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# Minimizing of Using Potassium Fertilizer by Using Foliar Spraying and Organic Manuring and Its Effect on Maize Productivity and Soil Properties

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## ABSTRACT

Two field experiments were performed in the Agricultural Farm of Sids Agricultural Research Station, ARC, Beni-Suef Governorate during two seasons of 2016 and 2017 to evaluate using foliar spraying of 2% mono-potassium sulphate or di-potassium sulphate twice for minimizing the use of chemical potassium fertilizer (0.0, 50 and 100 kg $K_2SO_4$ /fed) under different doses of organic manure (0.0, 2.5 and 5 t/fed chicken manure )and its effect on maize productivity, namely, growth parameters (plant height and dry weight/plant), yield components (number of rows/ear, number of grains/row and 100-grain yield), grain and stover yields and NPK uptake as well as some soil chemical properties, i.e., pH, EC,OM and soil available NPK. The results indicate that increasing level of organic manure was significantly increased maize growth, yield and its components and NPK uptake, also it improved all studied soil properties, except soil salinity which increased with increasing manure levels. Foliar spraying of di-potassium sulphate surpassed mono-potassium sulphate on maize productivity. Increasing the level of chemical potassium sulphate as soil application enhanced maize productivity and soil available K after harvest. Added 50 kg/fed potassium sulphate + foliar spraying of 2% di-potassium sulphate twice + 5t chicken manure/fed give highest maize productivity.

**Keywords**: Maize, growth parameters NPK uptake, mono-potassium sulphate, di-potassium sulphate, chicken manure and chemical soil properties.

## INTRODUCTION

Among the cereals, maize (Zea mays L ) ranks third crop after wheat and rice. It providing nutrition to humans as well as livestock and poultry. It constitutes an important source of carbohydrates, vitamin B and minerals. It is used in the form of bread, cake and porridge in many parts of Asia, Africa and America (Bukhish *et al*, 2003). Maize grain contain about 71% starch, 9% protein, 4.5 oil, 8.5% fiber and 7% ash (Hurburgh,1989 and Chaudhary,1993). Maize is very efficient utilizer of solar energy and has immense potential for higher yield. It is the stable food crop and the base of the most rural diets, as well as a cash crop. In poor communities, it is the main source of calories and protein, as well as the primary weaning food for babies. In developed countries, maize is consumed mainly as second.

Potassium is an important nutrient for improving the crop yield per unit area. It is vital for physiological processes, water availability, photosynthesis, assimilate transport and enzyme activation with a direct effect on crop production. Potassium deficiency reduces the leaves number and size of individual leaf as a result, photosynthetic activity of plant was affected (William, 2008). If potassium is inadequate, the stomatal activity decrease and transpiration loss increases. Grain yield increases by enhancing the uptake of potassium under the arid condition (Damon and Rengel, 2008). Generally, soils have large capacity to provide K to crop plants under normal conditions (Ranjha *et al*, 1990), but increase in cropping intensity, extensive removal of plants from the field and introduction of high yielding hybrid varieties are resulted in considerable exhaust of soil K (Malik *et al*, 1989). The price of potassium fertilizers is getting higher and becoming unaffordable by formers, consequently, foliar spraying of potassium is more suitable target oriented and economical technique for increasing the fertilizer use efficiency and grain yield over soil application.

Organic fertilizer is one of the most limiting factors for vertical and horizontal agricultural production, especially under Egyptian conditions (Saleh *et al*, 1997).

Organic manure can increase soil productivity by providing essential plant nutrients and by improving soil physical properties. When compost are incorporated into soil, a gradual assimilation occurs through chemical and biological reactions. Mineralization of manures release nutrients for plant uptake. Organic manure amendments are expected to improve soil physical and chemical conditions (Ali, 2001). Also, organic manure generally increased the ability of the soils to held moisture, expanded the available water capacity and decreased the modulus of rupture of compacted soil (Nidal, 2003).

This investigation was conducted aiming to explore the effect of foliar application of mono- and di-potassium phosphate in comparing with application of potassium sulphate as soil application under different level of organic manure on maize productivity.

## MATERIALS AND METHODS

Two field experiments were conducted at the Experiment Farm of Sids Agricultural Research Station, ARC, Beni-Suef Governorate in 2016 and 2017 seasons to evaluate the effect of different levels of chemical potassium fertilizers as soil application, i.e., 0.0, 50.0 and 100.0 kg/fed potassium sulphate (48% $K_2O$) and foliar spraying of different sources of potassium fertilizers at rate of 2% twice ( without, mono-potassium phosphate; 0.0, 50.0 and 34.0 and di-potassium sulphate; 0.0, 40.0 and 52.0% N, $P_2O_5$ and $K_2O$, respectively) under different chicken manure levels (0.0, 2.5 and 5.0 t/fed) on growth, yield and yield components and N, P and K uptake of maize. Experimental soil was clay in texture with slightly alkaline in reaction, having low organic matter, low in available nitrogen and phosphorus and moderate in available potassium (according to A.O.A.C, 1975). The experimental design was split-split design in complete randomized block, where chicken manure levels were allocated in main plots and chemical potassium fertilizer treatments as soil application were devoted in sub-plots, while foliar spraying of potassium treatments were done in sub-sub plots. The preceding crop is wheat the two seasons all other agricultural practices were applied as usually done in the district.

Organic manure treatments were added before planting during land preparation. Table 1: indicate the chemical composition of chiken manure used in the experiment .Soil application of potassium treatments were applied in two equal doses, before first and second

irrigation, while foliar spraying treatments were done twice after month from planting and after one month later. Nitrogen fertilizer was applied for all plots at rate of 75 kg/fed as ammonium nitrate (33.35% N) in two equal doses before the first and second irrigation, while phosphorus fertilizer was added for all plots before sowing at rate of 22 kg $P_2O_5$/fed as mono-calcium superphosphate (15.5% $P_2O_5$ ).

**Table 1. Chemical composition of the used chicken manures (according to A.O.A.C., 1975).**

| Chemical composition | 2016 | 2017 |
|---|---|---|
| pH (1:2.5 chicken manure-water suspension) | 7.71 | 7.78 |
| Ec,$dSm^{-1}$ (1:5 chicken manure-water extraction) | 6.19 | 6.55 |
| Total organic matter (%) | 53.36 | 56.19 |
| Total organic carbon (%) | 30.95 | 32.90 |
| Total nitrogen (%) | 2.15 | 2.23 |
| Total phosphorus (%) | 0.39 | 0.41 |
| Total potassium (%) | 0.96 | 0.92 |
| C/N ratio | 1/14.4 | 1/14.8 |

Maize grains of Single cross 10 were sown in 15th and 17th June in the two growing seasons, respectively. The experimental plot consisted of five ridges 3.5 meters in length and 60 cm apart (10.5 $m^2$, 1/400 fed).

At harvesting, 10 ears and plants were randomly taken from each plot to determine growth characters (plant height, cm and dry weight/plant,g); yield components (number of rows/ear, number of grains/row and 100-grain weight in gram). Also, grain and stover yields were determine for all plots and converted to ardab and ton/fed, respectively. N, P and K concentration in grains and stover were determined (according to A.O.A.C ,1975) and converted to NPK uptake.

## RESULTS AND DISCUSSION

**Growth parameters:**

Data in Table 2 show the response of maize growth, namely, plant height and dry weight/plant to soil and foliar application of potassium under chicken manure application. As the main affect of K-soil application, the results clearly show that plant height and dry weight were significantly increased as potassium levels increased up to 100 kg K-sulphate/fed. Added 100 kg K-sulphate/fed as soil application caused plant height and dry weight/plant surpassed that due to without K fertilization by about 4.5 and 4.7%, respectively in the first season. The corresponding values for dry weight/plant were 4.7 and 3.9% in the second season.

**Table 2. Response of maize growth to soil and foliar spraying of potassium under chicken manure application.**

| K-sulphate (kg/fed) (A) | Chicken manure (t/fed) (B) | Potassium foliar spraying ( C ) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Plant height (cm) | | | | | | | | Dry weight/plant (g) | | | | | | | |
| | | without | | mono-k phosphate | | di-K phosphate | | mean | | without | | mono-k phosphate | | di-K phosphate | | mean | |
| | | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| 0.0 | 0.0 | 155.3 | 156.6 | 160.3 | 160.9 | 163.2 | 163.7 | 159.8 | 160.2 | 60.33 | 61.61 | 63.16 | 63.35 | 65.16 | 66.11 | 62.88 | 63.69 |
| | 2.5 | 161.4 | 163.7 | 167.2 | 167.8 | 169.0 | 168.2 | 165.6 | 166.8 | 64.17 | 64.92 | 65.26 | 65.76 | 67.03 | 67.31 | 65.49 | 66.00 |
| | 5.0 | 166.9 | 167.5 | 170.5 | 170.9 | 172.6 | 172.5 | 170.0 | 170.3 | 67.93 | 68.33 | 70.63 | 71.03 | 73.17 | 73.35 | 70.58 | 70.90 |
| mean | | 161.2 | 162.6 | 166.0 | 166.5 | 168.3 | 168.1 | 165.1 | 165.8 | 64.14 | 64.95 | 66.35 | 66.71 | 68.45 | 68.92 | 66.31 | 66.86 |
| 50.0 | 0.0 | 163.7 | 165.5 | 168.1 | 168.8 | 169.9 | 168.9 | 166.9 | 168.1 | 63.13 | 64.21 | 67.33 | 66.56 | 67.25 | 66.70 | 65.90 | 65.82 |
| | 2.5 | 167.8 | 169.1 | 171.3 | 172.7 | 174.1 | 172.1 | 170.4 | 172.0 | 67.69 | 68.56 | 71.15 | 70.34 | 71.93 | 70.21 | 70.26 | 69.70 |
| | 5.0 | 172.3 | 175.6 | 176.7 | 177.1 | 179.3 | 178.7 | 175.9 | 177.3 | 69.18 | 70.36 | 73.06 | 73.19 | 73.18 | 73.06 | 71.81 | 72.20 |
| mean | | 167.9 | 170.1 | 172.0 | 172.9 | 174.4 | 173.2 | 171.0 | 172.5 | 66.67 | 67.71 | 70.51 | 70.03 | 70.79 | 69.99 | 69.32 | 69.24 |
| 100.0 | 0.0 | 168.5 | 168.6 | 168.7 | 168.9 | 169.9 | 168.9 | 168.7 | 169.1 | 63.23 | 64.51 | 67.36 | 66.62 | 67.36 | 66.69 | 65.98 | 65.94 |
| | 2.5 | 171.3 | 172.3 | 171.3 | 173.5 | 174.3 | 172.3 | 171.6 | 173.4 | 67.72 | 69.37 | 71.30 | 70.70 | 71.96 | 70.35 | 70.33 | 70.14 |
| | 5.0 | 175.6 | 178.6 | 176.7 | 177.8 | 178.8 | 179.1 | 177.1 | 178.4 | 69.25 | 70.64 | 73.22 | 73.25 | 73.36 | 73.19 | 71.94 | 72.36 |
| mean | | 171.8 | 173.2 | 172.2 | 173.4 | 174.3 | 173.4 | 172.5 | 173.6 | 66.73 | 68.17 | 70.63 | 70.19 | 70.89 | 70.08 | 69.42 | 69.48 |
| mean of chicken manure | 0.0 | 162.5 | 163.6 | 165.7 | 166.2 | 167.7 | 167.1 | 165.1 | 165.8 | 62.23 | 63.44 | 65.95 | 65.51 | 66.59 | 66.50 | 64.92 | 65.15 |
| | 2.5 | 166.8 | 168.4 | 169.9 | 171.3 | 172.5 | 170.9 | 169.2 | 170.7 | 66.53 | 67.62 | 69.24 | 68.93 | 70.31 | 69.29 | 68.69 | 68.61 |
| | 5.0 | 171.6 | 173.9 | 174.6 | 175.3 | 176.9 | 176.8 | 174.3 | 175.3 | 68.79 | 69.78 | 72.30 | 72.49 | 73.24 | 73.20 | 71.44 | 71.82 |
| mean of foliar spraying | without | | | | | | | 167.0 | 168.6 | | | | | | | 65.85 | 66.94 |
| | mono-K | | | | | | | 170.1 | 170.9 | | | | | | | 69.16 | 68.98 |
| | di-K | | | | | | | 172.3 | 171.6 | | | | | | | 70.04 | 69.66 |
| L.S.D. at 0.05 | A | | | | | | | 3.16 | 3.75 | | | | | | | 1.35 | 1.46 |
| | B | | | | | | | 2.55 | 2.47 | | | | | | | 1.06 | 1.25 |
| | C | | | | | | | 3.36 | 3.04 | | | | | | | 1.62 | 1.68 |
| | AB | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | AC | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | BC | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | ABC | | | | | | | 4.01 | 3.85 | | | | | | | 1.95 | 2.00 |

