EFFECT OF ORGANIC AND INORGANIC FERTILIZER ON AVAILABILITY OF POTASSIUM IN SOIL AND YIELD OF CHICKPEA (Cicer arietinum L.).

H. S. Y. Akrawi
Lecturer
haifa.yaseen@su.edu.krd
Department of Soil and water Science, College of Agriculture, Salahadin University, Erbil - Iraq.

ABSTRACT

A field experiments was conducted to evaluate the effect of soil amendments with organic and inorganic fertilizer (chemical fertilizer) on the potassium availability, improve growth and yield of chickpea (Cicer arietinum L). In this experiment each organic and inorganic fertilizer (NPK 15: 15: 15) was added as amount equivalent to potassium (K) at levels 0, 12.5, 25, 50, 100 kg K ha^{-1}. Results revealed that there were significant effect of application organic and inorganic fertilizer on soluble and exchangeable K in soils, the application of organic and inorganic fertilizer at level of 100 kg K ha^{-1} increased the soluble K from 4.1mg L^{-1} to 7.99 and 6.00 mg L^{-1} respectively while, the exchangeable K increase from 23.46 mg kg^{-1} soil to 118.47 and 74.29 mg kg $^{-1}$ soil respectively. The uses of the previous treatments were also effective to gain higher yield of chickpea. Application of 100 kg K ha^{-1} in both organic and inorganic fertilizer gave significantly the highest value. The highest biological yield (2537.78 and 2422.22 kg ha^{-1}) was obtained when the soil amended with 100 kg K ha^{-1} organic matter and inorganic fertilizer respectively.

Key word: Potassium, organic fertilizer, inorganic fertilizer, chickpea (Cicer arietinum L.)

تاثير االسماد العضوي والمعدني في جاهزية البوتاسيوم في التربة و حاصل الحمص (Cicer arietinum L.)

هيفاء صديق ياسين عقراوي
مدرس
haifa.yaseen@su.edu.krd
قسم علوم التربة و المياه- كلية الزراعة- جامعة صلاح الدين- اربيل – العراق.

المستخلص

اجريت تجربة حقلية لتقييم تاثير تربة معاملة بسماد عضوي و معدني في جاهزية البوتاسيوم و زيادة حاصل الحمص. في هذه التجربة كلا من السماد العضوي و المعدني تم اضافتها على اساس نسبة ثابتة للبوتاسيوم و بخمس مستويات (100, 50, 25, 12.5, 0) كغم بوتاسيوم هـ $^{-1}$. وقد اشارت النتائج الى التأثير المعنوي للسماد العضوي و المعدني في كمية البوتاسيوم الذائب و المتبادل في التربة. ادى اضافة السماد العضوي و المعدني لمستوى 100 كغم بوتاسيوم هـ $^{-1}$ الى زيادة البوتاسيوم الذائب من 4.1 ملغم لتر$^{-1}$ الى 7.99 و 6.00 ملغم لتر$^{-1}$ على التوالي. بينما ادى الى زيادة البوتاسيوم المتبادل من 23.46ملغم كغم$^{-1}$ تربة الى 118.47 و 74.29 ملغم كغم$^{-1}$ تربة. كذلك استخدام المعاملات السابقة ادى الى زيادة حاصل الحمص، حيث شهدت استخدام 100 كغم بوتاسيوم هـ $^{-1}$ اعلى قيمة معنوية لحاصل حبوب الحمص 2537.78 و2422.22 كغم هـ$^{-1}$ في كلا السمادين العضوي و المعدني بالتتابع.

الكلمات المفتاحية: بوتاسيوم، اسمدة العضوية، اسمدة المعدنية، حمص (Cicer arietinum L.).

