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Comparative efficacy of KCl blended composts and sole application of KCl or K_2SO_4 in improving K nutrition, photosynthetic capacity and growth of maize

Naila Farooq[1], Shamsa Kanwal[1], Allah Ditta[2*], Azhar Hussain[3], Muhammad Naveed[1], Muhammad Usman Jamshaid[4] and Muhammad Iqbal[1]

[1]Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, 38040, Pakistan
[2]Department of Environmental Sciences, Shaheed Benazir Bhutto University Sheringal, Dir (U), 18000, Khyber Pakhtunkhwa, Pakistan
[3]Department of Soil Science, University College of Agriculture & Environmental Sciences, The Islamia University of Bahawalpur, 63100-Pakistan
[4]Department of Soil Science, Muhammad Nawaz Sharif University of Agriculture, Old Shujabad road, Multan

Abstract

Under arid and semiarid climate conditions, application of muriate of potash (KCl) results in salinity problem due to its higher chloride (Cl^-) contents. In order to combat this problem, KCl was blended with different sources of compost (fruits and vegetables, poultry, press mud and cow dung) in order to get a dilution effect of composts. A pot experiment was conducted to evaluate the comparative efficacy of KCl blended composts and KCl or K_2SO_4 alone on growth, physiology and K nutrition of maize. Different composts applied @ 500 kg ha^{-1} were blended with KCl in such a way that each combination received the same amount of K as in case of recommended KCl and K_2SO_4 alone. Muriate of potash blended poultry compost significantly improved various growth parameters like plant height (19%), root length (60%), root (100%) and shoot fresh weight (64%), root (88%) and shoot dry weight (81%) and chlorophyll contents (29%) compared to KCl alone. However, the maximum physiological parameters were observed with KCl blended press mud compost. Similarly, KCl blended poultry compost significantly increased K concentration and uptake in shoot (26 and 122%) and root (39 and 133%) compared to KCl alone. Post-harvest soil analysis showed an increase of about 2 folds in K contents in KCl blended poultry compost compared to KCl alone. Based on the above results, KCl blended composts proved better in improving various growth, physiological and K nutrition of maize compared to the application of KCl and K_2SO_4 alone.

Keywords: Compost, muriate of potash, chloride contents, potassium sulfate, K nutrition

Introduction

In existing cropping system of Pakistan, maize (*Zea mays* L.) occupies third place after wheat and rice according to area under cultivation. It is mainly cultivated in Khyber Pukhtunkhwa (KP) and Punjab provinces during two seasons (spring and autumn). Potassium (K) demand in maize is particularly high during rapid growth and may reach up to about 8 kg ha^{-1} K_2O day^{-1} (Engels, 1993). Soils of Pakistan are usually deficient in N and P but during the last decade, it has also been reported that about 25% of the arable soils and 75% of paddy soils are K deficient (Akhtar *et al.,* 2003). Potassium deficiency may lead to reduction in number and size of leaves which ultimately lead to less photosynthetic rate per unit area, hence low yield of crops (Rengel and Damon, 2008; William, 2008). It plays a key role in energy metabolism, protein synthesis, and solute transport, cell turgor in rapidly expanding cells and acts as a counter cation for anion accumulation (Cakmak, 2005).

Use of organic amendments has been found to be effective in reducing the hazardous effects of Cl^- on crop plants (Zakir *et al.,* 1997). Organic fertilizers have long been known for improving growth and yield of crops through the provision of macro- as well as micro-nutrients (Chamani *et al.,* 2008). Similarly, application of organic fertilizers improved leaf water and osmotic potential to ameliorate the negative effects of sea water salts by enhancing the availability of some cations like K^+ and phytohormones (Marshall and Porter, 1991). However, their sole application to feed increasing population is not possible due to low and slower supply of nutrients to support modern intensive agriculture. Recently, interest has been renewed in integrating the use of organic and inorganic fertilizers. Application of organic fertilizers have been found to improve organic matter contents of the soil and soil structure by improving microbial activity (Ros *et al.,* 2006) ultimately improving the availability of nutrients to the crop plants. However, few studies have reported the

*Email: allah.ditta@sbbu.edu.pk

efficacy of applying organic fertilizers to decrease the negative impact of salt stress (Zakir *et al.,* 1997; Abou El-Magd *et al.,* 2008). Similar is the case with mechanisms lying behind this amelioration. During composting, certain plant growth promoting materials (auxin, amino acids and vitamins) are produced, attracting beneficial microbes which suppress soil borne diseases and holds its nutrients in organic or slow release form (Chamani *et al.,* 2008).

