorus concentration in the soil was significantly affected by different levels of phosphoric acid. The higher content of P under emitter is attributed to the accumulation of P during the fertilization cycle.

Soil acidification caused by phosphoric acid occurred to a large extent in the volume of soil below the emitters. Acidification was greater at the higher rates of the acid treatments. Under desert condition and calcareous soil, fertilization with phosphoric acid as a fertilizer source is suggested to be practiced repeatedly for its convenience, advantages and efficiency.
Keywords: Phosphoric acid , fodder beet , soil-P.

INTRODUCTION

The main purpose for producing forage crops is to feed sheep and cattle, which can be converted into protein-rich products for people. Grasses and legumes have traditionally been considered to be the most important fodders for livestock (Beatan and Berger, 1974). Fodder beet is considered one of the best fodder crops, which is suitable for Egyptian environment in addition to its tolerant to salinity. Despite the proven importance of fodder beet as a forage crop, growers seldom devote as much attention to its cultivation and fertilization as the other cash crops.

The application of plant nutrients through drip irrigation system (fertilization) has recently expanded due to its efficiency and convenience. Drip irrigation, which is a highly efficient method of water application, is also ideally suited for regulating the supply rate of water-soluble fertilizers (Papadcpoulos and Eliades, 1987 and Elfving, 1982).

Some of research trials on fodder beet which is conducted under saline water and desert condition were restricted primarily to N, P and K nutrients since high-yielding forage crops require such nutrients in substantial amounts (Wassif *et al.* 1987, Salem *et al.* 1988 and El-Sersawy, 1996).

Timing of fertilizers application is very important. For example, timing of N addition can be a critical factor on sandy soils. Late application has resulted in poor utilization (Stanley and Rhoads, 1977 and Gascha et al. 1984). The scheduled biweekly application of N is more efficient than with equal quantities applied in two sides dressing (Rhoads et al. 1978 and Wesley, 1979).

El-Maghara area, which located at the middle of Sinai (Egypt) is considered as a vital area for horizontal agricultural expansion in North Sinai and for building human community in the desert. Large increase in yield and quality of fodder beet under drip irrigation system are possible from adequate and quality of fertilization and timing of application, where P level in soil is not sufficient. For the above reason, this study investigates the effects of fertilization with phosphoric acid at different both rates and timing of application on yield, vegetative growth, soil P and pH below the emitters for fodder beet crop.

MATERIALS AND METHODS

Site of Experiment:

The experimental site was located at the Maghara Research Station of Desert Research Center at North Sinai. The soil had a soil pH of 8.2, EC 2.0dSm-1, an exchangeable cation content of Ca 0.55, Mg 0.15, K 0.61 and Na 12.8 Cmol kg-1 of soil. The soil is classified as sandy soil with 15.9% Ca CO3, 0.55% organic matter, 2.9 mg kg-1 available P, 0.02% total N, 31 mg kg-1 available K. The salinity of artesian irrigation water was about 2400 mg kg-1.

The Treatments:

The experimental treatments were 5 treatments of P applied with drip irrigation water as phosphoric acid at rates equivalent 0, 10, 20, 30, 40 and 50 kg P_2O_5/feddan. All treatments were received 90 kg/fed N as nitric acid (HNO3) and 50 kg/fed. K_2O as soluble potassium sulfate. The treatments were replicated 4 times in a randomized block design and were applied to 3 rows of fodder beet grown at 70 x 50 cm spacing (70 cm between lines and 50 cm between emitters). Irrigation water as drip irrigation system was applied to each of the plant from containers connected to drip lines.

As an average, over the seven months duration of the experiment during the winter season started Oct. 2000, the experimental treatments of phosphoric acid were splitted and applied each two weeks and each four weeks of successive fertilization.

Chemical Analysis:

At the end of growing season, soil cores were taken from below the emitters. Soil samples were prepared for analysis. Soil samples were extracted by ammonium bicarbonate and DTPA to determine the available P according to Soltanpour and Schwab (1977). Phosphorus was determined by ascorbic acid method as described by Olsen and Dean (1965), and measured by spectrophotometer. Measurements of soil pH on paste was carried out as indicated by McLean (1982). Also, fodder beet was harvested and fresh root yield and leaves were determined in addition to length and circuit of roots.

Calculation of Phosphoric Acid used:

The P content of fertilizers has been expressed in terms of P_2O_5 equivalent. The conversion of %P to P_2O_5 and vise versa is illustrated here with phosphoric acid (H3PO4).

%P in acid (75%) = 31/98 x 100x 75 / 100 = 23.7

%P = % P_2O_5 x 0.43

% P_2O_5 = %P x 2.29

% P_2O_5 (in acid) = 23.7 x 2.29 = 54.3

Amount of acid kg/red. = P treatment kg/fed./ 0.237

Amount of acid kg/fed. = P_2O_5 treatment kg/fed. / 0.543

RESULTS AND DISCUSSION

Effect of phosphoric acid levels:

1-Yield of roots and leaves:

The fresh yield of roots and leaves increased with elevating phosphoric acid rate. Table (1) includes data related to production of fresh roots and leaves as affected by application of phosphoric acid. Obviously, P induced positive significant above the control treatment. The increases in yield were progressive with the level of P addition in case of roots and leaves. The highest response was associated with 40 kg P_2O_5/fed, which produced 33.9 ton/fed of fresh roots and 4.4 ton/fed of fresh leaves. The magnitudes of increases were about twice in relative to control productivity.

