EFFECT OF NPK FERTILIZATION ON YIELD OFMAIZE AND POTATO

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ABSTRACT

Two field experiments were conducted at the College of Agriculture, University of Baghdad in a silty clay loam soil .The 1st trial included five combinations of elements N-P-K 0-0-0,100-100-100,200-100-100,200-100-200, and 300-100-200 Kg ha-1, and two irrigation scheduling regimes by application of water when 50 and 75 of available water depletion and maize plants were used as plant indicator. The 2nd trial included three combinations of elements N-P-K 0-0-0,100-100-100, and 200-100-200, Kg ha-1 with potato used as plant indicator. Results of the 1st trial indicated that significant effect of nutrient applied on plant height. The treatment 200-100-200 gave the best results with 7.3% increase in plant height compared to control treatment. Plant height was higher in the 75% compared to 50% water depletion treatment. Neither nutrient combinations nor water regimes alone gave any significant differences effects on dry matter yield and grain yield. However, there was a significant interaction effect on grain yield with control treatment at 50% water depletion giving best results (250 gm plant-1). The results of 2nd trial indicated significant effect of nutrients application on potato tuber yield with treatment 200-100-200 giving showed a highest yield with 20.16 ton ha-1. It was concluded that crop genus, soil type, method of irrigation, and surrounding environmental conditions have affected plant responses to treatments applied. However, generally speaking the treatment 200-100-200 was almost the best treatment in both trials in terms of plant height of maize and grain and tuber yield of maize and potato respectively. The lacks of clear cut response to water regime treatments in the 1st trial signify the rationalization of water applications especially for spring sawn corn crop.\

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تأثير التسميد بالنتروجين والفسفور والبوتاسيوم في انتاجية محصولي الذرة الصفراء والبطاطا

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المستخلص

نفذت تجربتان حقليتان في الحقل المخصص للبحوث في كلية الزراعة – جامعة بغداد في تربة مزيجة طينية غرينية.تـضمنت التجربـة الاولى خمس معاملات لمستويات مختلفة من NPK هي القياس و100-100-100 و200-100-100 و200-100-300،200-100-200 كغم هـ-1 .تم ذلك تحت نظامين لاضافة المياه تمثلت باضافة الماء عند استنزاف 50 % و 75 % من الماء الجاهز للتربـة وتـأثير ذلك في انتاجية الذرة الصفراء. اما التجربة الثانية فأنها تضمنت ثلاث معاملات لمستويات NPK هـي القيـاس و100-100-100 و 200-100-200 كغم هـ-1 وتأثير ذلك في انتاجية البطاطا. بينت نتائج التجربة الاولى ان هناك تأثيراً معنوياً للمغذيات المـضافة فـي ارتفاع النبات واعطت المعاملة 200-100-200 افضل النتائج مع 7.3% زيادة في ارتفاع النبات مقارنةً مع معاملة القياس.ارتفاع النبات كان اعلى في المعاملة 75 % مقارنةً بالمعاملة 50 % استنزاف من الماء الجاهز.لم يكن هناك تأثيراً معنوياً لا للمغـذيات ولا لنظـامي الماء كل على حده في صفتي انتاج المادة الجافة وانتاج الحبوب ولكن كان هناك تداخل معنوي بين المعاملات المختلفة وافـضل انتـاج للحبوب كان مع معاملة القياس واستنزاف 50 % (250 غم نبات-1).اما نتائج التجربة الثانية فأشارت بشكل واضح الى استجابة البطاطا للأسمدة المضافة والمعاملة 200-100-200 كغم هـ-1 اعطت افضل انتاج مقداره 20.16 طن هـ-1. عدم وضوح التاثيرات للمعـاملات في هذة الدراسة لاسيما جدولة اضافة المياه يؤكد ضرورة تقنين المياه لاسيما في الزراعة الربيعية لمحصول الذرة الصفراء. يستنتج مـن هذة الدراسة ان الاستجابة للمستويات السمادية والنظام المائي تختلف حسب المحصول ونوعه ونوع التربة وطريقـة الـري والظـروف المحيطة وهنا الموسم الزراعي.