It is obvious to notice that the difference between the effect of 100 and 50 kg K-sulphate on plant height and dry weight/plant not reach to the significance value. The increment of maize growth due to increasing potassium levels may be attributed to K effects on one or more of the following physiological functions: (a) carbohydrate metabolism or formation breakdown and translocation of starch, (b) control and regulation of activities of various essential elements, and (c) activation of various enzymes (Zorkany, 2014). The results are in harmony with those obtained by Sidrak (2007) and Ali *et al* (2016).

As for foliar spraying of potassium, the data reveal that foliar spraying of both mono- or di-potassium phosphate had a positive effect on maize plant height and dry weight comparing with without foliar spraying. The relative increasing of plant height due to mono-potassium phosphate or di-potassium over without foliar spraying reached to 1.9 and 3.2% in the first season, respectively.

Similar trends were obtained for the second season and for maize dry weight/plant in the two seasons. It is worthy to observed that the difference between the effect of the two foliar spraying treatments on plant height and dry weight/plant was not reach to significance value. The promoting effect of foliar spraying of potassium is probably may be due to the activation of enzymes that helped the plants to increase their heights and weights. Moreover, Amanulla *et al* (2015) stated that foliar nutrition under semi arid climates not only applied nutrients, but also beneficial in terms of providing water to crop. Also, foliar K application is particularly well adapted to this form of fertilization because soon foliar spraying takes place and rapidly translocate from the leaves (Mengel, 2002). Similar results were obtained by Hu *et al* (2008) and Khan *et al* (2017).

With regard to chicken manure application, the data in Table 2 clearly show that increasing chicken manure level from 0.0 up to 5.0 t/fed increased both plant height and dry weight/plant. Added 5.0 t chicken manure/fed increased both plant height and dry weight/plant by about 3.0 and 5.6% for plant height and 3.8 and 4.0 and 10.0% for dry weight plants in first season over 0.0 and 2.5 t/fed chicken manure respectively. Similar trends were obtained in the second season. The positive effect of chicken manure on maize growth is mainly due to chicken manure contain lot of nutrients, having high content of organic matter (Table1) which in turn improved soil chemical and physical properties (Singh and Yadav, 1986) These results are in line with those obtained by Abd-Elattif (2007) and El-Sheref (2012).

The data of the interaction between any two factors and among the three factors. Clearly show that maize growth did not respond to the studied interactions, except the interaction among the three factors. The tallest and heaviest maize plants were recorded under the treatment of 50 or 100kg potassium sulphate as soil application + 2% foliar spraying of di-potassium phosphate twice + 5.0 t/fed compost. Whereas, the treatment of without potassium, whether soil or foliar application and without manuring gave the shortest and lightest plants.

**Yield components:**

Maize yield components, i.e., number of rows/ear, number of grains/row and 100-grain weight as affected by potassium applied as soil or foliar application under chicken manure application and their interactions is presented in Table 3. As the main affect of soil potassium fertilization, the data show that number of rows/ear, number of grains/row and 100-grain weight were significantly affected by increasing soil potassium fertilization up to 100 kg K-sulphate/fed. The weight of under 100 kg/fed potassium sulphate. The relative increasing in number of rows/ear, number of grains/ear and 100-grain weight caused by 100 kg/fed K-sulphate reached to 5.7, 2.6 and 1.8% over control in the first season and 5.8, 3.6 and 1.5% in the second one, respectively. The increment in maize yield components as affected by increasing K level is mainly due to the maximum availability of K that may have increased photosynthetic activities and more dry matter was accumulated and partitioned to the grains. In addition, Mengel and Kirkby (1987) mentioned that K has important role in improving water use efficiency which improved plant growth and increase cell divition. Bukhsh *et al* (2009) reported that maize produced maximum number of grains/ear and increased grains weight due to increase in K level. These results are in accordance with those obtained by Sadiq and Jan (2001) and Akhtar *et al* (2003).

**Table 3. Response of yield components of maize to soil and foliar spraying of potassium under chicken manure application.**

| K-sulphate (kg/fed) (A) | Chicken manure (t/fed) (B) | Potassium foliar spraying ( C ) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Number of rows/ear | | | | | | mean | | Number of grains/ear | | | | | | mean | | 100-grain weight (g) | | | | | | mean | |
| | | without | | mono-k phosphate | | di-K phosphate | | | | without | | mono-k phosphate | | di-K phosphate | | | | without | | mono-k phosphate | | di-K phosphate | | | |
| | | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| 0.0 | 0.0 | 12.13 | 12.31 | 13.58 | 13.61 | 13.95 | 13.97 | 13.22 | 13.30 | 43.33 | 43.37 | 43.72 | 43.78 | 43.91 | 43.96 | 43.65 | 43.70 | 28.11 | 28.13 | 28.41 | 28.42 | 28.65 | 28.67 | 28.39 | 28.41 |
| | 2.5 | 12.33 | 12.46 | 13.91 | 14.01 | 14.41 | 14.46 | 13.55 | 13.64 | 43.91 | 43.96 | 44.13 | 44.16 | 44.78 | 44.82 | 44.27 | 44.31 | 28.53 | 28.56 | 28.92 | 28.93 | 29.03 | 29.06 | 28.83 | 28.85 |
| | 5.0 | 12.55 | 12.61 | 14.81 | 14.73 | 14.99 | 15.03 | 14.12 | 14.12 | 44.23 | 44.29 | 44.36 | 44.41 | 44.61 | 44.63 | 44.40 | 44.44 | 28.83 | 28.86 | 29.13 | 29.15 | 29.36 | 29.39 | 29.11 | 29.13 |
| mean | | 12.34 | 12.46 | 14.10 | 14.12 | 14.45 | 14.49 | 13.63 | 13.69 | 43.82 | 43.87 | 44.07 | 44.12 | 44.43 | 44.47 | 44.11 | 44.15 | 28.49 | 28.52 | 28.82 | 28.83 | 29.01 | 29.04 | 28.77 | 28.80 |
| 50.0 | 0.0 | 12.45 | 12.50 | 13.83 | 13.86 | 14.02 | 14.08 | 13.43 | 13.48 | 44.37 | 44.42 | 44.77 | 44.81 | 44.96 | 44.97 | 44.70 | 44.73 | 28.62 | 28.66 | 29.83 | 28.86 | 29.11 | 29.17 | 29.19 | 28.90 |
| | 2.5 | 12.76 | 12.80 | 14.30 | 14.36 | 14.61 | 14.66 | 13.89 | 13.94 | 44.81 | 44.99 | 45.26 | 45.29 | 45.50 | 45.57 | 45.19 | 45.28 | 28.80 | 28.91 | 29.20 | 29.26 | 29.53 | 29.56 | 29.18 | 29.24 |
| | 5.0 | 13.10 | 13.13 | 15.11 | 15.16 | 15.42 | 15.46 | 14.54 | 14.58 | 45.01 | 45.26 | 45.61 | 45.68 | 45.97 | 45.99 | 45.53 | 45.64 | 28.99 | 29.03 | 29.50 | 29.52 | 29.81 | 29.86 | 29.43 | 29.47 |
| mean | | 12.77 | 12.81 | 14.41 | 14.46 | 14.68 | 14.73 | 13.95 | 14.00 | 44.73 | 44.89 | 45.21 | 45.26 | 45.48 | 45.51 | 45.14 | 45.22 | 28.80 | 28.87 | 29.51 | 29.21 | 29.48 | 29.53 | 29.26 | 29.20 |
| 100.0 | 0.0 | 13.26 | 13.29 | 13.86 | 13.87 | 14.06 | 14.11 | 13.73 | 13.76 | 44.80 | 44.83 | 44.80 | 44.82 | 44.97 | 44.99 | 44.86 | 46.21 | 28.63 | 28.67 | 29.83 | 28.89 | 29.13 | 29.19 | 29.20 | 28.92 |
| | 2.5 | 14.02 | 14.23 | 14.35 | 14.40 | 14.66 | 14.68 | 14.34 | 14.44 | 45.03 | 45.15 | 45.29 | 45.32 | 45.56 | 45.57 | 45.29 | 45.35 | 28.80 | 28.91 | 29.21 | 29.27 | 29.54 | 29.59 | 29.18 | 29.26 |
| | 5.0 | 14.86 | 15.01 | 15.11 | 15.22 | 15.53 | 15.50 | 15.17 | 15.24 | 45.26 | 45.31 | 45.66 | 45.70 | 45.98 | 46.02 | 45.63 | 45.68 | 28.99 | 29.04 | 29.52 | 29.53 | 29.85 | 29.87 | 29.45 | 29.48 |
| mean | | 14.05 | 14.18 | 14.44 | 14.50 | 14.75 | 14.76 | 14.41 | 14.48 | 45.03 | 45.10 | 45.25 | 46.61 | 45.50 | 45.53 | 45.26 | 45.75 | 28.81 | 28.87 | 29.52 | 29.23 | 29.51 | 29.55 | 29.28 | 29.22 |
| mean of | 0.0 | 12.61 | 12.70 | 13.76 | 13.78 | 14.01 | 14.05 | 13.46 | 13.51 | 44.17 | 44.21 | 44.43 | 45.80 | 44.61 | 44.64 | 44.49 | 44.88 | 28.45 | 28.49 | 28.36 | 28.72 | 28.96 | 29.01 | 29.93 | 28.74 |
| chicken | 2.5 | 13.04 | 13.16 | 14.19 | 14.56 | 14.56 | 14.60 | 13.93 | 14.01 | 44.58 | 44.70 | 44.89 | 44.92 | 45.28 | 45.32 | 44.92 | 44.98 | 28.71 | 28.79 | 29.11 | 29.15 | 29.37 | 29.40 | 29.06 | 29.12 |
| manure | 5.0 | 13.50 | 13.58 | 15.01 | 15.31 | 15.31 | 15.33 | 14.65 | 14.65 | 44.83 | 44.95 | 45.21 | 45.26 | 45.52 | 45.55 | 45.19 | 45.25 | 28.94 | 28.98 | 29.38 | 29.40 | 29.67 | 29.71 | 29.33 | 29.36 |
| mean of foliar spraying | without | | | | | | | 13.05 | 13.15 | | | | | | | 44.53 | 44.62 | | | | | | | 28.70 | 28.75 |
| | mono-K | | | | | | | 14.32 | 14.36 | | | | | | | 44.84 | 45.33 | | | | | | | 29.28 | 29.09 |
| | di-K | | | | | | | 14.63 | 14.66 | | | | | | | 45.14 | 45.17 | | | | | | | 29.33 | 29.37 |
| L.S.D. at 0.05 | A | | | | | | | 0.24 | 0.23 | | | | | | | 0.36 | 0.38 | | | | | | | 0.22 | 0.23 |
| | B | | | | | | | 0.35 | 0.30 | | | | | | | 0.31 | 0.35 | | | | | | | 0.32 | 0.34 |
| | C | | | | | | | 0.21 | 0.20 | | | | | | | 0.26 | 0.25 | | | | | | | 0.36 | 0.39 |
| | AB | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | AC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | BC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | ABC | | | | | | | 0.76 | 0.81 | | | | | | | 0.61 | 0.67 | | | | | | | 0.55 | 0.56 |

