EFFECT OF POTASSIUM FERTILIZER ON GROWTH AND YIELD OF CORN PLANTS IN SOME SOILS AT SULAIMANI GOVERNORATE.

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ABSTRACT

Field experiment was conducted to study the effect of KCl fertilizer on growth and yield of corn *Zea mays* L (Abu- Ghraib 106) was grown during the summer season of 2005 at two different locations in Sulaimani governorate. The first at Kanypanka and the second at Bazyan. KCl fertilizer was used with different rates (0, 75, 150, 225, 300 kg $K^{+}ha^{-1}$). Results indicated that the increasing of application of KCl fertilizer caused an increase in dry matter yield by an amount of 71.17% for Kanypanka location and 51.45% for Bazyan location. Grain yield was increased by the ratio of 30.17% and 55.45% for Kanypanka and Bazyan location respectively. The relative yield was 91.72 to 85.44 % for Kanypanka location and 97.00 to 65.83% for Bazyan location. The K-fertilizer response was increased from 8.27 to 41.56% at Kanypanka location while at Bazyan location was 3.00 to 34.25%. Fertilizer use efficiency ranged from 61.63 to 85.53% for Kanypanka location and from 26.60 to 54.83 % for Bazyan location

INTRODUCTION

The main task of new regime in Iraq is to improve national economy. Agriculture is considered one of the main resources of economy of the country; therefore the government is planning now to intensify agriculture in order to increase the national income. Application of mineral fertilizers and adoption modern methods of irrigation is considered the main methods of intensifying the Iraqi agriculture. Nitrogen and phosphorus fertilizers have been extensively used since long time, while potassium fertilizers have been forgotten in fertilizer recommendation in Iraq due to the widespread belief that Iraqi soils are well supplied with native potassium. The results of recent field experiments have shown that there is good response for potassium fertilizers by various crops (Al-Zubaidi, 2001).

The status of potassium in Iraqi soil have been studied by many investigators (Al-Zubaidi and Pagel, 1979; Edan *et al*., 1987), the results of these investigators had shown that the Iraqi soil are rich in potassium, determined or tested by traditional methods of analysis. Besides the Iraqi soils are characterized by high capacity of potassium fixation due to the presence of beidillite mineral. Using thermodynamic and kinetics methods showed that the rate of release of potassium from Iraqi soils is very low and this may explain the response of most Iraqi soils to K-fertilizers application in spite of their high content of potassium (Al-Zubaidi, 2004).

Through its function as an activator of numerous enzymatic reactions and in electrochemical processes, potassium (K) plays a key role in assimilation; phloem loading and long-distance assimilate transport, in nitrogen (N) metabolism and in storage processes. Thus, K is indispensable for yield and quality in plant. In its role

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as an osmotically active cation and in controlling the water relations in plants, K has a vital role in the response of crop to adverse climatic and soil conditions such as drought, frost or salinity. And last but not least, potassium is very much involved in the mechanisms involved in plants resistance and tolerance to pathogens (Krauss and Johnston, 2002).

To fulfill these many roles in plants, K is absorbed in rather large quantities, even exceeding the amount of nitrogen. Another unique feature is that the bulk of the uptake of K occurs within a short period of time in annual crops, for cereals usually before the onset of flowering. Daily K uptake rates were between 5 and 10 kg K h^{-1} are not uncommon for high yielding annual crops. When soils with a low K content fail to release adequate amounts of K into the soil solution, yield is decreased and quality impaired and the crops are more susceptible to biotic and abiotic stress irrespective to the supply of other nutrients (Krauss and Johnston, 2002).

Potassium accumulation during the early growth stages of corn is faster than that of dry matter (Welch and Flannery, 1985). The dilution effects and translocation of K form leaves and stalk to the cob and grains cause a rapid decline in K in the vegetative shoot. Peak demand for K is in the short pretasseling stage (14-21 days) when about 38% to 59% of total K uptake occurs (Hanway, 1962). In this short period, average daily uptake of K ranges from 2.31 to 10.74 kg h^{-1} of total K in the plant at grain harvest (Welch and Flannery, 1985).

The purpose of this investigation is to study the effect of K fertilizer on plant response and fertilizer use efficiency in different soil types from Sulaimani Governorate. Also the study will be included the K uptake and relative yield of corn plants.