INTRODUCTION

Potassium is one of the three major essential nutrients which plants absorb in amount similar more or less to that of nitrogen (23). Potassium content in plant tissue not only is higher than that of other cations but it is also the most important cation in many physiological and biochemical processes. Although the overall effects of K on photosynthesis, carbohydrate and protein synthesis and on the water economy of the plant have been confirmed in numerous experiments (25, 26, 27, 28). The actual functions of this element in the physiology of the plant and in yield formation have for long been obscure. The mobility and participation of K in the activation of important enzyme reactions are two important fundamental characteristics of this element. The uptake of K is frequently as high as or even higher than the uptake of nitrogen (25). For example, a maize cultivar producing a grain yield of 12.6 t. ha^{-1} removes about 23 kg of K in the grains. Potato is a heavy remover of soil potassium and is the nutrient taken up in the greatest quantity. Imas &Bansal (24) indicated that the tuber remove 1.5 times as much K as N and 4-5 times the amount of P. According to Perrenoud (34), a crop yielding 37 t. ha^{-1} removes 113 kg N, 45 Kg P_2O_5 and 196 Kg K_2O per hectare. However, fertilizers use and applications became increasingly unbalanced, and N: K ratios went down from 1.0:0.74 in the 60ies to 1.0:0.27 at the end of last century, as a global trend (32).The main reason for this unbalanced fertilization is that potassium has to be imported in many countries of the world and for this reason potassium fertilizers are quite expensive especially when we talk about sulfate sources. If we compare this situation with nitrogen fertilizers especially urea, we realize that urea manufactured locally in many countries and it is fairly of low price .This situation quite true in Iraqi agriculture (7 , 14).The other reason is related to the old - new hypothesis which says that arid and semiarid regions have enough potassium and no need for its application. Field experiments in Iraq and other areas in the world proved that this hypothesis not always true, especially under intensive agriculture. For example, vegetables grown under protected cover (i.e. plastic houses)are given N & P fertilizers in high amounts but without K application.. This situation leads K to be the limiting factor for plant growth. Therefore, workers encouraged to balance their fertilizers application for higher yield and with low harm to environment(i.e. implementing of DRIS)(4 , 21 , 22). Imas & Bansal (24) indicated that high yield of potato can only be sustained through the application of optimal NPK doses in balanced proportion. On other side, many cases are known in which no correlation has been found between soil potassium test and yield response to potash application(26).This was confirmed by trials using kinetics which indicated that even when the capacity of K is medium to high the rate of release or the rate of K movement to plant roots is fairly slow and low to crop demands (i.e. even if K chemically available it is not bioavailable)(16).Most Iraqi soils classified as low -moderate in its content of K and very low in its rate of release(8 , 10 , 15). A number of crops (field & vegetable crops) responded to K fertilizers application even when soil test indicated a high content (11 , 12) for potato and maize respectively). However, under certain situations there was no response to K applications (1). Soil type, crop genus, method of irrigation, and surrounding growth conditions factors affecting responses to K applications (32).In a field experiment using different sources, rates of K fertilizers applied under different irrigation methods the response was only under more efficient irrigation method(drip & sprinkler through fertigation (9). It is quite evident that crop yield can be improved through balanced fertilization (28 , 29) and good water management practices (35).Alternate furrow irrigation for maize gave reasonable results in rationalization of water use and productivity of maize (5,6)

Therefore, this article aimed to address part of this issue through applying different ratios and levels of N, K and fixed amount of P to investigate their effect on maize and potato growth & yield.

MATERIALS & METHODS

Two Field experiments were conducted at the College of Agriculture, University of Baghdad on a silty clay loam soil, (Terrifluvents). Soil samples from A horizon (0-0.3m) were air dried, ground and then sieved through 2 mm sieve. Soil samples then analyzed (18,33) for physical and chemical soil properties. Results of analyses are shown in Table 1a.The treatments of the 1st trial included 5 rates of elemental N-P-K: 0-0-0, 100-