Concerning the main affect of K as foliar spraying, the data in Table 3 indicate that foliar spraying of potassium had a positive effect on the three studied maize yield components. It could be arranged the effect of foliar K-fertilizer on yield components in the descending order as follow: di-potassium phosphate > mono-potassium phosphate > without foliar spraying. The superiority of di-potassium phosphate than mono-potassium phosphate is mainly due to the high

Potassium content in di-potassium phosphate 52% $K_2O$ than mono-potassium phosphate (34% $K_2O$). The positive effect of foliar spraying of K could be attributed to its effect on maize growth as abovementioned discussed. These results are similar to those obtained by Chemma *et al* (1999) and Aown *et al* (2012).

Regarding the chicken manure affect, the results clearly show that with increasing chicken manure level, the yield component parameters of maize were increased. The highest values of number of rows/ear, number of grains/row and 100-grain yield were recorded under 5.0 t chicken manure/fed, while no manuring yielded the lowest ones. The enhancement of chicken manure on maize yield components is mainly due to its positive effect on maize growth as discussed earlier in Table 2. These results agree with those obtained by Luikham *et al* (2003) and Saleh and Nawar (2003).

As the interaction affect, The data clearly show that the three studied maize yield components were significantly affected by the interaction among the three studied factors ( A×B×C). In general, the highest values of number of rows/ear, number of grains/row and 100-grain weight were exerted under the treatment of 50 or 100 kg K-sulphate as soil application + 2% foliar spraying of di-potassium phosphate + 5.0 t chicken manure/fed. On the other hand, the maize plants without soil or foliar spraying and without manuring possessed the lowest yield components of maize.

**Yields:**

Data in Table 4 represent the affect of soil and foliar application of potassium and chicken manure and their interactions on grain and stover yields. As for the soil potassium application, it is evident from the data that grain and stover yields of maize were significantly increased by increasing the potassium fertilization level from 0.0 to 100.0 kg K-sulphate/fed in the two growing seasons. The relative increasing in grain and stover yields due to 100 kg K-sulphate/fed when compared to 0.0 and 50.0 kg K-sulphate/fed reached to 4.6 and 1.7, and 15.7 and 12.8% ,respectively in the first season. The same trends were obtained in the second season. The increment of maize yields caused by soil potassium application is mainly due to its affect on maize growth and yield components as discussed before (Table 2 and 3). Furthermore, Yosefi *et al* (2011) and Iqbal *et al* (2014) reported That the enhanced in grain and stover yields of maize resulted to K application might be due to increased activity of growth promoting hormones on the crucial role of potassium in synthesis of carbohydrates, photosynthetic process, nitrogen assimilation and improved tolerance to drought. These results are similar to those obtained by Khalil *et al* (2002) and Zorkany (2014).

**Table 4. Response of maize yields to soil and foliar spraying of potassium under chicken manure application.**

| K-sulphate (kg/fed) (A) | Chicken manure (t/fed) (B) | Potassium foliar spraying ( C ) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Grain yield (ardab/fed) | | | | | | | | stover yield (ton/fed) | | | | | | | |
| | | without | | mono-k phosphate | | di-K phosphate | | mean | | without | | mono-k phosphate | | di-K phosphate | | mean | |
| | | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| 0.0 | 0.0 | 17.85 | 18.13 | 19.21 | 19.33 | 19.75 | 19.86 | 18.94 | 19.11 | 3.10 | 3.16 | 3.20 | 3.26 | 3.26 | 3.29 | 3.19 | 3.24 |
| | 2.5 | 18.36 | 18.96 | 19.86 | 19.95 | 20.33 | 20.41 | 19.52 | 19.77 | 3.35 | 3.38 | 3.46 | 3.50 | 3.51 | 3.54 | 3.44 | 3.47 |
| | 5.0 | 19.17 | 19.66 | 20.27 | 20.46 | 20.70 | 20.83 | 20.05 | 20.32 | 3.61 | 3.67 | 3.74 | 3.78 | 3.82 | 3.86 | 3.72 | 3.77 |
| mean | | 18.46 | 18.92 | 19.78 | 19.91 | 20.26 | 20.37 | 19.50 | 19.73 | 3.35 | 3.40 | 3.47 | 3.51 | 3.53 | 3.56 | 3.45 | 3.49 |
| 50.0 | 0.0 | 18.47 | 18.99 | 19.79 | 19.86 | 20.05 | 20.26 | 19.44 | 19.70 | 3.47 | 3.51 | 3.63 | 3.67 | 3.71 | 3.75 | 3.60 | 3.64 |
| | 2.5 | 19.15 | 19.69 | 20.13 | 20.36 | 20.44 | 20.75 | 19.91 | 20.27 | 3.75 | 3.82 | 3.94 | 3.98 | 4.16 | 4.19 | 3.95 | 4.00 |
| | 5.0 | 20.06 | 20.68 | 21.05 | 21.29 | 21.26 | 21.50 | 20.79 | 21.16 | 3.98 | 4.05 | 4.14 | 4.19 | 4.22 | 4.27 | 4.11 | 4.17 |
| mean | | 19.23 | 19.79 | 20.32 | 20.50 | 20.58 | 20.84 | 20.04 | 20.38 | 3.73 | 3.79 | 3.90 | 3.95 | 4.03 | 4.07 | 3.89 | 3.94 |
| 100.0 | 0.0 | 19.46 | 14.93 | 19.83 | 19.88 | 20.08 | 20.29 | 19.79 | 18.37 | 3.76 | 3.74 | 3.66 | 3.69 | 3.73 | 3.76 | 3.72 | 3.73 |
| | 2.5 | 20.16 | 20.75 | 20.25 | 20.39 | 20.46 | 20.81 | 20.29 | 20.65 | 3.98 | 4.03 | 3.97 | 4.01 | 4.18 | 4.21 | 4.04 | 4.08 |
| | 5.0 | 20.85 | 21.20 | 21.13 | 21.32 | 21.27 | 21.59 | 21.08 | 21.37 | 4.22 | 4.28 | 4.16 | 4.21 | 4.23 | 4.29 | 4.20 | 4.26 |
| mean | | 20.16 | 18.96 | 20.40 | 20.53 | 20.60 | 20.90 | 20.39 | 20.13 | 3.99 | 4.02 | 3.93 | 3.97 | 4.05 | 4.09 | 3.99 | 4.02 |
| mean of | 0.0 | 18.59 | 17.35 | 19.61 | 19.69 | 19.96 | 20.14 | 19.39 | 19.06 | 3.44 | 3.47 | 3.50 | 3.54 | 3.57 | 3.60 | 3.50 | 3.54 |
| chicken | 2.5 | 19.22 | 19.80 | 20.08 | 20.23 | 29.41 | 20.66 | 19.91 | 20.23 | 3.69 | 3.74 | 3.79 | 3.83 | 3.95 | 3.65 | 3.81 | 3.74 |
| manure | 5.0 | 20.03 | 20.51 | 20.82 | 21.02 | 21.08 | 21.31 | 20.64 | 20.95 | 3.94 | 4.00 | 4.01 | 4.06 | 4.09 | 4.14 | 4.01 | 4.07 |
| mean of | without | | | | | | | 19.28 | 19.22 | | | | | | | 3.69 | 3.74 |
| foliar | mono-K | | | | | | | 20.17 | 20.31 | | | | | | | 3.77 | 3.81 |
| spraying | di-K | | | | | | | 20.48 | 20.70 | | | | | | | 3.87 | 3.91 |
| L.S.D. at 0.05 | A | | | | | | | 0.27 | 0.29 | | | | | | | 0.09 | 0.08 |
| | B | | | | | | | 0.32 | 0.34 | | | | | | | 0.26 | 0.20 |
| | C | | | | | | | 0.29 | 0.32 | | | | | | | 0.07 | 0.08 |
| | AB | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | AC | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | BC | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | ABC | | | | | | | 0.47 | 0.50 | | | | | | | 0.30 | 0.36 |

As for foliar spraying of potassium, data indicate that grain and stover yields were significantly affected by potassium foliar spraying treatments. Maximum grain and stover yields were obtained by maize plants under foliar spray of di-potassium phosphate (20.48 and 3.87 in the first season and 20.70 and 3.91 ardab and t/fed in the second one, respectively. While, plants without foliar spraying recorded less grain and stover yield (19.28 and 3.69 in the first season and 19.22 and 3.74 ardab and t/fed in the second season, respectively. Foliar spraying of di-potassium phosphate increased grain and stover yield by about 6.2 and 3.0%) as compared to control in first season, respectively. Similar trends were obtained in second season. The enhancement in grain and stover yields caused by foliar spraying of potassium is mainly due to its affect on maize growth and yield components as mentioned before. In this connection, Mohamed *et al* (2010) and Jabeen and Ahmed (2011) mentioned that foliar application of potassium had apositive effect on biological activity, metabolism and stimulating the photosynthetic pigments and enzyme activity which encourage the vegetative growth of plants, consequently increased maize yields. These results are in harmony with those obtained by Singth *et al* (2005) and Romheld and Kirkby (2010).

With respect to organic manure, the data clearly reveal that grain and stover yields of maize were significantly affected by chicken manure application. Added 0.0, 2.5 and 5.0 t chicken manure/fed yielded 19.28, 20.17 and 20.48 ardab grains/fed and 3.69, 3.77 and 3.87 ton stover/fed in the first season, respectively. Same trend was obtained in the second season. It is obvious to notice that grain and stover yields were increased as chicken manure level increased from 0.0 to 5.0 t/fed. This finding is mainly due to the improvement affect of organic manure on soil fertility and physical and chemical properties, consequently enhanced plant growth and yields of maize (Hassanien, 2009). These results are in line with those obtained by Seddik (2006) and El-Sheref (2012).