MATERIALS AND METHODS

Two locations in Sulaimani governorate in Kurdistan were selected for this trial, the first one is Kanypanka (578 masl 35^o 22' 37''N 45^o 43'33'' E)(Typic Haploxerolls) and the second one is Bazyan (875 masl 35^o 38' 22''N 45^o 02'17'' E)(Typic Xerorthents) for conducting the experiment at each location. Detailed descriptions of chemical and physical properties of these soils were shown in Table (1). Soil samples from Ap horizon (0-30cm) after collection from the field were air-dried, ground and then sieved through a 2mm sieve. Soil chemical and physical analyses were conducted according to methods mentioned in Page *et al*. (1982).

The experiment was designed to study the effect of KCl fertilizer on corn response to KCl application, therefore *Zea mays* L (Abu- Ghraib 106) was grown during the summer season of 2005 at the field of Kanypanka Agriculture Station on 7, July, 2005 and at Bazyan Agriculture Station on 8, July, 2005. The treatments were KCl fertilizer with different application rates, which were (0, 75, 150, 225, 300 kg $K^{+}ha^{-1}$), N and P fertilizers were applied at fixed rate of 200 kg N ha^{-1} as urea and 200kg P_2O_5 ha^{-1} as triple superphosphate respectively.

The experiment was conducted under conventional furrow irrigation system; the plots were irrigated every 5-7 days at required time. Randomized Complete Block Design (RCBD) with three replicates was used. Each plot area was 7.5 m^2 (3m x 2.5m) and consisted of 4 rows of 2.5 m long each and the drilling patterns comprised of 70 cm between rows and 20 cm between plants, the seeds were sown in a 5-6 cm depth.

The K fertilizer with P and half of N fertilizers were mixed and applied in the form of banding at distance of 5 cm from seed sites and another half amount of N fertilizer was applied after one month from germination. The plant samples for analyses were collected from the center of 2 rows from each plot. The plants were harvested on 13, October, 2005 at Kanypanka location and on 21, October, 2005 at Bazyan location. The harvested corn shoots were weighted and dried at 65^{o}C for 72 hr to determine the dry matter yield. Dried plant material were digested by using 1:1 (H_2SO_4: H_2O_2) to evaluate of plant nutrients contains (Schuffeelen and Van Schuwenburg, 1961). Potassium in acid digested extracts was determined by flame photometer. Total K uptake and percentage yield and percentage K recovery were calculated according to (Gate and Nelson, 1965).

Table (1): Some physical and chemical properties of soil used in field experiment.

Properties		Location	
		Kanypanka	Bazyan
Particle Size Distribution(PSD) g kg^{-1}	Sand	33.9	58.6
	Silt	508.0	574.5
	Clay	458.1	366.9
Texture Class		SiC	SiCL
pH		7.46	7.83
EC_e dS m^{-1} at 25^{o}C		0.72	0.52
Soluble ions mmol L^{-1}	Ca^{2+}	1.60	2.11
	Mg^{2+}	0.34	0.91
	Na^{+}	0.42	0.74
	K^{+}	0.08	0.11
	HCO_3^{-}	2.75	5.08
	Cl^{-}	0.42	0.78
	SO_4^{2-}	0.93	0.87
Exchangeable cations $cmol_c$ kg^{-1}	Ca_{ex}	42.21	35.08
	Mg_{ex}	2.30	5.98
	K_{ex}	0.70	0.75
	Na_{ex}	0.48	0.43
O. M. g kg^{-1}		26.50	31.70
$CaCO_3$ equivalent g kg^{-1}	Total	227.50	197.70
	Active	100	70

Statistical analysis: Least significant differences for comparison between treatments at level of significant (0.05) and simple correlation were preformed according to Milton and Jesse(1995) between depending variable Yield, plant K concentration, total K uptake and the most important independent variables.

Biological parameters were calculated as following:

Relative yield = (yield of control / yield of fertilized treatment) x 100…………..(1)

%Response = (yield fertilized – yield control) / yield fertilized x 100….……… (2)

FUS =[{K-uptake(fertilized) –K-uptake (control)} / K-added] x 100…………(3)

According to Westerman (1990) and Tisdale, *et al*. (1997).