100-100, 200-100-100, 200-100-200, and 300-100-200 Kg ha^{-1} respectively. Water regimes (scheduling) applications included two treatments: applying water at 50% and 75% depletion of available water (10, 31) (i.e. number of water application differ in the two treatments). Treatments were replicated 4 times and arranged at the field according to RCBD. Maize (*Zea mays* L) Buhoth 106 cultivar seeds were sown in furrows(0.75 m apart and 0.20 m between hills) prepared after plowing and leveling .The seeds were planted at the 2nd week of March 2005 .All required management practices were done as recommended. Dizenon 60% was applied to each plant after 3 weeks of emergence. At the 1st month all plots were watered similarly (applying water at 50% depletion).This was to insure good germination, vegetative and root growth. After this period, water applications were scheduled according to previously mentioned. Scheduling of irrigation some times faces difficulties due to not easily controlled situations such as unavailability of water at the calculated time. At maturity, all plants of middle furrows in each experimental unit were taken for calculations of plant height, dry matter and grain yield. The 2nd trial was conducted on clay loam soil,(Terrifluvents). Soil samples were collected, treated and analyzed as previously described. Results of analyses are shown in (Table 1b). The treatments for the 2nd trial included 3 rates of N-P-K: 0-0-0 , 100-100-100, 200-100-200 , Kg ha^{-1}. Treatments were replicated 3 times and arranged at the field according to RCBD. Potato (*Solanum tuberosum* L) CV. Dezery was planted at mid of February 2005 in furrows (0.75 m apart and 0.25 m between plants) .All recommended management practices were done. All experimental units were irrigated evenly and weekly through the growing season until two weeks before harvest.. Fertilizer treatments applied in three split applications (planting, vegetative, and flowering stages).Data were analyzed using SAS (37)and differences among treatments were compared .

Table 1 some of physical & chemical properties of soil used.

Soil Properties	Units	1st trial(1a)	2nd trial(1b)
		Values	
pH	-	7.20	7.52
EC_e	dS m^{-1}	2.20	3.86
$CaCO_3$	g Kg^{-1}	234	230
OM	g Kg^{-1}	14.2	12.5
Available N(NO_3+NH_4)	mg Kg^{-1}	58	80
Available P	mg Kg^{-1}	95	117
Available K (soluble + exchangeable)	mg Kg^{-1}	227	278
	$Cmol_cKg^{-1}$	0.58	0.71
Sand	g Kg^{-1}	160	340
Silt	g Kg^{-1}	460	300
Clay	g Kg^{-1}	380	360
Texture		Silty clay loam	Clay loam

RESULTS & DISCUTION

Experiment one : Results of plant height increased significantly with 200-100-200 can be attributed to good balanced levels of nutrients supply to plants. The role of balanced N-P-K for cell growth and development is quite known (23, 28, 32).This result is similar to that of Al-Sa'ady (9). Table 2 also indicates that applying water less frequently (i.e. at 75% depletion of available water) gave fairly better plant height than applying water more frequently (50% depletion). This can be explained according to the interactions between moisture levels and nutrient availability. Narrowing the time among irrigation intervals could have under this situation negative effects on root respiration and nutrients loss.(9 , 10 , 20).Besides, maize plant heights known to be affected by moisture distribution efficiency and fertilizers applications(36).Table 3 and 4 display results of maize dry matter and grain yield, respectively. From these two tables it can be seen that control treatment gave similar if not better than treated. This can be explained either due to enough soil available amounts of nutrients at this treatment (Tables 1a). The history of the experiment site known by repeated applications of different amount of fertilizers due to its use as a research experimental site. This was clear and reflected on data in Table 1. Although the correlation between soil test and crop response to fertilizers application not always positive, the critical soil test for K around 141 mg Kg^{-1} (0.36 $Cmol_cKg^{-1}$ for exchangeable K (13 , 38) .This means that there is almost enough amounts of available K. On the other hand, maize production at spring season conditions in Iraq some times faces some difficulties at high temperature at the grain filling. High temperature at this stage or low rainfall or shortage of water could negatively affect grain filling (30).Besides, the lack of response to applied treatment could be attributed to the method of irrigation used. It is indicated by some workers that response to applied fertilizers are affected by method of irrigation (9). Al-Sa'ady (9) found in a field experiments conducted in two locations in Iraq that maize respond to K applications under drip compared to furrow irrigation. Hassan (22),was not be able to establish DRIS norms depending on soil test for a silty clay soil planted with maize due to instability of soil test and complexity of soil. Therefore, our finding was in the same trend of that of Al-Sa'ady (9). However, these results differ than others (2 , 11) that found significant effects to nutrients applied to maize. Al-Amery (2), applied N-P-K in a rate of 320-100-160 Kg. ha^{-1} in a silty loam soil that soil K test around 160 mg K .Kg^{-1}soil(0.41 Cmol $_c$ K Kg^{-1}soil).Al-Falahi (3),used DRIS and found that best combination for maize was N200,P200,K100 Kg ha^{-1} applied to soil and as foliar.