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INTRODUCTION

Chickpea (*Cicer arietinum* L.) is important legume crop due to its high nutritional value, it content high level of protein and can compensate human diet in protein, it contains 24.6% protein and 64.6% carbohdrates Abu-Salem and Abou (1). Chickpea is mainly cultivated in the northern provinces of the Iraqi country under rain fed conditions. According to FAO (12) the total cultivated area with chickpea in Iraq was 180000 ha in 2003 and the average production was 104000 ton. Potassium is one of the macro-nutrient considered essential for crop growth and yield development. It has a foremost role in number physiological process like carbohydrate metabolism, protein synthesis, Osmoregulation and cation-anion balance, Additionally K participate in the activities of at least 60 different enzymes involved in plant growth Tisdale et al., (29). Therefore, elucidation of the mechanisms underlying responses and adaptation of plants to K deficiency is of key importance. Although application of K fertilizers is an effective way to minimize K deficiency-induced loss of crop production, the economic burdens associated with the use of fertilizers, particularly in developing countries, are a limiting factor. Depending of the availability to plant, Potassium in soil can be grouped in to four different forms which are solution, exchangeable, non-exchangeable and mineral Sparks (26). The slow release of exchangeable K compared to plant demand is primarily related to the deficiency of K in the soil Sparks and Huang, (27). Agriculture soils of Iraq contain enough amount of total K compare to the other worldwide soils but, the most of this continues are not available to plant Al-Obaidi (4). Low organic matter (O.M.) content in the soil is one of the major causes of the deficiency of potassium Loas and Ogaard (16), therefore applying organic manures may solve this problem. Superiority of organic matter over chemical fertilizer is proven in crop production. Because of the depletion of soil fertility, interest is growing worldwide in using organic manures for crop production Delate and Camberdeth (10). Additional, organic matter will improve the physical and chemical property of soil Bouajila and Sanaa (8). Upon decomposition of organic matter, amino acid will be release which has great influence on potassium release from clay minerals. Increasing and extending the application of organic fertilizer can reduce the need for chemical fertilizers and decrease adverse environmental effects. Because our soils in Iraq is calcareous soils which have low ability to release potassium in to soils Akrawi (2). Many studies found a positive yield response of chickpea to K- fertilizer, but the rate of K required varies according to growth conditions. Ali et al., (3) and Goud et al., (13) demonstrated that the K-fertilizer application improve grain yield shoot and root biomass compared to control. Jadeja et al., (15) refer that chickpea grain yield, highest and number of primary and secondary branch per plant increased gradually with 60 and 80 kg K_2O ha^{-1}. This research was aimed to compare between organic and inorganic fertilizer in their efficiency to available potassium in to soil and their influence of chickpea yield

MATERIALS AND METHODS

Field experiments were conducted in Grdarasha farm, Agriculture College University of Salahaddin- Erbil. The area is located at latitude 36°0N longitude 44°01 E at an altitude of 411m above the mean sea level. The soil samples were air dried and ground to pass through a 2 mm sieve for some chemical and physical analysis (Table 1), including particle size distribution, calcium carbonate equivalent (CCE), soil pH, organic matter (OM), Electrical conductivity (EC), cation exchange capacity (CEC), and exchangeable K was extracted from soil by using NH_4OAc Rowell,(22).

Table 1. Physicochemical properties of top soil sample (0 – 30) cm

PSD g kg^{-1}			Texture class	pH	EC dS m^{-1}	CEC $cmol_c$ kg^{-1}	O M g kg^{-1}	$CaCO_3$ Equivalents		Soluble K mg L^{-1}	Exchangeable K mg kg^{-1}
Sand	Silt	Clay						Total	Active		
146.67	538.33	315.00	SiCL	7.72	0.76	31.42	11.75	310.00	143.00	4.30	27.37

The experiment was arranged in a randomized complete block design (RCBD), with three replications. Distance between the blocks and between the plots was 2 m. The net plot size of experiment was (2 * 1.5 m). Chickpea seed were planted in the plots in 4 rows at 30 cm distance between the rows and 10 cm distance between the plant to plant in rows. Five levels of potassium (0, 12.5, 25, 50, 100) kg K ha^{-1} were add as organic and inorganic fertilizer as a source of K. The organic fertilizer was poultry manure mixed with wheat straw which obtained from (Erbil Agricultural Research Centre-EARC). The chemical properties of organic fertilizer are showed in table 2.

Table 2. Some chemical characteristics of the studied organic fertilizer (compost).