RESULTS AND DISCUSSION

Dry matter and grain yield: Potassium fertilizer application significantly increased dry matter yield and grain yield (Table 2). Dry matter yield was from 9.76 to 16.70 and 8.42 to 12.79 M*g*.ha^{-1} for Kanypanka and Bazyan location respectively. While, the grain yield was from 6.33 to 8.24 and 5.05 to 7.85Mg.ha^{-1}for Kanypanka and Bazyan location, respectively (Table 2). The percentage increase in dry matter yield was 71.1% for Kanypanka and 51.90% for Bazyan location. While the percentage increase of grain yield was 30.17% for Kanypanka and was 55.45% for Bazyan and the percentage increase of K-uptake was 122.85% for Kanypanka and 78.96% for Bazyan location comparing with control treatment. These results indicated clearly that increasing K- fertilization caused a linear increasing in each grain and dry matter yield and K-uptake for two locations as shown in Figures (1, 2, 3, 4, 5 and 6) which indicated a positive relationship (R^2=.0.958, 0.912, 0.955) for Kanypanka location and (R^2= 0.954, 0.837, 0.963) for Bazyan location between K-level and dry matter, grain yield and K-uptake respectively. This refers to K fertilizers demand. The results agree with Devitt, *el al*.(1984) Heckman and Kamprath(1992) Krauss(1993) Reham (1995) they referred that the application of K fertilizer are important to increase the yield of corn plant. Reham, 1995 referred that is necessary to apply K fertilizer for corn plant even if soil analysis showed adequate amount of available K. Fertilizer Use Efficiency (FUS) from the Kanypanka location was increased for the first and second fertilizer levels but decreased from the third level to 61.63% in spite of increasing of dry matter yield and K- uptake this maybe due to K fixation and reversible dynamics which decreased the availability of potassium through the growth period, after the third level the (FUS) increased to 81.28% comparing with control treatment. This clearly reverses the role of soil texture and the type of dominant clay mineral in the soil. While from Bazyan location we show the (FUS) was increased from 26.60% to 54.03% this mean that the soil of Bazyan has the K deficient comparing with Kanypanka location.

Potassium uptake by corn plant: The uptake of nutrients from soil by plants depends upon the amount of nutrient available and the movement of the ion in the soil solution (Graham, 1973; Graham and Camillus, 1979). Soil literature abounds with reports related to the various aspects of ion uptake by plant for major elements. This information when correlated to crop yield has resulted in the use of soil chemistry to determine amount of fertilizer needed to add to the soil for a successful crop.

The results in Table (3) referred to the significant affect of potassium fertilizer on potassium uptake of corn plant in Kanypanka and Bazyan location in Sulaimani governorate. These results show also that increasing potassium fertilizer addition from 75 to 300 kg K ha^{-1}.As KCl, significantly increased the uptake of K by corn from 198.48 to 442.31 kg ha^{-1} for Kanypanka location and from 128.02 to 290.12 kg ha^{-1}for Bazyan location. The increasing percentage of K uptake was (122.85%) at Kanypanka and (126.62%) at Bazyan location respectively when compared with control treatment. The results indicated clearly that increasing K-fertilization caused a linear increasing in K uptake for two locations (Fig. 5 & 6) which refers to K fertilizers demand. These results are agreed with results reported by Shahin, *et al*. (1987) Krauss (1993) Seiffert, *et al*. (1995) Rogerio and Antonio (2001).They found that fertilization of K increased uptake of K for corn plant.

Effect of potassium level on (%) of response and relative yield: Result in Table (3) referred that the relative yield was decreased from 91.72 to 58.44% for Kanypanka location and from 97.00 to 65.83 % for Bazyan location. While the response percentage for dry matter yield affected by K fertilizer level and soil type, the range of response percentage increased with increasing K fertilizer level from 8.27 to 41.56% for Kanypanka location and from 3.00 to 34.25 % for Bazyan location. This could due to K fertilizer utilized by plant for increasing metabolism activity (Mengel and Kirkby, 1982; Havlin *et al*., 1999).