Regarding the interaction affect, the results clearly reveal that both grain and stover yields were affected only by the interactions among the three studied factor (A×B×C). In general, maize plants received 50 or 100 kg K-sulphate/fed + 2% foliar spraying of di-potassium sulphate + 5.0 t chicken manure/fed exhibited the highest grain and stover yields. On the other hand, the plants without soil or foliar potassium and without chicken manure application exerted the lowest grain or stover yields.

**N,P and K uptake:**

The data presented in Tables 5,6 and 7 show the affect of treatments on N,P and K uptake in grains and/or stover. The results clearly show that N,P and K uptake by grains and/or stover were significantly affected by added K-sulphate as soil application, where increasing potassium levels from 0.0 to 100.0 kg K-sulphate resulted in increasing N, P and K uptake in grains and stover as well as total uptake. The increment in total N,P and K uptake due to 100 kg K-sulphate/fed reached to 6.2 , 21.3 ; 3.2 , 12.0 and 7.0 , 29.6 %, comparing with 50 kg K – sulphate / fed and without potassium fertilization. respectively in the first season. Same trends were obtained in the second season. The positive effect of soil K-sulphate application, can be explained by its affect on grains and stover yields, since nutrient uptake calculated by multiplying grain or stover yields by its nutrient percentage (Table 1 and 2 in appendix). Similar results were obtained by Zorkany (2000) and Zeidan and Kramany (2001).

**Table 5. Response of NPK uptake of maize grains to soil and foliar spraying of potassium under chicken manure application.**

| K-sulphate (kg/fed) (A) | Chicken manure (t/fed) (B) | Potassium foliar spraying ( C ) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N uptake (kg/fed) | | | | | | | | P uptake (kg/fed) | | | | | | | | K uptake (kg/fed) | | | | | | | |
| | | without | | mono-K phosphate | | di-K phosphate | | mean | | without | | mono-K phosphate | | di-K phosphate | | mean | | without | | mono-K phosphate | | di-K phosphate | | mean | |
| | | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| 0.0 | 0.0 | 28.24 | 28.68 | 31.20 | 31.66 | 32.35 | 32.53 | 30.60 | 30.96 | 6.25 | 6.35 | 7.26 | 7.31 | 7.47 | 7.51 | 6.99 | 7.06 | 17.49 | 18.02 | 20.17 | 20.30 | 21.84 | 21.97 | 19.83 | 20.10 |
| | 2.5 | 32.13 | 33.18 | 35.31 | 35.75 | 36.72 | 37.15 | 34.72 | 35.36 | 6.94 | 7.17 | 8.06 | 8.10 | 8.25 | 8.57 | 7.75 | 7.95 | 19.79 | 20.70 | 23.08 | 23.18 | 24.48 | 24.57 | 22.45 | 22.82 |
| | 5.0 | 35.96 | 36.61 | 39.16 | 39.82 | 40.28 | 40.54 | 38.47 | 38.99 | 8.32 | 8.53 | 9.93 | 8.88 | 9.27 | 9.33 | 9.17 | 8.91 | 23.08 | 23.40 | 24.97 | 25.21 | 26.37 | 26.54 | 24.81 | 25.05 |
| mean | | 32.11 | 32.82 | 35.22 | 35.74 | 36.45 | 36.74 | 34.59 | 35.10 | 7.17 | 7.35 | 8.42 | 8.10 | 8.33 | 8.47 | 7.97 | 7.97 | 20.12 | 20.71 | 22.74 | 22.90 | 24.23 | 24.36 | 22.36 | 22.65 |
| 50.0 | 0.0 | 32.84 | 33.50 | 35.74 | 36.42 | 37.05 | 37.44 | 35.21 | 35.79 | 6.46 | 6.91 | 7.48 | 7.51 | 7.58 | 7.66 | 7.17 | 7.36 | 20.69 | 21.53 | 23.00 | 23.36 | 24.14 | 24.39 | 22.61 | 23.09 |
| | 2.5 | 36.46 | 37.49 | 38.89 | 39.62 | 40.06 | 40.96 | 38.47 | 39.36 | 7.51 | 7.72 | 8.17 | 8.27 | 8.30 | 8.42 | 7.99 | 8.14 | 22.79 | 23.43 | 24.24 | 24.51 | 25.47 | 25.85 | 24.17 | 24.60 |
| | 5.0 | 39.60 | 40.53 | 42.44 | 43.52 | 43.46 | 44.25 | 41.83 | 42.77 | 8.71 | 8.98 | 10.61 | 9.54 | 9.52 | 9.33 | 9.61 | 9.28 | 24.99 | 25.77 | 27.11 | 27.42 | 28.57 | 28.90 | 26.89 | 27.36 |
| mean | | 36.30 | 37.17 | 39.02 | 39.85 | 40.19 | 40.88 | 38.50 | 39.30 | 7.56 | 7.87 | 8.75 | 8.44 | 8.47 | 8.47 | 8.26 | 8.26 | 22.82 | 23.58 | 24.78 | 25.10 | 26.06 | 26.38 | 24.56 | 25.02 |
| 100.0 | 0.0 | 35.42 | 27.59 | 36.09 | 36.74 | 37.39 | 37.78 | 36.30 | 34.04 | 7.08 | 5.43 | 7.77 | 7.51 | 7.59 | 7.67 | 7.48 | 6.87 | 23.43 | 17.98 | 24.15 | 24.21 | 24.74 | 25.00 | 24.11 | 22.40 |
| | 2.5 | 39.23 | 40.67 | 39.41 | 39.96 | 40.39 | 41.37 | 39.68 | 40.67 | 8.18 | 8.42 | 8.22 | 8.28 | 8.59 | 8.74 | 8.33 | 8.48 | 25.12 | 26.15 | 25.23 | 25.41 | 26.35 | 26.80 | 25.57 | 26.12 |
| | 5.0 | 42.03 | 43.33 | 42.89 | 43.88 | 43.77 | 44.13 | 42.90 | 43.78 | 9.05 | 9.20 | 10.35 | 9.25 | 9.53 | 9.67 | 9.64 | 9.37 | 27.15 | 27.60 | 28.10 | 28.36 | 28.59 | 29.02 | 27.95 | 28.33 |
| mean | | 38.89 | 37.20 | 39.46 | 40.19 | 40.52 | 41.09 | 39.62 | 39.49 | 8.10 | 7.68 | 8.78 | 8.35 | 8.57 | 8.69 | 8.48 | 8.24 | 25.23 | 23.91 | 25.83 | 25.99 | 26.56 | 26.94 | 25.87 | 25.61 |
| mean of chicken manure | 0.0 | 32.17 | 29.92 | 34.34 | 34.94 | 35.60 | 35.92 | 34.04 | 33.60 | 6.60 | 6.23 | 7.50 | 7.44 | 7.55 | 7.61 | 7.21 | 7.10 | 20.54 | 19.18 | 22.44 | 22.62 | 23.57 | 23.79 | 22.18 | 21.86 |
| | 2.5 | 35.94 | 37.11 | 37.87 | 38.44 | 39.06 | 39.83 | 37.62 | 38.46 | 7.54 | 7.77 | 8.15 | 8.22 | 8.38 | 8.58 | 8.02 | 8.19 | 22.57 | 23.43 | 24.18 | 24.37 | 25.43 | 25.74 | 24.06 | 24.51 |
| | 5.0 | 39.20 | 40.16 | 41.50 | 42.41 | 42.50 | 42.97 | 41.07 | 41.85 | 8.69 | 8.90 | 10.30 | 9.22 | 9.44 | 9.44 | 9.47 | 9.19 | 25.07 | 25.59 | 26.73 | 27.00 | 27.84 | 28.15 | 26.55 | 26.91 |
| mean of foliar spraying | without | | | | | | | 35.77 | 35.73 | | | | | | | 7.61 | 7.63 | | | | | 23.39 | | 22.73 | 24.66 |
| | mono-K | | | | | | | 37.90 | 38.59 | | | | | | | 8.65 | 8.30 | | | | | 24.45 | | 25.89 | |
| | di-K | | | | | | | 39.05 | 39.57 | | | | | | | 8.46 | 8.54 | | | | | 25.62 | | | |
| LS.D at 0.05 | A | | | | | | | 1.03 | 1.16 | | | | | | | 0.16 | 0.18 | | | | | 1.00 | | 0.95 | |
| | B | | | | | | | 1.11 | 1.03 | | | | | | | 0.21 | 0.22 | | | | | 1.05 | | 0.97 | |
| | C | | | | | | | 1.20 | 1.25 | | | | | | | 0.26 | 0.27 | | | | | 1.07 | | 1.01 | |
| | AB | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | N.S | | N.S | |
| | AC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | N.S | | N.S | |
| | BC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | N.S | | N.S | |
| | ABC | | | | | | | 1.66 | 1.57 | | | | | | | 0.36 | 0.30 | | | | | 1.70 | | 1.65 | |

**Table 6. Response of NPK uptake of maize stover to soil and foliar spraying of potassium under chicken manure application.**