Various potassic fertilizers (K_2SO_4, KCl, KH_2PO_4 and KNO_3) are being used and their selection is based on their availability, price, ease of use and solubility (Elam *et al.*, 1995). Sulfate of potash (K_2SO_4) is a preferable source of K as it has low salt index and improves plant's potential to disease resistance. Moreover, sulfur becomes available as an additional nutrient which has a critical role in nitrogen metabolism and crucial for oilseed crops. K_2SO_4 is preferably used for salt and chloride sensitive crops (Marschner, 1995). However, KCl is an economical source of K with 60-63% K_2O and has high solubility at 20 °C (13% dissolves in 8 minutes) compared to K_2SO_4 which has only 4% dissolution in 25 minutes (Elam *et al.*, 1995). Moreover, peasant farmers cannot afford the use of high cost inorganic K fertilizers. So, there is dire need to find out some strategies in order to combat the problems associated with the use of KCl and making it an economical source of K for crop plants. The major concern with the use of KCl is that it contains about 45-47% chloride (Cl^-) content which ultimately increases the pH and cause salinity problem when applied to alkaline soils. For normal plant growth and physiological functions, Cl^- is a complementary anion and an undesirable but unavoidable micronutrient (Fixen *et al.*, 1986). Chloride (Cl^-) is required in photosystem II during oxidation state to split water molecules.

Application of organic fertilizers indirectly helps to ameliorate the salt stress in plants. No direct mechanism has been reported. With the application of organic fertilizers, growth and yield of various crops like *Brassica oleracea* and *Spinacia oleracea* (El-Missery, 2003), *Allium cepa* (Saleh *et al.*, 2003) and *Foeniculum vulgare* (Abou El-Magd *et al.*, 2008) was significantly improved even under saline water irrigation. Moreover, Na^+ contents in the vegetative parts of sweet fennel fertilized with organic manure were significantly reduced compared to the control and K^+ contents were increased under saline conditions (Abou El-Magd *et al.*, 2008). Similarly, application of organic fertilizers improved leaf water and osmotic potential to ameliorate the negative effects of sea water salts by enhancing the availability of some cations like K^+ and phytohormones (Marshall and Porter, 1991).

In order to use an economical source with higher contents of K under arid and semiarid climate conditions, one strategy could be to have a dilution effect of KCl via the application of organic fertilizers. It would not only help improve physiochemical and biological properties of soil but also result in less use of KCl and ultimately less buildup of salts via Cl^- contents. Based on these hypotheses, a pot experiment was conducted to evaluate the comparative efficacy of the application of KCl blended compost vs. KCl alone and KCl blended compost vs. K_2SO_4 alone using maize as a test crop.

Materials and Methods

A pot experiment was conducted to evaluate the effects of KCl blended different sources of compost in greenhouse of the Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad (UAF), Pakistan. Maize variety Hy-corn 786 was used. Before the start of experiment, bulk surface soil (0-15cm) sample was collected and pre-sowing analyses for physicochemical properties were performed using standard methods (US Salinity Laboratory Staff, 1954). The physicochemical properties of soil used for filling of pots were found to be as: texture, sandy clay loam; organic matter, 0.76%; EC, 1.45 dS m^{-1}; pH, 7.52; available K, 66 mg kg^{-1} and CEC, 11 $cmol_c$ kg^{-1}. To each pot, 8 kg soil (2 mm) was transferred and pots were arranged according to the completely randomized design (CRD) in triplicate. Six healthy seeds of maize were sown per pot and after the plant establishment only three plants were maintained in each pot by uprooting rest of them.

The compost was prepared following the method as described by Ditta *et al.* (2015) with some modifications. Briefly, the composting materials consisting of fruit peels and vegetable wastes were collected from the local market. The poultry waste, press mud and cow dung were collected from poultry farm, sugar mill (Chaudhary Sugar Mills, Faisalabad) and nearby farm house, respectively. The collected materials were oven dried (70°C) for 24 h and ground to fine powder (< 2.0 mm) with the help of electric grinder. The crushed materials were subjected to composting process. After 7 days, recommended rates of KCl were individually blended with compost in 50:50 ratio by mass.