Table 2 Effects of fertilizers application treatments & water regime on plant height (cm)

fertilizers application treatments(F) Kg element ha^{-1}			water regime depletion of Available water(W)		mean
N	P	K	50%	75%	
0	0	0	238.0	233.8	335.9
100	100	100	233.0	258.8	246.0
200	100	100	226.0	240.0	233.0
200	100	200	243.8	262.5	253.1
300	100	200	245.0	253.8	244.0
mean			237.0	249.8	
LSD 0.05 F = 20.5 ,W= 13.0 , F × W =29.5					

Table 3. Effects of fertilizers application treatments & water regime on dry matter yield (g plant $^{-1}$)

fertilizers application treatments(F) Kg element ha^{-1}			water regime depletion of Available water(W)		mean
N	P	K	50%	75%	
0	0	0	517.5	522.5	520.0
100	100	100	510.0	499.0	504.3
200	100	100	500.0	500.0	500.0
200	100	200	520.0	503.3	511.6
300	100	200	525.8	506.5	516.1
mean			515.0	506.0	
LSD 0.05 F =24.9(NS) ,W= 15.7 (NS) , F × W =37(NS)					

Table 4 Effects of fertilizers application treatments & water regime on grain yield (gm plant $^{-1}$)

fertilizers application treatments(F) Kg element ha^{-1}			water regime depletion of Available water(W)		mean
N	P	K	50%	75%	
0	0	0	250.0	207.0	228.5
100	100	100	140.0	213.0	176.5
200	100	100	220.0	150.0	185.0
200	100	200	240.0	207.0	223.5
300	100	200	220.0	213.0	216.5
mean			214.0	198.0	
LSD 0.05 F =74.8 (NS) ,W= 47.3(NS) , F × W =105.7(*)					

Second trial: Results of marketable potato tubers yield are shown in Table 5. Results indicated significant increase in the yield with 200-100-200 treatment compared to control. This can be attributed to good balanced levels of nutrients supply to plants. As mentioned above potato responds highly to nutrients application(24).In Iraq many researchers indicated high response to balanced nutrient applications(12 , 17).. Although the critical soil test for K around 141 mg Kg^{-1} (0.36 $Cmol_cKg^{-1}$ for exchangeable K (13). There are some publications which

indicated that for some soils and under some conditions the critical level of soil K test was around 450 mg Kg^{-1} (1.15 $Cmol_cKg^{-1}$ (27).

Therefore, the response to nutrient application is possible even though soil test indicated level higher than 200 mg K Kg^{-1} soil (Table 1).However, Abdu Rassoul (1) did not find any response to different levels of K applied with N ,P and different levels of organic matter in a field experiment with potatoes in a medium texture soil contained only 200 mg K Kg^{-1}soil (0.51 $Cmol_c$ K Kg^{-1}soil).

Therefore, it can be seen that the degree of response depends on soil test, crop genus and expected yield, amount of N-P-K applied, and method of irrigation. Also, the effects of different water regimes on maize yield were not clear cut and this can be due to the growth season and water r

Table 5 Effects of fertilizers application treatments potato tuber yield ($t\ ha^{-1}$)

fertilizers application treatments(F) Kg element ha^{-1}			Marketable Tuber Yield ($t\ ha^{-1}$)
N	P	K	
0	0	0	12.33
100	100	100	15.50
200	100	200	20.16
mean			16.00
LSD 0.05 F = 0.51			

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