| K-sulphate (kg/fed) (A) | Chicken manure (t/fed) (B) | Potassium foliar spraying ( C ) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N uptake (kg/fed) | | | | | | | | P uptake (kg/fed) | | | | | | | | K uptake (kg/fed) | | | | | | | |
| | | without | | mono-K phosphate | | di-K phosphate | | mean | | without | | mono-K phosphate | | di-K phosphate | | mean | | without | | mono-K phosphate | | di-K phosphate | | mean | |
| | | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| 0.0 | 0.0 | 26.04 | 26.86 | 28.16 | 28.69 | 28.69 | 28.95 | 27.63 | 28.17 | 5.89 | 6.00 | 7.68 | 7.82 | 7.17 | 7.24 | 6.91 | 7.02 | 26.35 | 26.54 | 29.12 | 29.34 | 30.97 | 30.93 | 28.81 | 28.94 |
| | 2.5 | 29.82 | 30.08 | 31.83 | 32.55 | 32.64 | 33.28 | 31.43 | 31.97 | 7.71 | 7.77 | 9.34 | 9.45 | 8.78 | 8.85 | 8.61 | 8.69 | 30.49 | 30.42 | 33.22 | 32.90 | 34.75 | 34.69 | 32.82 | 32.67 |
| | 5.0 | 33.57 | 34.50 | 36.28 | 36.29 | 37.05 | 37.44 | 35.63 | 36.08 | 9.39 | 9.54 | 11.22 | 11.34 | 10.70 | 10.81 | 10.44 | 10.56 | 35.38 | 35.23 | 37.03 | 36.67 | 39.35 | 38.99 | 37.25 | 36.96 |
| mean | | 29.81 | 30.48 | 32.09 | 32.51 | 32.79 | 33.22 | 31.56 | 32.07 | 7.66 | 7.77 | 9.41 | 9.54 | 8.88 | 8.97 | 8.65 | 8.76 | 30.74 | 30.73 | 33.12 | 32.97 | 35.02 | 34.87 | 32.96 | 32.86 |
| 50.0 | 0.0 | 30.54 | 31.24 | 33.76 | 34.13 | 34.87 | 35.25 | 33.06 | 33.54 | 6.59 | 6.67 | 8.71 | 8.81 | 8.16 | 8.25 | 7.82 | 7.91 | 31.92 | 31.94 | 39.20 | 39.27 | 41.55 | 41.63 | 37.56 | 37.61 |
| | 2.5 | 34.88 | 35.53 | 37.82 | 38.21 | 40.35 | 41.06 | 37.68 | 38.27 | 9.00 | 8.79 | 10.64 | 10.75 | 10.40 | 10.48 | 10.01 | 10.01 | 36.00 | 35.91 | 44.13 | 43.78 | 49.09 | 48.60 | 43.07 | 42.76 |
| | 5.0 | 38.21 | 38.88 | 40.99 | 41.06 | 41.78 | 42.70 | 40.33 | 40.88 | 10.35 | 10.53 | 12.42 | 12.57 | 11.82 | 11.96 | 11.53 | 11.69 | 39.40 | 39.29 | 49.68 | 49.86 | 51.48 | 51.24 | 46.85 | 46.80 |
| mean | | 34.54 | 35.22 | 37.52 | 37.80 | 39.00 | 39.67 | 37.02 | 37.56 | 8.65 | 8.66 | 10.59 | 10.71 | 10.13 | 10.23 | 9.79 | 9.87 | 35.77 | 35.71 | 44.34 | 44.30 | 47.37 | 47.16 | 42.49 | 42.39 |
| 100.0 | 0.0 | 34.59 | 34.41 | 36.97 | 37.64 | 38.05 | 38.73 | 36.54 | 36.93 | 7.52 | 7.11 | 9.15 | 9.23 | 8.58 | 8.65 | 8.42 | 8.33 | 36.47 | 35.53 | 42.09 | 41.70 | 44.39 | 43.99 | 40.98 | 40.41 |
| | 2.5 | 37.81 | 38.29 | 41.69 | 42.51 | 43.89 | 44.63 | 41.13 | 41.81 | 9.15 | 9.27 | 11.12 | 11.23 | 10.45 | 10.53 | 10.24 | 10.34 | 39.80 | 39.90 | 47.64 | 47.72 | 51.83 | 51.78 | 46.42 | 46.47 |
| | 5.0 | 41.78 | 42.37 | 44.93 | 45.89 | 45.68 | 46.76 | 44.13 | 45.01 | 10.97 | 11.56 | 12.48 | 13.05 | 11.84 | 12.01 | 11.76 | 12.21 | 44.31 | 44.08 | 51.58 | 51.36 | 54.57 | 54.48 | 50.15 | 49.97 |
| mean | | 38.06 | 38.36 | 41.20 | 42.01 | 42.54 | 43.37 | 40.60 | 41.25 | 9.21 | 9.31 | 10.92 | 11.17 | 10.29 | 10.40 | 10.14 | 10.29 | 40.19 | 39.84 | 47.10 | 46.93 | 50.26 | 50.08 | 45.85 | 45.62 |
| mean of chicken manure | 0.0 | 30.39 | 30.84 | 32.96 | 33.49 | 33.87 | 34.31 | 32.41 | 32.88 | 6.67 | 6.59 | 8.51 | 8.62 | 7.97 | 8.05 | 7.72 | 7.75 | 31.58 | 31.34 | 36.80 | 36.77 | 38.97 | 38.85 | 35.78 | 35.65 |
| | 2.5 | 34.17 | 34.63 | 37.11 | 37.76 | 38.96 | 39.66 | 36.75 | 37.35 | 8.62 | 8.61 | 10.37 | 10.48 | 9.88 | 9.95 | 9.62 | 9.68 | 35.43 | 35.41 | 41.66 | 41.47 | 45.22 | 45.02 | 40.77 | 40,63 |
| | 5.0 | 37.85 | 38.58 | 40.73 | 41.08 | 41.50 | 42.30 | 40.03 | 40.66 | 10.24 | 10.54 | 12.04 | 12.32 | 11.45 | 11.59 | 11.24 | 11.49 | 39.70 | 39.53 | 46.10 | 45.96 | 48.47 | 48.24 | 44.75 | 44.58 |
| mean of foliar spraying | without | | | | | | | 34.14 | 34.69 | | | | | | | 8.51 | 8.58 | | | | | | | 35.57 | 35.43 |
| | mono-K | | | | | | | 36.94 | 37.44 | | | | | | | 10.31 | 10.47 | | | | | | | 41.52 | 41.40 |
| | di-K | | | | | | | 38.11 | 38.75 | | | | | | | 9.77 | 9.87 | | | | | | | 44.22 | 44.04 |
| L.S.D. at 0.05 | A | | | | | | | 1.13 | 1.14 | | | | | | | 0.30 | 0.31 | | | | | | | 0.88 | 1.01 |
| | B | | | | | | | 1.20 | 1.22 | | | | | | | 0.27 | 0.26 | | | | | | | 0.89 | 1.00 |
| | C | | | | | | | 1.02 | 1.05 | | | | | | | 0.21 | 0.22 | | | | | | | 0.90 | 0.97 |
| | AB | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | AC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | BC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | ABC | | | | | | | 2.01 | 2.35 | | | | | | | 0.53 | 0.48 | | | | | | | N.S | N.S |

**Table 7. Response of total NPK uptake of maize to soil and foliar spraying of potassium under chicken manure application.**

| K-sulphate (kg/fed) (A) | Chicken manure (t/fed) (B) | Potassium foliar spraying ( C ) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total N uptake (kg/fed) | | | | | | | | Total P uptake (kg/fed) | | | | | | | | Total K uptake (kg/fed) | | | | | | | |
| | | without | | mono-K phosphate | | di-K phosphate | | mean | | without | | mono-K phosphate | | di-K phosphate | | mean | | without | | mono-K phosphate | | di-K phosphate | | mean | |
| | | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| 0.0 | 0.0 | 54.23 | 55.51 | 59.32 | 60.32 | 61.03 | 61.45 | 58.19 | 59.09 | 12.17 | 12.31 | 14.93 | 15.10 | 14.61 | 14.71 | 13.90 | 14.04 | 43.81 | 44.54 | 49.32 | 49.61 | 52.85 | 52.93 | 48.66 | 49.03 |
| | 2.5 | 61.97 | 63.29 | 67.09 | 68.29 | 69.32 | 70.46 | 66.13 | 67.35 | 14.61 | 14.89 | 17.39 | 17.59 | 17.01 | 17.39 | 16.34 | 16.62 | 50.33 | 51.16 | 56.29 | 56.03 | 59.21 | 59.23 | 55.28 | 55.47 |
| | 5.0 | 69.49 | 71.09 | 75.40 | 76.07 | 77.37 | 77.93 | 74.09 | 75.03 | 17.77 | 18.04 | 21.11 | 20.19 | 19.99 | 20.10 | 19.62 | 19.44 | 58.42 | 58.61 | 62.03 | 61.92 | 65.75 | 65.57 | 62.07 | 62.03 |
| mean | | 61.90 | 63.30 | 67.27 | 68.23 | 69.24 | 69.95 | 66.14 | 67.16 | 14.85 | 15.08 | 17.81 | 17.63 | 17.20 | 17.40 | 16.62 | 16.70 | 50.85 | 51.44 | 55.88 | 55.85 | 59.27 | 59.24 | 55.33 | 55.51 |
| 50.0 | 0.0 | 63.36 | 64.71 | 69.53 | 70.55 | 71.95 | 72.63 | 68.28 | 69.30 | 13.01 | 13.55 | 16.23 | 16.35 | 15.71 | 15.88 | 14.98 | 15.26 | 52.63 | 53.49 | 62.23 | 62.65 | 65.67 | 66.05 | 60.18 | 60.73 |
| | 2.5 | 71.37 | 73.05 | 76.68 | 77.81 | 80.39 | 81.96 | 76.15 | 77.61 | 16.53 | 16.52 | 18.85 | 19.00 | 18.73 | 18.93 | 18.04 | 18.15 | 58.81 | 59.31 | 68.34 | 68.31 | 74.59 | 74.41 | 67.25 | 67.34 |
| | 5.0 | 77.77 | 79.37 | 83.45 | 84.61 | 85.21 | 86.92 | 82.14 | 83.63 | 19.02 | 19.47 | 23.00 | 22.08 | 21.31 | 21.26 | 21.11 | 20.94 | 64.37 | 65.05 | 76.81 | 77.25 | 80.03 | 80.11 | 73.74 | 74.14 |
| mean | | 70.83 | 72.38 | 76.55 | 77.66 | 79.18 | 80.50 | 75.52 | 76.85 | 16.19 | 16.51 | 19.36 | 19.14 | 18.58 | 18.69 | 18.04 | 18.12 | 58.60 | 59.28 | 69.13 | 69.40 | 73.43 | 73.52 | 67.05 | 67.40 |
| 100.0 | 0.0 | 70.05 | 62.04 | 73.02 | 74.35 | 75.41 | 76.55 | 72.83 | 70.98 | 14.65 | 12.51 | 16.95 | 16.76 | 16.19 | 16.35 | 15.93 | 15.21 | 59.93 | 53.53 | 66.23 | 65.99 | 69.15 | 68.97 | 65.10 | 62.83 |
| | 2.5 | 77.04 | 78.94 | 81.13 | 82.43 | 84.33 | 86.03 | 80.83 | 82.47 | 17.30 | 17.72 | 19.31 | 19.48 | 19.01 | 19.24 | 18.54 | 18.81 | 64.95 | 66.09 | 72.89 | 73.06 | 78.21 | 78.63 | 72.02 | 72.59 |
| | 5.0 | 83.78 | 85.73 | 87.80 | 89.71 | 89.41 | 90.85 | 87.00 | 88.76 | 20.00 | 20.75 | 22.81 | 22.33 | 21.35 | 21.65 | 21.39 | 21.58 | 71.43 | 71.73 | 79.65 | 79.73 | 83.11 | 83.49 | 78.06 | 78.32 |
| mean | | 76.96 | 75.57 | 80.65 | 82.16 | 83.05 | 84.48 | 80.22 | 80.74 | 17.32 | 16.99 | 19.69 | 19.52 | 18.85 | 19.08 | 18.62 | 18.53 | 65.44 | 63.78 | 72.92 | 72.93 | 76.82 | 77.03 | 71.73 | 71.25 |
| mean of chicken manure | 0.0 | 62.55 | 60.75 | 67.29 | 68.41 | 69.46 | 70.21 | 66.43 | 66.46 | 13.28 | 12.79 | 16.04 | 16.07 | 15.50 | 15.65 | 14.94 | 14.84 | 52.12 | 50.52 | 59.26 | 59.42 | 62.56 | 62.65 | 57.98 | 57.53 |
| | 2.5 | 70.13 | 71.76 | 74.97 | 76.18 | 78.01 | 79.48 | 74.37 | 75.81 | 16.15 | 16.38 | 18.52 | 18.69 | 18.25 | 18.52 | 17.64 | 17.86 | 58.03 | 58.85 | 65.84 | 65.80 | 70.67 | 70.76 | 64.85 | 65.13 |
| | 5.0 | 77.01 | 78.73 | 82.22 | 83.46 | 84.00 | 85.23 | 81.08 | 82.47 | 18.93 | 19.42 | 22.31 | 21.53 | 20.88 | 21.00 | 20.71 | 20.65 | 64.74 | 65.13 | 72.83 | 72.97 | 76.30 | 76.39 | 71.29 | 71.50 |
| mean of foliar spraying | without | | | | | | | 69.90 | 70.42 | | | | | | | 16.12 | 16.19 | | | | | | | 58.30 | 58.17 |
| | mono-K | | | | | | | 74.82 | 76.02 | | | | | | | 18.95 | 18.76 | | | | | | | 65.98 | 66.06 |
| | di-K | | | | | | | 77.16 | 78.31 | | | | | | | 18.21 | 18.39 | | | | | | | 69.84 | 69.93 |
| L.S.D.at 0.05 | A | | | | | | | 1.13 | 1.14 | | | | | | | 0.30 | 0.31 | | | | | | | 0.88 | 1.01 |
| | B | | | | | | | 1.20 | 1.22 | | | | | | | 0.27 | 0.26 | | | | | | | 0.89 | 1.00 |
| | C | | | | | | | 1.02 | 1.05 | | | | | | | 0.21 | 0.22 | | | | | | | 0.90 | 0.97 |
| | AB | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | AC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | BC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | ABC | | | | | | | 2.01 | 2.35 | | | | | | | 0.53 | 0.48 | | | | | | | N.S | N.S |