Properties	pH	Ec $ds.m^{-1}$	N%	P%	K%
Compost	8.3	2.03	1.52	0.42	0.55

While NPK fertilizer was used as an inorganic fertilizer, which contain (15: 15: 15) N P K respectively. The both organic and inorganic fertilizer was added separately to the soil. The plants were harvested at maturity stage. Plant height, grain yield and biological yield were determined by harvesting the middle two rows of each plot. The percentage of Harvest index (HI%), percentage relative grain yield (RGY) and percentage response (R%)were determined by using the below equations reported by Dobermann (11) and Sparks(28):-

$$\%HI = \frac{Y}{B} * 100$$

$$RGY = \frac{Y}{Y_0}$$

$$\%R = \frac{Y_k - Y_0}{Y_0} * 100$$

Wherein: Y= grain yield, Y_k= grain yield with K fertilizer, Y_0= grain yield without K fertilize (control), B= biological yield. The potassium content of matured grain was determined by Flam photometer Motsara and Roy (18). Data analyzed by using Statgraphics XV5 to find ANOVA and means compared using Fischer's least significant difference (LSD). The differences were considered significant at $p < 0.05$.

RESULTS AND DISCUSSION

Effect of organic and inorganic fertilizer on Soluble and Exchangeable K in soil: The effect of organic and inorganic fertilizer were examined in a field trial. The results showed that the application of compost and NPK fertilizer had a significant effect on the soluble K in soils, it was increased with increasing the application level of K fertilizer. The application of compost and NPK at level of 100 Kg K ha^{-1} to soil increased the soluble K from 4.1 mg L^{-1} to 7.99 and 6.00 mg L^{-1} respectively (Table 3), with respective relative increase of 1.95 and 1.46 times. In general compost fertilizer recorded highest value of soluble K within all application levels in a comparison with NPK fertilizer. The reason might be due to the role of organic fertilizer (compost) in slowly release nutrients like N, P and K. or may be due to the organic acid which resulted from decomposition of the organic matter; this in turn resulted in an increase soluble K Bhattacharya et al. (7). These results are in accordance with the conclusion of other researchers who found that the cations such as Ca^{2+}, Mg^{2+} and K^+ were produced during compost decomposition Sarwar et al. (23). Also, Al-Obaidi and Hamdany (5) they reported that the available potassium increase from 176 mg kg^{-1} to 387, 373 and 388 mg kg^{-1} with applied Sheep manure, Urea and Sheep manure + Urea fertilizer respectively.

Table 3. Effect of organic and inorganic fertilizer on available K in soil after harvest

levels of K kg ha^{-1}	Soluble K mg L^{-1}		Excheangable K mg Kg^{-1}	
	Organic fertilizer	Inorganic fertilizer	Organic fertilizer	Inorganic fertilizer
0	4.1	4.1	23.46	23.46
12.5	4.2	4.5	30.11	24.24
25	5.9	5.1	50.83	30.50
50	6.06	5.3	77.03	39.10
100	7.99	6	118.47	74.29
LSD	0.45	0.45	6.65	6.65

The results in Table 3 shows that the increase in K application from 0 to 100 Kg K ha^{-1} with adding both organic and synthetic fertilizer causes significant increase in exchangeable K. Thus, the exchangeable K in soil increased from 23.46 to 118.47 and 74.29 mg kg^{-1} soil respectively, with relative increase of 4.97 and 3.11 times. This may be attributing to the adsorption of K ions on the exchange site of clay minerals and organic matter Bhattacharya et al., (7). The results are confirmed by findings of Rashed (21) who found that the application of 0 to 100 Kg K fed^{-1} as adding Potassium sulfate, filter mud cake, Sheep manure and poultry manure to the calcareous sandy soil lead to increase in exchangeable K from 32.34 mg kg^{-1} to 53.93, 52.10, 77.71 and 63.72 mg kg^{-1} respectively. Aspasia et al., (6) also recorded that combined use of NPK and farmyard manure FYM increased soil organic carbon, total N, P and exchangeable K by 47, 31, 13 and 73%, respectively compared to the soil application of NPK fertilizers.