There were six treatments in all viz. T_1 = KCl alone (@ 125 kg K_2O ha^{-1}), T_2 = K_2SO_4 alone (@ 125 kg K_2O ha^{-1}), T_3 = KCl blended fruits and vegetables compost, T_4 = KCl blended poultry compost, T_5 = KCl blended press mud compost and T_6 = KCl blended cow dung compost. In each treatment, compost was applied @ 500 kg ha^{-1}. Compost was analyzed for NPK and remaining doses of recommended NPK (62.5, 87.5 and 80 mg kg^{-1} soil, respectively) were mixed with respective composts using chemical fertilizers viz. urea, diammonium phosphate and KCl, respectively. The physicochemical properties of the composts used are tabulated in Table 1. Tap water was used to maintain optimum moisture for plant growth throughout the experimental period. Irrigation time was based on plant and soil conditions.

Before harvesting the crop, plant height was measured using meter rod. After harvesting, fresh and dry weights of shoot and root were recorded using measuring balance. Both shoot and root samples were thoroughly washed with distilled water and then blot dried with tissue paper before sun drying. Sun dried plant samples were placed in oven at 72 °C for 72 h until constant weight was achieved. The soil from each pot was washed to collect root samples.

Physiological parameters of maize plants under different treatments were recorded at midday (between 10:00 and 14:00) using fully expanded flag leaves. Portable infra-red gas analyzer [IRGA (LCA-4) Germany] was used (at 1,200–1,400 µmol m^{-2} s^{-1} photosynthetic photon flux density) to measure photosynthetic rate (A), transpiration rate (E), stomatal conductance (gs), and sub-stomatal CO_2

Table 1: The chemical analysis of different sources of compost

Parameter	Fruit and vegetable compost	Poultry compost	Press mud compost	Cow dung compost
pH	5.73±0.09	6.50±0.06	6.77±0.09	7.83±0.03
EC (dS m^{-1})	3.18±0.03	3.97±0.02	4.7±0.05	4.3±0.03
Carbon (%)	19.73±0.05	16.98±0.17	28.94±0.32	26.24±0.79
Nitrogen (%)	2.13±0.06	6.22±0.06	1.76±0.06	1.73±0.06
Phosphorus (%)	0.42±0.06	2.78±0.11	1.78±0.09	0.99±0.11
Total K (%)	1.00±0.02	1.9±0.03	1.1±0.01	0.70±0.02
C:N	9.26±0.23	2.73±0.07	16.44±0.36	15.20±0.92
C:P	49.56±7.65	6.11±0.19	16.34±0.83	27.13±2.51
C:K	19.73±1.03	8.93±0.66	26.33±1.70	37.48±1.31
Chloride (%)	0.08±0.01	0.17±0.03	0.09±0.01	0.69±0.02

Table 2: Effect of KCl blended with different sources of compost on growth parameters of maize

Treatment	Plant Height (cm)	Root Length (cm)	Shoot Fresh Weight (g)	Root Fresh Weight (g)	Shoot Dry Weight (g)	Root Dry Weight (g)
T_1	36^c (0)	9.4^d (0)	44^d (0)	4^c (0)	21^d (0)	1.6^c (0)
T_2	37^c (3)	9.3^d (-1)	44^d (0)	4^c (0)	22^d (5)	1.6^c (0)
T_3	40^b (11)	13.0^b (38)	63^b (43)	7^a (75)	31^b (48)	2.0^b (25)
T_4	43^a (19)	15.0^a (60)	72^a (64)	8^a (100)	38^a (81)	3.0^a (88)
T_5	41^b (14)	12.0^c (28)	50^c (14)	6^b (50)	27^c (29)	1.7^c (6)
T_6	39^b (8)	13.0^b (38)	53^c (20)	7^b (75)	26^c (24)	2.0^b (25)

Note: T_1=MOP (muriate of potash); T_2=SOP (sulfate of potash); T_3=KCl blended with fruit and vegetable compost; T_4=KCl blended with poultry compost; T_5=KCl blended with press mud; T_6=KCl blended with cow dung compost
() = % increase from the control
(-) = % decrease from the control
Values having same letters in a column are statistically non-significant with respect to each other (* = significant at $p < 0.05$).