Considering foliar spraying of potassium, the data indicate that foliar spraying of potassium had a markedly affect on N,P and K uptake. Comparing with control, spraying mono-potassium phosphate increased total N,P and K uptake by about 7.0 ,17.6 and 13.2 % in first season comparing with control, respectively. The corresponding increasing due to di-potassium phosphate were 10.4 , 13.0 and 19.8% in the abovementioned respect. It is worthy to notice that foliar spraying of mono- or di-potassium phosphate had a greater affect on increasing P and K uptake than N uptake, which mainly due to presence phosphorus and potassium in its content. The effect of foliar spraying of potassium on maize grain and stover yields as well as its effect on NPK concentration in grains

and stover is a good explanation for its effect on NPK uptake.

These results are similar to those obtained by Zorkany (2014) and Hassanien (2018). As for organic manure, the data indicate that N,P and K uptake by grains and/or stover were significantly increased by increasing chicken manure levels up to 5.0 t/fed. The highest mean values of total N,P and K due to applied 5.0 t chicken manure/fed were 81.08, 70.71 and 71.29 kg/fed in the first season, respectively, while the lowest total N,P and K uptake were recorded under without manuring (66.43 , 14.14 and 57.98 kg/fed, respectively in the first season). Same trends were obtained in the second season. The promotive effect of chicken manure on nutrient uptake may be referred to the improvement of soil reaction caused by manuring, which in turn increased nutrient solubility(Brar *et al*, 2001). Also, these increments may be due to the high N,P and K content in chicken manure used in the experimental soil as shown in Table 1. These results are in harmony with those obtained by Esilaba *et al* (2000) and El-Sheref (2012).

As for the interaction between treatments, the data indicate N,P and K uptake were affected only by the interaction among the three studied factors. In general, the maize plants received 50 or 100 kg K-sulphate as soil application + 2% foliar spraying of di-potassium phosphate + 5.0 t chicken manure/fed yielded the highest N,P and K by grains and/or stover. On the other hand, the maize plants without potassium fertilization or manuring produced the lowest N,P and K.

**Some chemical soil properties:**

The influence of soil or foliar fertilization and organic manure application and their interaction on some chemical properties after maize harvest are shown in Table 8. The data reveal that the values of soil reaction, salinity and organic matter noted after maize harvest were non considerably exaggerated by K-fertilization, whether soil or foliar application. On the other and, these properties was significantly affected by manuring. Chicken manure treatments improved both soil reaction and soil organic matter, while it increased soil salinity. It is obvious to notice that the affect of chicken manure on soil properties is increased as its level increased. The decreasing in soil pH due to organic manure could be attributed to the acidifying effect of organics produced during the course of continuous decomposition of applied chicken manure (Hizal, 1993). The promative effect of chicken manure on soil organic matter is mostly explained by the higher content of organic matter in chicken manure (Table 1), beside the relative slow of its decomposition (Kunda, 2006). The increase in soil salinity due to increasing chicken manure levels may be ascribed to its high salinity content as shown in Table 1 (Wong *et al*, 1999). These results are similar to those obtained by El-Shabrawy (2012) for soil pH, Sharif *et al* (2004) for soil organic matter and El-Shreef (2012) for soil salinity. It is evident from the data that the studied chemical soil properties did not respond to the interaction between the treatments.

**Table 8. Response of some chemical soil properties after maize harvesting to soil and foliar spraying of potassium under chicken manure application.**

| K-sulphate (kg/fed) (A) | Chicken manure (t/fed) (B) | Potassium foliar spraying ( C ) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | pH | | | | | | | | EC | | | | | | | | O.M | | | | | | | |
| | | without | | mono-K phosphate | | di-K phosphate | | mean | | without | | mono-K phosphate | | di-K phosphate | | mean | | without | | mono-K phosphate | | di-K phosphate | | mean | |
| | | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| 0.0 | 0.0 | 8.13 | 8.12 | 8.13 | 8.13 | 8.12 | 8.13 | 8.13 | 8.13 | 1.26 | 1.26 | 1.26 | 1.27 | 1.26 | 1.26 | 1.26 | 1.26 | 1.42 | 1.42 | 1.43 | 1.42 | 1.43 | 1.42 | 1.43 | 1.42 |
| | 2.5 | 8.08 | 8.07 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 1.32 | 1.32 | 1.33 | 1.33 | 1.32 | 1.33 | 1.32 | 1.33 | 1.57 | 1.57 | 1.57 | 1.57 | 1.57 | 1.58 | 1.57 | 1.57 |
| | 5.0 | 8.04 | 8.04 | 8.08 | 8.04 | 8.04 | 8.04 | 8.05 | 8.04 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.66 | 1.66 | 1.67 | 1.66 | 1.66 | 1.66 | 1.66 | 1.66 |
| mean | | 8.08 | 8.08 | 8.10 | 8.08 | 8.08 | 8.08 | 8.09 | 8.08 | 1.31 | 1.31 | 1.32 | 1.32 | 1.31 | 1.32 | 1.31 | 1.32 | 1.55 | 1.55 | 1.56 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 |
| 50.0 | 0.0 | 8.12 | 8.13 | 8.12 | 8.12 | 8.12 | 8.12 | 8.12 | 8.12 | 1.26 | 1.26 | 1.27 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.42 | 1.43 | 1.42 | 1.42 | 1.42 | 1.43 | 1.42 | 1.43 |
| | 2.5 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.58 | 1.57 | 1.57 | 1.58 | 1.57 | 1.57 | 1.57 | 1.57 |
| | 5.0 | 8.04 | 8.04 | 8.04 | 8.04 | 8.05 | 8.04 | 8.04 | 8.04 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.67 | 1.66 | 1.67 | 1.66 | 1.67 | 1.66 | 1.67 | 1.66 |
| mean | | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 1.32 | 1.32 | 1.32 | 1.32 | 1.32 | 1.32 | 1.32 | 1.32 | 1.56 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 |
| 100.0 | 0.0 | 8.12 | 8.12 | 8.13 | 8.13 | 8.12 | 8.12 | 8.12 | 8.12 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.43 | 1.42 | 1.43 | 1.42 | 1.42 | 1.42 | 1.43 | 1.42 |
| | 2.5 | 8.08 | 8.08 | 8.08 | 8.08 | 8.07 | 8.08 | 8.08 | 8.08 | 1.34 | 1.33 | 1.34 | 1.33 | 1.34 | 1.33 | 1.34 | 1.33 | 1.57 | 1.57 | 1.56 | 1.57 | 1.57 | 1.57 | 1.57 | 1.57 |
| | 5.0 | 8.04 | 8.04 | 8.04 | 8.04 | 8.04 | 8.05 | 8.04 | 8.04 | 1.36 | 1.36 | 1.36 | 1.35 | 1.36 | 1.36 | 1.36 | 1.36 | 1.66 | 1.66 | 1.67 | 1.66 | 1.67 | 1.66 | 1.67 | 1.66 |
| mean | | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 1.32 | 1.32 | 1.32 | 1.31 | 1.32 | 1.32 | 1.32 | 1.32 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 | 1.55 |
| mean of chicken manure | 0.0 | 8.12 | 8.12 | 8.13 | 8.13 | 8.12 | 8.12 | 8.12 | 8.12 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.26 | 1.42 | 1.42 | 1.43 | 1.42 | 1.42 | 1.42 | 1.43 | 1.42 |
| | 2.5 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 8.08 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.33 | 1.57 | 1.57 | 1.57 | 1.57 | 1.57 | 1.57 | 1.57 | 1.57 |
| | 5.0 | 8.04 | 8.04 | 8.05 | 8.04 | 8.04 | 8.04 | 8.04 | 8.04 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.36 | 1.66 | 1.66 | 1.67 | 1.66 | 1.67 | 1.66 | 1.67 | 1.66 |
| mean of foliar spraying | without | | | | | | | 8.08 | 8.08 | | | | | | | 1.32 | 1.32 | | | | | | | 1.55 | 1.55 |
| | mono-K | | | | | | | 8.09 | 8.08 | | | | | | | 1.32 | 1.32 | | | | | | | 1.55 | 1.55 |
| | di-K | | | | | | | 8.08 | 8.08 | | | | | | | 1.32 | 1.32 | | | | | | | 1.55 | 1.55 |
| L.S.D. at 0.05 | A | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | B | | | | | | | 0.02 | 0.01 | | | | | | | 0.03 | 0.03 | | | | | | | 0.03 | 0.03 |
| | C | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | AB | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | AC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | BC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | ABC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |

**Soil fertility:**

The data in Table 9 represent the effect of soil and foliar fertization of potassium and organic manure application and their interactions on soil fertility in term of soil available N,P and K after maize harvest. The results clearly show that potassium fertilization as soil application was only affected soil available K after harvest, which may be attributed to added potassium as soil application may be absorbed in the soil as $K^+$ and part of them remain in soil after harvest without leaching. On the other hand, added

potassium as foliar spraying did not affect soil fertility. Mean while, chicken manure application enhanced soil available N,P and K after harvest, which mostly due to the content of N,P and K applied to soil within manure itself, also the decomposition of the organic manure formation to mineralized form of N, P and K (Mann *et al*, 2006). These results are in line with those obtained by Ali (2001) and El-Sheref (2012). It is evident from the data that soil available N,P and K did not respond to the interactions between treatments.