Response of chickpea (*Cicer arietinum* L.) to potassium fertilizer

The addition of organic and inorganic fertilizer had a significant increase in biological yield of chickpea (*Cicer arietinum* L). Figure 1 showed that the highest biological yield was obtained by using 100 kg K ha^{-1} (2537.78 and 2422.22 kg ha^{-1}) best on using organic and inorganic fertilizer respectively. However, the lowest biological yield was recorded with untreated control (1768 kg ha^{-1}). Increase biological yield parameter at 100 kg K ha^{-1} in organic fertilizer might be due to the improvement in soil physical condition for plant growth along with increasing available of nutrient at early stage of crop growth. While inorganic fertilizer improving only nutrient supply. The results are in conformity with Boulbaba et al., (9) and Mohammadi et al., (17). Namvar et al., (19). also Zaki et al. (30) who reported that the significant increase in biological yield of chickpea from 2800 in control treatment to 3068 kg fad^{-1} with application 75 kg K_2O fad^{-1}.

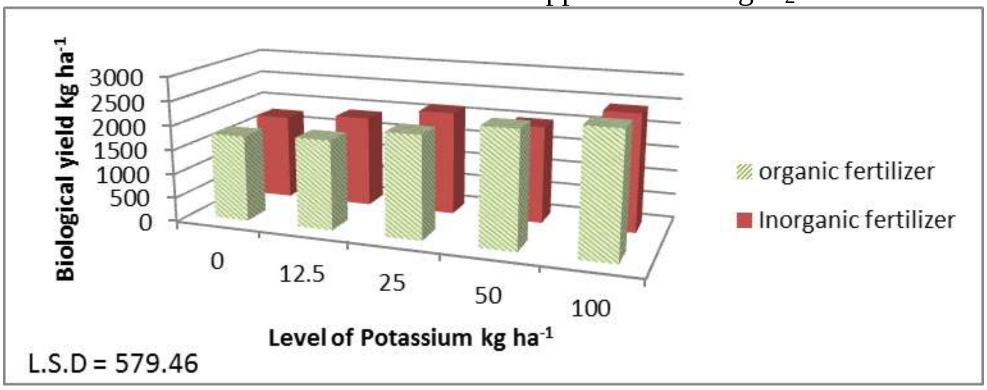

Figure 1. Effect of organic and inorganic fertilizers on biological yield weight.

Grain yield of chickpea influenced by various potassium levels are presented in Figure 2. the highest values of grain yield (2128.77 kg ha^{-1}) was recorded when chickpea treated with 100 Kg K ha^{-1} organic fertilizer followed by 50 and 25 Kg K ha^{-1}. Also inorganic fertilizer had significant increase of chickpea grain yield. The highest grain yield (1244.89 Kg ha^{-1}) was recorded when the chickpea fertilized with 100 kg K ha^{-1} inorganic fertilizer followed by using 50 , 25 Kg K ha^{-1}. These may be due to the effect of organic and inorganic fertilizer in meeting the nutrition requirements of chickpea crop. The results are in agreement with the finding of Mohammadi et al., (17) studied effect of organic matter and biofertilizers on chickpea quality, the results showed that the application of compost at 75 kg ha^{-1} and chemical fertilizer increases grain yield from 1310.7 to 1521.1 and 2119.4 kg ha^{-1} respectively as a compare with control treatment. Shukla et al., (24) and Sohu et al., (25) they recorded that the growth and yield of chickpea significantly increased with the collective application of organic manures and mineral fertilizers. Also Jadeja et al., (15) they recorded that the highest grain yield (2086 kg ha^{-1}) was obtained with application 60 kg ha^{-1} K_2O. However, the chickpea plant height was non- significantly affected by K application in both sours of organic and inorganic fertilizer.