Table (2): The effect of K fertilizer application on the grain yield, dry matter weight and K – uptake of corn plant

Location	Treatments	Grain yield	Dry matter	K-uptake
		Mg ha^{-1}		kg ha^{-1}
Kanypanka	K_0	6.33	9.76	198.48
	K_1	7.09	10.65	256.95
	K_2	7.37	14.03	326.77
	K_3	7.42	14.65	337.14
	K_4	8.24	16.70	442.31
	L.S.D$_{0.05}$	0.62	3.38	62.43
Bazyan	K_0	5.05	8.42	128.02
	K_1	6.00	8.68	147.97
	K_2	6.15	10.44	184.48
	K_3	6.24	12.16	226.85
	K_4	7.85	12.79	290.12
	L.S.D$_{0.05}$	0.84	1.76	84.15

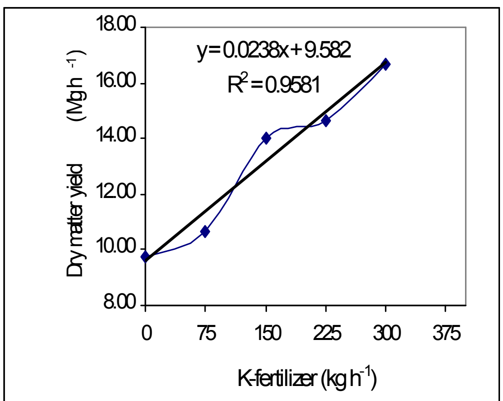

Fig.(1): The effect of K-fertilizer on dry matter yield of corn plant in Kanypoanka

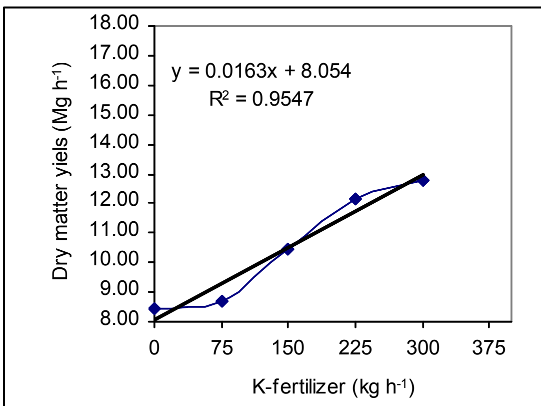

Fig.(2): The effect of K-fertilizer on dry matter yield of corn plant in Bazyan location

Table (3) Effect of potassium level on (%) of response, relative yield and fertilizer use efficiency.

K-fertilizer kg K ha^{-1}	Dry matter Mg ha^{-1}		K-uptake kg ha^{-1}		Relative yield (Control/ fertilized) x 100		Response%		Fertilizer use efficiency%	
	Kanypanka	Bazyan	Kanypanka	Bazyan	Kanypanka	Bazyan	Kanypanka	Bazyan	Kanypanka	Bazyan
0	9.76	8.42	198.48	128.02	……	……..	…….	……	……	……..
75	10.65	8.68	256.95	147.97	91.72	97.00	8.27	3.00	77.96	26.60
150	14.03	10.44	326.77	184.48	69.57	80.65	30.43	19.35	85.53	37.64
225	14.65	12.16	337.14	226.85	66.62	69.24	33.38	30.76	61.63	43.92
300	16.70	12.79	442.31	290.12	58.44	65.83	41.56	34.25	81.28	54.03

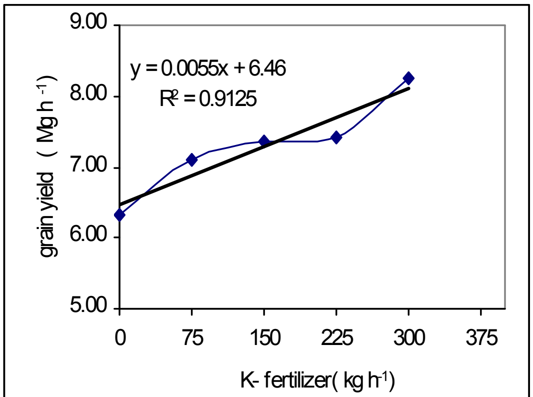

Fig.(3):The effect of K-fertilizer on grain yield of corn plant in Kanypanka location

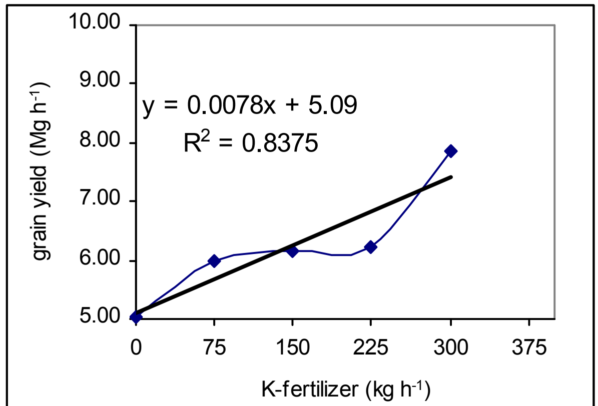

Fig.(4):The effect of K-fertilizer on grain yield of corn plant in Bazyan location.