**Table 9. Response of soil fertility after maize harvesting to soil and foliar spraying of potassium under chicken manure application.**

| K-sulphate (kg/fed) (A) | Chicken manure (t/fed) (B) | Potassium foliar spraying ( C ) | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Available N (ppm) | | | | | | | | Available P (ppm) | | | | | | | | Available K (ppm) | | | | | | | |
| | | without | | mono-k phosphate | | di-K phosphate | | mean | | without | | mono-k phosphate | | di-K phosphate | | mean | | | | | | | | mean | |
| | | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| 0.0 | 0.0 | 22 | 24 | 22 | 24 | 23 | 24 | 22 | 24 | 12 | 14 | 12 | 14 | 13 | 14 | 12 | 14 | 172 | 174 | 172 | 173 | 173 | 175 | 172 | 174 |
| | 2.5 | 27 | 29 | 27 | 29 | 27 | 29 | 27 | 29 | 13 | 15 | 14 | 15 | 14 | 15 | 14 | 15 | 178 | 179 | 177 | 179 | 178 | 179 | 178 | 179 |
| | 5.0 | 31 | 33 | 30 | 33 | 31 | 33 | 31 | 33 | 14 | 17 | 15 | 16 | 15 | 16 | 15 | 16 | 185 | 187 | 186 | 187 | 185 | 187 | 185 | 187 |
| mean | | 27 | 29 | 26 | 29 | 27 | 29 | 27 | 29 | 13 | 15 | 14 | 15 | 14 | 15 | 14 | 15 | 178 | 180 | 178 | 180 | 179 | 180 | 178 | 180 |
| 50.0 | 0.0 | 22 | 24 | 22 | 25 | 22 | 24 | 22 | 24 | 12 | 14 | 12 | 14 | 12 | 14 | 12 | 14 | 180 | 182 | 181 | 183 | 181 | 182 | 181 | 182 |
| | 2.5 | 27 | 29 | 27 | 28 | 27 | 30 | 27 | 29 | 13 | 16 | 13 | 15 | 14 | 15 | 13 | 15 | 184 | 187 | 185 | 187 | 185 | 187 | 185 | 187 |
| | 5.0 | 32 | 33 | 31 | 34 | 31 | 33 | 31 | 33 | 14 | 17 | 14 | 17 | 15 | 16 | 14 | 17 | 189 | 195 | 188 | 195 | 189 | 196 | 189 | 195 |
| mean2 | | 27 | 29 | 27 | 29 | 27 | 29 | 27 | 29 | 13 | 16 | 13 | 15 | 14 | 15 | 13 | 15 | 184 | 188 | 185 | 188 | 185 | 188 | 185 | 188 |
| 100.0 | 0.0 | 23 | 25 | 23 | 24 | 22 | 25 | 23 | 25 | 12 | 14 | 12 | 14 | 12 | 14 | 12 | 14 | 185 | 188 | 185 | 187 | 184 | 187 | 185 | 187 |
| | 2.5 | 27 | 29 | 27 | 29 | 27 | 29 | 27 | 29 | 13 | 15 | 13 | 15 | 13 | 15 | 13 | 15 | 190 | 193 | 191 | 194 | 190 | 194 | 190 | 194 |
| | 5.0 | 31 | 34 | 31 | 33 | 31 | 34 | 31 | 34 | 14 | 17 | 14 | 16 | 14 | 17 | 14 | 17 | 196 | 196 | 197 | 196 | 196 | 197 | 196 | 196 |
| mean | | 27 | 29 | 27 | 29 | 27 | 29 | 27 | 29 | 13 | 15 | 13 | 15 | 13 | 15 | 13 | 15 | 190 | 192 | 191 | 192 | 190 | 193 | 190 | 192 |
| Mean of chicken manure | 0.0 | 22 | 24 | 22 | 24 | 22 | 24 | 22 | 24 | 12 | 14 | 12 | 14 | 12 | 14 | 12 | 14 | 179 | 181 | 179 | 181 | 179 | 181 | 179 | 181 |
| | 2.5 | 27 | 29 | 27 | 29 | 27 | 29 | 27 | 29 | 13 | 15 | 13 | 15 | 14 | 15 | 13 | 15 | 184 | 186 | 184 | 187 | 184 | 187 | 184 | 187 |
| | 5.0 | 31 | 33 | 31 | 33 | 31 | 33 | 31 | 33 | 14 | 17 | 14 | 16 | 15 | 16 | 14 | 17 | 190 | 193 | 190 | 193 | 190 | 193 | 190 | 193 |
| mean of foliar spraying | without | | | | | | | 27 | 29 | | | | | | | 13 | 15 | | | | | | | 184 | 187 |
| | mono-K | | | | | | | 27 | 29 | | | | | | | 13 | 15 | | | | | | | 185 | 187 |
| | di-K | | | | | | | 27 | 29 | | | | | | | 14 | 15 | | | | | | | 185 | 187 |
| L.S.D. at 0.05 | A | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | 1.75 | 1.30 |
| | B | | | | | | | 1.11 | 1.02 | | | | | | | 0.07 | 0.06 | | | | | | | 1.02 | 1.16 |
| | C | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | AB | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | AC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | BC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |
| | ABC | | | | | | | N.S | N.S | | | | | | | N.S | N.S | | | | | | | N.S | N.S |

## CONCLISION

It could be concluded that the fertilized maize plants with 50.0 kg K-sulphate/fed + 2% foliar spraying of di-potassium phosphate twice + 5.0 t/fed chicken manure had better performance to maize productivity and improved soil properties after harvest under the conditions of Middle Egypt, Beni-Suef Governorate, this result means that it could be save about 50 kg potassium sulphate by spraying di-potassium sulphate.

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# APPENDIX

**Table 1. Response of NPK concentration in maize grains to soil and foliar spraying of potassium under chicken manure application.**

| K-sulphate (kg/fed) (A) | Chicken manure (t/fed) (B) | Potassium foliar spraying ( C ) | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N % | | | | | | | | P % | | | | | | | | K % | | | | | | | | | |
| | | without | | mono-K phosphate | | di-K phosphate | | mean | | without | | mono-K phosphate | | di-K phosphate | | mean | | without | | mono-K phosphate | | di-K phosphate | | mean | |
| | | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| 0.0 | 0.0 | 1.13 | 1.13 | 1.16 | 1.17 | 1.17 | 1.17 | 1.15 | 1.16 | 0.25 | 0.25 | 0.27 | 0.27 | 0.27 | 0.27 | 0.26 | 0.26 | 0.70 | 0.71 | 0.75 | 0.75 | 0.79 | 0.79 | 0.75 | 0.75 |
| | 2.5 | 1.25 | 1.25 | 1.27 | 1.28 | 1.29 | 1.30 | 1.27 | 1.28 | 0.27 | 0.27 | 0.29 | 0.29 | 0.29 | 0.30 | 0.28 | 0.29 | 0.77 | 0.78 | 0.83 | 0.83 | 0.86 | 0.86 | 0.82 | 0.82 |
| | 5.0 | 1.34 | 1.33 | 1.38 | 1.39 | 1.39 | 1.39 | 1.37 | 1.37 | 0.31 | 0.31 | 0.35 | 0.31 | 0.32 | 0.32 | 0.33 | 0.31 | 0.86 | 0.85 | 0.88 | 0.88 | 0.91 | 0.91 | 0.88 | 0.88 |
| mean | | 1.24 | 1.24 | 1.27 | 1.28 | 1.28 | 1.29 | 1.26 | 1.27 | 0.28 | 0.28 | 0.30 | 0.29 | 0.29 | 0.30 | 0.29 | 0.29 | 0.78 | 0.78 | 0.82 | 0.82 | 0.85 | 0.85 | 0.82 | 0.82 |
| 50.0 | 0.0 | 1.27 | 1.26 | 1.29 | 1.31 | 1.32 | 1.32 | 1.29 | 1.30 | 0.25 | 0.26 | 0.27 | 0.27 | 0.27 | 0.27 | 0.26 | 0.27 | 0.80 | 0.81 | 0.83 | 0.84 | 0.86 | 0.86 | 0.83 | 0.84 |
| | 2.5 | 1.36 | 1.36 | 1.38 | 1.39 | 1.40 | 1.41 | 1.38 | 1.39 | 0.28 | 0.28 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.85 | 0.85 | 0.86 | 0.86 | 0.89 | 0.89 | 0.87 | 0.87 |
| | 5.0 | 1.41 | 1.40 | 1.44 | 1.46 | 1.46 | 1.47 | 1.44 | 1.44 | 0.31 | 0.31 | 0.36 | 0.32 | 0.32 | 0.31 | 0.33 | 0.31 | 0.89 | 0.89 | 0.92 | 0.92 | 0.96 | 0.96 | 0.92 | 0.92 |
| mean | | 1.35 | 1.34 | 1.37 | 1.39 | 1.39 | 1.40 | 1.37 | 1.38 | 0.28 | 0.28 | 0.31 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.85 | 0.85 | 0.87 | 0.87 | 0.90 | 0.90 | 0.87 | 0.88 |
| 100.0 | 0.0 | 1.30 | 1.32 | 1.30 | 1.32 | 1.33 | 1.33 | 1.31 | 1.32 | 0.26 | 0.26 | 0.28 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.86 | 0.86 | 0.87 | 0.87 | 0.88 | 0.88 | 0.87 | 0.87 |
| | 2.5 | 1.39 | 1.40 | 1.39 | 1.40 | 1.41 | 1.42 | 1.40 | 1.41 | 0.29 | 0.29 | 0.29 | 0.29 | 0.30 | 0.30 | 0.29 | 0.29 | 0.89 | 0.90 | 0.89 | 0.89 | 0.92 | 0.92 | 0.90 | 0.90 |
| | 5.0 | 1.44 | 1.46 | 1.45 | 1.47 | 1.47 | 1.46 | 1.45 | 1.46 | 0.31 | 0.31 | 0.35 | 0.31 | 0.32 | 0.32 | 0.33 | 0.31 | 0.93 | 0.93 | 0.95 | 0.95 | 0.96 | 0.96 | 0.95 | 0.95 |
| mean | | 1.38 | 1.39 | 1.38 | 1.40 | 1.40 | 1.40 | 1.39 | 1.40 | 0.29 | 0.29 | 0.31 | 0.29 | 0.30 | 0.30 | 0.30 | 0.29 | 0.89 | 0.90 | 0.90 | 0.90 | 0.92 | 0.92 | 0.91 | 0.91 |
| mean of chicken manure | 0.0 | 1.23 | 1.24 | 1.25 | 1.27 | 1.27 | 1.27 | 1.25 | 1.26 | 0.25 | 0.26 | 0.27 | 0.27 | 0.27 | 0.27 | 0.26 | 0.27 | 0.79 | 0.79 | 0.82 | 0.82 | 0.84 | 0.84 | 0.82 | 0.82 |
| | 2.5 | 1.33 | 1.34 | 1.35 | 1.36 | 1.37 | 1.38 | 1.35 | 1.36 | 0.28 | 0.28 | 0.29 | 0.29 | 0.29 | 0.30 | 0.29 | 0.29 | 0.84 | 0.84 | 0.86 | 0.86 | 0.89 | 0.89 | 0.86 | 0.86 |
| | 5.0 | 1.40 | 1.40 | 1.42 | 1.44 | 1.44 | 1.44 | 1.42 | 1.42 | 0.31 | 0.31 | 0.35 | 0.31 | 0.32 | 0.32 | 0.33 | 0.31 | 0.89 | 0.89 | 0.92 | 0.92 | 0.94 | 0.94 | 0.92 | 0.92 |
| mean of foliar spraying | without | | | | | | | 1.32 | 1.32 | | | | | | | 0.28 | 0.28 | | | | | | | 0.84 | 0.84 |
| | mono-K | | | | | | | 1.34 | 1.36 | | | | | | | 0.31 | 0.29 | | | | | | | 0.86 | 0.86 |
| | di-K | | | | | | | 1.36 | 1.36 | | | | | | | 0.29 | 0.30 | | | | | | | 0.89 | 0.89 |
| L.S.D. at 0.05 | A | | | | | | | | | | | | | | | | | | | | | | | | |
| | B | | | | | | | | | | | | | | | | | | | | | | | | |
| | C | | | | | | | | | | | | | | | | | | | | | | | | |
| | AB | | | | | | | | | | | | | | | | | | | | | | | | |
| | AC | | | | | | | | | | | | | | | | | | | | | | | | |
| | BC | | | | | | | | | | | | | | | | | | | | | | | | |
| | ABC | | | | | | | | | | | | | | | | | | | | | | | | |