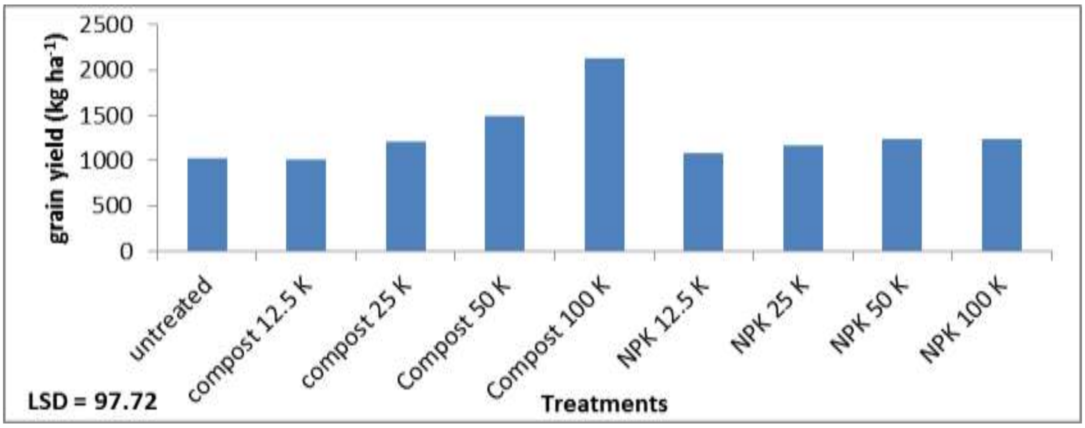

Figure 2. Effect of organic and inorganic fertilizers on grain yield weight.

Result in Table 4 indicates the effect of increasing various levels of K in both sources of fertilizers had significant increase the seed potassium contents over the untreated control. The highest grain K contents 2.87, 2.39 % were obtained from 100 Kg K ha^{-1} organic and inorganic fertilizer respectively. However, the lowest grain K contents were recorded with untreated control 1.96%. The result of comparative influence of organic and inorganic fertilizer on grain K content show that the effect of organic fertilizer was higher than that of inorganic fertilizer. The response of chickpea to different levels of K fertilizer attributed to the potassium deficiency in study soil (4.3 mg L^{-1}) This value of soluble K^+ in soil samples was lower than critical value 19.55 mg L^{-1} according to international potash Institute IPI (14). The results are confirmed by finding of Akrawi (2), Al-Obaidi and Hamadany (5); and Rashed (21) who reported that grain K content increased with application of K fertilizer in both organic and inorganic fertilizer. Therefore, it could be concluded that the mineral fertilizer NPK can be replaced by the organic fertilizers to improve the yield of the chickpea, in addition to offer sound environmental condition.

Table 3. Effect of different levels of Potassium on grain K content, Harvest index (%HI), Response, and Relative grain yield

K levels Kg ha^{-1}	Grain K content %		HI %		Response grain yield %		Relative grain yield	
	Organic fertilizer	Inorganic fertilizer	Organic fertilizer	Inorganic fertilizer	Organic fertilizer	Inorganic fertilizer	Organic fertilizer	Inorganic fertilizer
0	1.96	1.96	58	58				
12.5	2.00	2.00	54	59	-2.245	4.70	0.97	1.04
25	2.45	2.21	57	55	17.78	13.75	1.17	1.13
50	2.52	2.32	67	62	44.96	20.13	1.45	1.20
100	2.87	2.39	83	51	106.76	20.91	2.06	1.21
L.S.D	0.13		ns		ns		ns	

ns = non-significant

The result in Table 3 notes that with increase of organic fertilizer the Harvest index (HI) is also increased proportionally, but with application of inorganic fertilizer this relationship is not found this may refers to that use of inorganic fertilizer causes an increasing invigorative growth and their for decreasing in Harvest index (HI). Similar result were reported by Shukla et al (24) they found that significant increase chickpea HI% with increasing applied bio-organic matter, while the chemical fertilizer non-significant effected on chickpea HI%. The results of influence different levels of potassium fertilizer on response grain yield was showed in Table 4. The grain yield of chickpea showed a positive response to K fertilizer from control to 100 kg K ha^{-1}. In both source of fertilizer the maximum response was observed in 100 kg K ha^{-1}. While there is no response in 12.5 kg K ha^{-1} (Table 4). The relative grain yield was increase with increasing levels of K fertilizer. The heights value was recorded in 100 kg K ha^{-1} it increased 2.06 and 1.21 time for organic and inorganic fertilizer respectively. But the lowest value was recorded at 12.5 kg K ha^{-1} in organic fertilizer table 4.

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