Table (1): Effect of phosphoric acid as source of fertilizer on fresh roots, leaves, root length and root circuit of fodder beet*.

P_2O_5 Treatments kg/fed*	Fresh roots ton/fed	Fresh leaves ton/fed	Root length (cm)	Root circuit (cm)
0	19.2	2.1	17.4	43.6
10	24.4	2.8	22.1	46.9
20	25.9	3.2	23.0	47.5
30	29.5	3.8	23.9	48.8
40	33.9	4.4	25.8	51.3
50	32.2	4.00	24.6	50.6
LSD	1.23	0.98	1.11	1.35

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

2-Root length and circuit:

From data reported in Table (1) it is obvious that phosphoric acid application increased significantly length and circuit of roots. The most effective P level in this respect was 40 kg P_2O_5/fed, which gave 25.8 cm of root length and 51.3 root circuit, compared to 17.4 and 43.6 cm, respectively.

Timing effect of phosphoric acid application:

Splitting phosphoric acid application into two equal doses at two and four weeks is significantly effective on roots yield. Leaves yield; in addition to root length and circuit were relatively increased as affected by timing but not significant as indicated in Table (2).

Table 2: Effect of timing of phosphoric acid application on roots, leaves, root length and root circuit*.

P levels kg/fed*	Roots ton/fed		Leaves ton/fed		Root length (cm)		Root circuit (cm)	
	4w	2w	4w	2w	4w	2w	4w	2w
0	19.2	19.2	2.1	2.1	17.4	17.4	43.6	43.6
10	21.6	27.3	2.6	3.0	21.3	22.8	48.5	48.4
20	23.5	28.4	3.1	3.2	22.2	23.9	46.1	48.9
30	27.7	31.2	3.5	4.1	23.5	24.3	48.4	49.2
40	33.0	34.9	3.9	4.8	25.3	26.4	50.9	51.8
50	30.6	33.8	3.6	4.4	24.4	24.8	50.4	50.5
Main effect	25.9	29.1	3.1	3.6	22.3	23.3	47.5	48.8
LSD 0.05	1.69		N.S.		N.S.		N.S.	

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

Concerning the main effect of timing of P fertilization, there was a significant increase in yield of roots (Table 2). The most effective timing of P acid application is proven to be at each two weeks in comparing to each four weeks. For example, the biweekly application increased the yield up to 29.1 ton/fed of roots in relative to 25.9 ton/fed for the four weeks application, as a main effect. Leaves yield, root length and root circuit were increased, but not significantly responded to the biweekly application in the same trend for root yield (Table 2).

Available soil P:

Phosphorus concentration in the soil is significantly (LSD 0.05 = 1.15) affected by different levels of phosphoric acid (Fig. 1). Phosphorus was added as phosphoric acid, where P available values in soil varied between 2.9 mg kg-1 P in the control treatment and 15.2 mg kg-1 P from 40 kg P_2O_5/fed under emitter. A content of 3 mg kg-1 P is considered as low value for plant growth and 4 to 7 mg kg-1 is critical range (Soltanpour and Schwab 1977). The higher content of P under emitter is attributed to the accumulation of P during the fertilization cycle.

The ability to meet P fertilizer applications to meet crop needs throughout the growing season is critical. It is well known that there is a slow reaction that tends to remove phosphate from the soil solution and make it less available to plants, there seems to be great benefit from applying either continuously on often throughout the growing season.

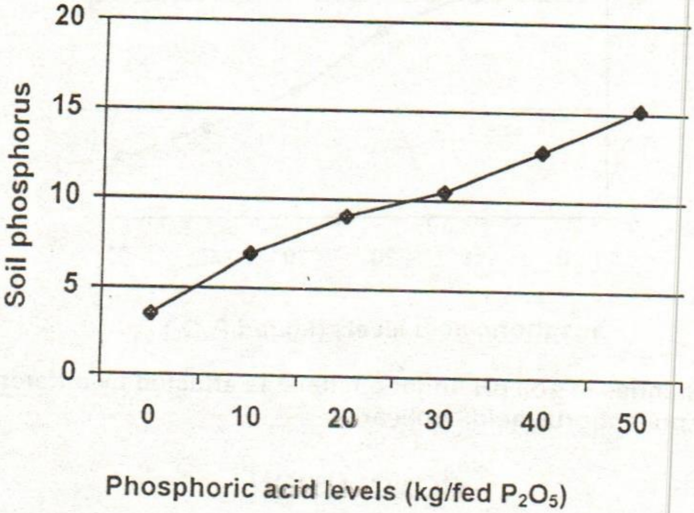

Fig (1): Available soil P under emitters as affected by different levels of phosphorus acid application

In general, plant needs P to be added either before planting, at planting on shortly after planting. Under desert condition there are a situation where applying P through the drip irrigation system is expected to provide the most efficient use of P during the cropping season.