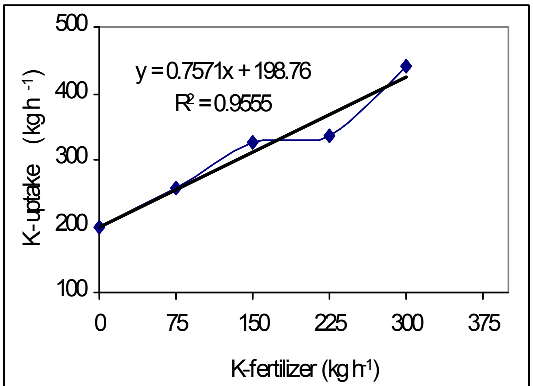

Fig.(5): The effect of K-fertilizer on K-uptake by corn plant in Kanypanka location.

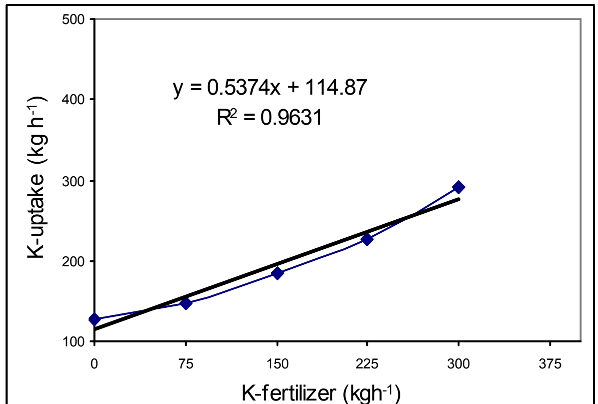

Fig.(6): the effect of K-fertilizer on K-uptake by corn plant in Bazyan locaton

تأثير إضافة السماد البوتاسي في نمو و حاصل الذرةالصفراء في بعض ترب محافظة السليمانية

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الخلاصة

أجريت تجربة حقلية لدراسة إستجابة محصول الذرة الصفراء للسماد البوتاسي. وتمت زراعة نباتات الذرة الصفراء صنف (أبوغريب١٠٦) خلال الموسم الصيفي عام ٢٠٠٥في موقعين مختلفتين ضمن محافظة السليمانية. و كانت الموقع الأول في كاني بانكة والموقع الثاني في بازيان . وتم إستخدام السماد البوتاسي على صورة كلوريد البوتاسيوم (KCl) و بخمسة مستويات مختلفة (صفر ، ٧٥، ١٥٠، ٢٢٥، ٣٠٠ كغم بوتاسيوم لكل هكتار) .أشارت نتائج الدراسة إلى زيادة في حاصل المادة الجافة و حاصل حبوب الذرة عند زيادة مستويات السماد البوتاسي المضاف ، و بلغت نسبة الزيادة في حاصل المادة الجافة ٧١.١٧% للموقع الأول و ٥١.٤٥% للموقع الثاني. بينما بلغت الزيادة في نسبة حاصل الحبوب ٣٠.١٧% و ٥٥.٤٥% لموقع كاني بانكة و بازيان على التوالي.و كذلك تراوح الحاصل النسبي من ٩١.٧٢% إلى ٨٥.٥٤% للموقع كاني بانكة و من ٩٧.٠٠% إلى ٦٥.٨٣% لموقع بازيان.كانت الزيادة في الإستجابة للسماد البوتاسي من ٨.٢٧% إلى ٤١.٥٦% لموقع

كاني بانكة و ٣.٠٠% إلى ٣٤.٢٥% لموقع بازيان بينما بلغت كفاءة إستخدام السماد البوتاسي من ٦١.٦٣% إلى ٨٥.٥٣% لموقع كاني بانكة و من ٢٦.٦٠% إلى ٥٤.٨٣% لموقع بازيان.

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