**Table 2. Response of NPK concentration in maize stover to soil and foliar spraying of potassium under chicken manure application.**

| K-sulphate (kg/fed) (A) | Chicken manure (t/fed) (B) | Potassium foliar spraying ( C ) | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | N % | | | | | | | | P % | | | | | | | | K % | | | | | | | | | |
| | | without | | mono-K phosphate | | di-K phosphate | | mean | | without | | mono-K phosphate | | di-K phosphate | | mean | | without | | mono-K phosphate | | di-K phosphate | | mean | |
| | | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 | 2016 | 2017 |
| 0.0 | 0.0 | 0.84 | 0.85 | 0.88 | 0.88 | 0.88 | 0.88 | 0.87 | 0.87 | 0.19 | 0.19 | 0.24 | 0.24 | 0.22 | 0.22 | 0.22 | 0.22 | 0.85 | 0.84 | 0.91 | 0.90 | 0.95 | 0.94 | 0.90 | 0.89 |
| | 2.5 | 0.89 | 0.89 | 0.92 | 0.93 | 0.93 | 0.94 | 0.91 | 0.92 | 0.23 | 0.23 | 0.27 | 0.27 | 0.25 | 0.25 | 0.25 | 0.25 | 0.91 | 0.90 | 0.96 | 0.94 | 0.99 | 0.98 | 0.95 | 0.94 |
| | 5.0 | 0.93 | 0.94 | 0.97 | 0.96 | 0.97 | 0.97 | 0.96 | 0.96 | 0.26 | 0.26 | 0.30 | 0.30 | 0.28 | 0.28 | 0.28 | 0.28 | 0.98 | 0.96 | 0.99 | 0.97 | 1.03 | 1.01 | 1.00 | 0.98 |
| mean | | 0.89 | 0.89 | 0.92 | 0.92 | 0.93 | 0.93 | 0.91 | 0.92 | 0.23 | 0.23 | 0.27 | 0.27 | 0.25 | 0.25 | 0.25 | 0.25 | 0.91 | 0.90 | 0.95 | 0.94 | 0.99 | 0.98 | 0.95 | 0.94 |
| 50.0 | 0.0 | 0.88 | 0.89 | 0.93 | 0.93 | 0.94 | 0.94 | 0.92 | 0.92 | 0.19 | 0.19 | 0.24 | 0.24 | 0.22 | 0.22 | 0.22 | 0.22 | 0.92 | 0.91 | 1.08 | 1.07 | 1.12 | 1.11 | 1.04 | 1.03 |
| | 2.5 | 0.93 | 0.93 | 0.96 | 0.96 | 0.97 | 0.98 | 0.95 | 0.96 | 0.24 | 0.23 | 0.27 | 0.27 | 0.25 | 0.25 | 0.25 | 0.25 | 0.96 | 0.94 | 1.12 | 1.10 | 1.18 | 1.16 | 1.09 | 1.07 |
| | 5.0 | 0.96 | 0.96 | 0.99 | 0.98 | 0.99 | 1.00 | 0.98 | 0.98 | 0.26 | 0.26 | 0.30 | 0.30 | 0.28 | 0.28 | 0.28 | 0.28 | 0.99 | 0.97 | 1.20 | 1.19 | 1.22 | 1.20 | 1.14 | 1.12 |
| mean | | 0.92 | 0.93 | 0.96 | 0.96 | 0.97 | 0.97 | 0.95 | 0.95 | 0.23 | 0.23 | 0.27 | 0.27 | 0.25 | 0.25 | 0.25 | 0.25 | 0.96 | 0.94 | 1.13 | 1.12 | 1.17 | 1.16 | 1.09 | 1.07 |
| 100.0 | 0.0 | 0.92 | 0.92 | 1.01 | 1.02 | 1.02 | 1.03 | 0.98 | 0.99 | 0.20 | 0.19 | 0.25 | 0.25 | 0.23 | 0.23 | 0.23 | 0.22 | 0.97 | 0.95 | 1.15 | 1.13 | 1.19 | 1.17 | 1.10 | 1.08 |
| | 2.5 | 0.95 | 0.95 | 1.05 | 1.06 | 1.05 | 1.06 | 1.02 | 1.02 | 0.23 | 0.23 | 0.28 | 0.28 | 0.25 | 0.25 | 0.25 | 0.25 | 1.00 | 0.99 | 1.20 | 1.19 | 1.24 | 1.23 | 1.15 | 1.14 |
| | 5.0 | 0.99 | 0.99 | 1.08 | 1.09 | 1.08 | 1.09 | 1.05 | 1.06 | 0.26 | 0.27 | 0.30 | 0.31 | 0.28 | 0.28 | 0.28 | 0.29 | 1.05 | 1.03 | 1.24 | 1.22 | 1.29 | 1.27 | 1.19 | 1.17 |
| mean | | 0.95 | 0.95 | 1.05 | 1.06 | 1.05 | 1.06 | 1.02 | 1.02 | 0.23 | 0.23 | 0.28 | 0.28 | 0.25 | 0.25 | 0.25 | 0.25 | 1.01 | 0.99 | 1.20 | 1.18 | 1.24 | 1.22 | 1.15 | 1.13 |
| mean of chicken manure | 0.0 | 0.88 | 0.89 | 0.94 | 0.94 | 0.95 | 0.95 | 0.92 | 0.93 | 0.19 | 0.19 | 0.24 | 0.24 | 0.22 | 0.22 | 0.22 | 0.22 | 0.91 | 0.90 | 1.05 | 1.03 | 1.09 | 1.07 | 1.01 | 1.00 |
| | 2.5 | 0.92 | 0.92 | 0.98 | 0.98 | 0.98 | 0.99 | 0.96 | 0.97 | 0.24 | 0.23 | 0.27 | 0.27 | 0.25 | 0.25 | 0.25 | 0.25 | 0.96 | 0.94 | 1.09 | 1.08 | 1.14 | 1.12 | 1.06 | 1.05 |
| | 5.0 | 0.96 | 0.96 | 1.01 | 1.01 | 1.01 | 1.02 | 1.00 | 1.00 | 0.26 | 0.26 | 0.30 | 0.30 | 0.28 | 0.28 | 0.28 | 0.28 | 1.01 | 0.99 | 1.14 | 1.13 | 1.18 | 1.16 | 1.11 | 1.09 |
| mean of foliar spraying | without | | | | | | | 0.92 | 0.92 | | | | | | | 0.23 | o.23 | | | | | | | 0.96 | 0.94 |
| | mono-K | | | | | | | 0.98 | 0.98 | | | | | | | 0.27 | 0.27 | | | | | | | 1.09 | 1.08 |
| | di-K | | | | | | | 0.98 | 0.99 | | | | | | | 0.25 | 0.25 | | | | | | | 1.10 | 1.12 |
| L.S.D. at 0.05 | A | | | | | | | | | | | | | | | | | | | | | | | | |
| | B | | | | | | | | | | | | | | | | | | | | | | | | |
| | C | | | | | | | | | | | | | | | | | | | | | | | | |
| | AB | | | | | | | | | | | | | | | | | | | | | | | | |
| | AC | | | | | | | | | | | | | | | | | | | | | | | | |
| | BC | | | | | | | | | | | | | | | | | | | | | | | | |
| | ABC | | | | | | | | | | | | | | | | | | | | | | | | |

# تقليل استخدام الاسمدة البوتاسية باستخدام الرش واضافه الاسمده العضوية وتاثيرها علي انتاجية الذرة وخواص التربة

**غادة فتح الله حافظ الشريف ، حامد علي عوض الله و حنان محمد ابوالفتوح**
**معهد بحوث الاراضى و المياه و البيئة – مركز البحوث الزراعية – الجيزة – مصر**

اجريت تجربتان حقليتان بمحطة البحوث الزراعية بسدس مركز البحوث الزراعية محافظة بني سويف خلال موسمي النمو 2016 , 2017 لتقييم امكانيه تقليل الكميات المستخدمة من الاسمدة البوتاسية برش 2% من اسمدة المونو بوتاسيوم فوسفات او الداي بوتاسيوم فوسفات مرتان تحت استخدام مستويات مختلفة من سماد الدواجن (صفر , 2.5 , 5 طن /فدان) وتاثيرها علي صفات النمو والمحصول ومكوناته وامتصاص عناصر النيتروجين والفوسفور والبوتاسيوم لنبات الذرة وكذلك صفات التربة بعد الحصاد. وكانت اهم النتائج المتحصل عليها هي: زيادة مستويات التسميد العضوي كان لها تاثير معنوي علي زيادة طول النبات ووزنه الجاف وعدد الصفوف في الكوز وعدد الحبوب في الصف ووزن المائه حبه ومحصول الحبوب ومحصول القش وامتصاص عناصر النيتروجين والفوسفور والبوتاسيوم وكذلك تحسين صفات التربة وخصوبتها ماعدا ملوحة التربة التي زادت بالتسميد العضوي. ادي رش نبات الذرة بسماد الداي بوتاسيوم فوسفات الي اعلي قيم لصفات النمو والمحصول ومكوناته وامتصاص العناصر مقارنتا بسماد المونو بوتاسيوم فوسفات والكونترول ولم يوثر رش البوتاسيوم علي اي من صفات التربة وخصوبتها. ادي زيادة التسميد البوتاسي الي 100كجم كبريتات بوتاسيوم /فدان الي زيادة كل صفات النمو والمحصول ومكوناته وامتصاص العناصر وكذلك زيادة البوتاسيوم الميسر في التربة بعد الحصاد . من نتائج التداخل فقد ادي اضافة 50 كجم كبريتات بوتاسيوم/فدان + 2% رش داي بوتاسيوم فوسفات + 5 طن سماد دواجن الي انتاجية مساويه احصائيا للتسميد بمعدل 100 كجم كبريتات بوتاسيوم /فدان، مما يوضح امكانية توفير 50 كجم كبريتات بوتاسيوم/فدان باستخدام الرش الورقي بمعدل 2% مرتان لسماد داي بوتاسيوم فوسفات .ومن نتائج الدراسة يمكن التوصيه برش نبات الذرة الشامية بسماد الداي بوتاسيوم فوسفات بمعدل 2% مرتان + اضافة 50 كجم كبريتات بوتاسيوم/فدان + 5 طن سماد دواجن للحصول علي انتاجية مساوية لاضافة 100 كجم كبريتات بوتاسيوم.