Under drip irrigation system, only a portion of the total soil volume is wetted, where efficiency of P use could be increased by mixing phosphoric acid through the system.

Soil pH:

Application of phosphoric acid is greatly affect s[illegible]. Soil pH values were significantly different (LSD 0.05 = 0.53) (Fig. 2). Each increase in acid rate increases the acidity level from about 0.1 to 0.2 pH unit. At all rates of acid added, soil acidification occurred below the emitters. The higher rate of acids had a higher effect of acidity under emitters (pH 7.27).

Acidifying effects of the prolonged use of acid forming fertilizer are well known. These effects can be enhanced under drip fertilization system where application of phosphoric acid is concentrated in small volumes of soil under emitters rather than being spread over the soil surface.

The soil pH greatly affects the solubility of minerals, where, acidification of the soil below the emitter resulted in increased levels of Fe, Mn, Zn and Cu in the soil. (Soltanpour and Schwab, 1977).

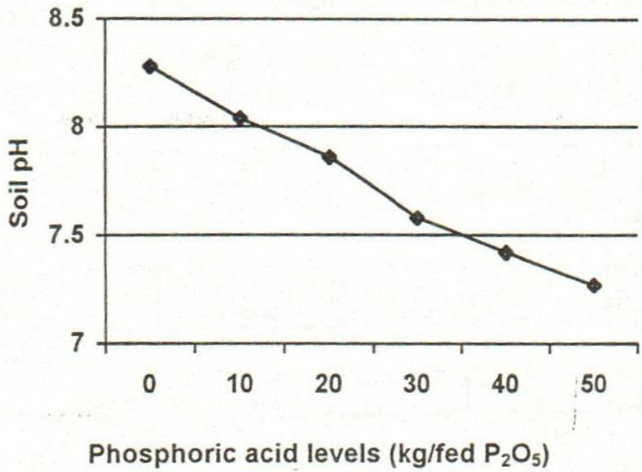

Fig (2): Changes in soil pH under emitters as affected by different levels of phosphorus acid application

CONCLUSION

Under drip fertilization system, where P is applied in the form of phosphoric acid (contains about 24% P or 55% P_2O_5) can have a significant effects on root and leaves of fodder beet crop productivity, in addition to root length and circuit. The most effective timing of phosphoric acid application is proven to be on biweekly basis. Applying phosphorus acid through drip irrigation system is expected to provide the most efficient use of P during the cropping season, where, only a portion of the total soil volume is wetted. Application of the acid is significantly affected soil pH, where the higher rate of the acid had a higher effect of acidity under emitters. Under desert condition and calcareous soils, fertilization with acids as a fertilizer sources is suggested to be practiced repeatedly for its advantages, efficiency and convenience.

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أثر معدل وتوقيت إضافة حمض الفوسفوريك مع مياه الرى على إنتاجية بنجر العلف ومحتوى الفوسفور وحموضة التربة أسفل النقاطات.

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مركز بحوث الصحراء – المطرية – القاهرة

يعتبر محصول بنجر العلف أحد أفضل محاصيل الأعلاف تحت الظروف المصرية ولزراعة هذا المحصول تحت مثل هذه الظروف خاصة فى المناطق الصحراوية مع استخدام الفوسفوريك بجرعات مختلفة وتوقيت إضافة مختلف كمصدر للسماد pH بالتربة أسفل النقاطات. وقد تم إجراء هذا البحث حيث تم إضافة ستة معاملات مختلفة من حمض الفوسفوريك (صفر، ١٠، ٢٠، ٣٠، ٤٠، ٥٠ كجم/ف فو٢أ٥) وذلك كل أسبوعين وكل أربعة أسابيع.

وقد حقق إضافة السماد زيادة معنوية فى إنتاج الجذور والأوراق وطول الدرنة ومحيطها، حيث أعطت المعاملة ٤٠ كجم/ف فو٢أ٥ أعلى إنتاجية. وقد كان إضافة الحمض كل أسبوعين هو التوقيت الأمثل لأعطاء أعلى إنتاجية. كما كان لإضافة حمض الفوسفوريك تأثير معنوى فى زيادة درجة الحموضة أسفل النقاطات بالإضافة إلى إرتفاع محتوى عنصر الفوسفور أسفل النقاطات أيضا نتيجة لتراكم العنصر بتكرار الإضافة فى مساحة محدودة من حجم التربة.

ولذلك فإن يقترح تحت ظروف الأراضى الصحراوية والجيرية باستخدام حمض الفوسفوريك تحت نظام الرى بالتنقيط كمصدر سماد فوسفاتى وذلك عن طريق الإضافة التكرارية لأعطاء أعلى كفاءة ممكنة.