Table 3: Effect of KCl blended with different sources on physiological parameters of maize

Treatment	Photosynthetic rate (µmol CO_2 m^{-2} s^{-1})	Transpiration rate (mmol H_2O m^{-2} s^{-1})	Stomatal conductance (mmol H_2O m^{-2} s^{-1})	Sub-stomatal conductance (mmol H_2O m^{-2} s^{-1})	Chlorophyll contents (mg g^{-1} FW)
T_1	16^c (0)	9^c (0)	0.133^d (0)	0.117^e (0)	17.0^c (0)
T_2	16^c (0)	11^c (22)	0.161^{bc} (21)	0.157^d (34)	19.5^b (15)
T_3	20.8^{ab} (30)	13^b (18)	0.172^{bc} (29)	0.166^c (42)	20.0^{ab} (18)
T_4	20^{ab} (25)	12^b (14)	0.180^{ab} (35)	0.183^b (56)	22.0^a (29)
T_5	19^b (19)	16^a (78)	0.201^a (51)	0.195^a (67)	19.0^{bc} (12)
T_6	21.2^a (32)	11^c (22)	0.180^{ab} (35)	0.165^c (41)	20.5^{ab} (15)

Note: T_1=MOP (muriate of potash); T_2=SOP (sulfate of potash); T_3=KCl blended with fruit and vegetable compost; T_4=KCl blended with poultry compost; T_5=KCl blended with press mud; T_6=KCl blended with cow dung compost
() = % increase from the control
Values having same letters in a column are statistically non-significant with respect to each other (* = significant at $p < 0.05$)

concentration (Ci). SPAD-502 meter (Konica-Minolta, Japan) was used to measure chlorophyll contents. Readings were recorded with four repeats from each treatment.

The K contents in root and shoot samples were determined according to Jackson; (1962). Briefly, ammonium acetate solution (33 mL) was added in 5 g air-dried soil placed in a 50-mL centrifuge tube and was shaken for 5 minutes on a shaker until the supernatant was clear. Combined ammonium acetate extracts were diluted to 100 mL with 1 N ammonium acetate solution. A series of suitable potassium standards were run and a calibration curve was drawn. The emission readings of the samples (soil extracts) were taken on Flame Photometer (PFP-7, Jenway, UK) at 767-nm wavelength and potassium (K) concentrations were calculated according to the following formula:

$$\text{Extrctable K (ppm)} = \text{ppm K (from callibration curve)} \times \frac{A}{Wt.}$$

Where: A = Total volume of the extract (mL)

Wt. = Weight of air-dry soil (g)

Potassium concentration and uptake in root and shoot was also calculated.

Data analysis

Data for different growth, physiological and yield attributes were collected and analyzed statistically using software "Statistix 8.1®" software package (Analytical Software, 2005) for analysis of variance (Steel *et al.*, 1997). The treatment means were compared by using least significance difference (LSD) test at 5% probability level.

Results

Data regarding the effect of the application of KCl blended composts, KCl and K_2SO_4 alone on growth parameters of maize is presented in Table 2. It is clear from the data that KCl blended poultry compost caused the maximum increase in the various growth parameters like plant height, root length, shoot and root fresh and dry weight. The minimum values for growth parameters were noted in case of application of KCl alone followed by K_2SO_4 alone. All KCl blended composts showed significant improvement in growth parameters compared to KCl or K_2SO_4 alone. Among KCl blended composts, the minimum increase in root length, shoot fresh weight, root fresh weight and root dry weight was noted in case of KCl blended press mud compost, followed by KCl blended cow dung compost and KCl blended fruit and vegetable compost, respectively. However, for plant height and shoot dry weight, the minimum was resulted with the application of KCl blended cow dung followed by KCl blended press mud compost and KCl blended fruit and vegetable compost, respectively.

Physiological parameters like photosynthesis (CO_2 assimilation rate), transpiration rate, stomatal and sub-stomatal conductance and chlorophyll contents were significantly improved with the application of KCl blended composts compared to that with the application of KCl and K_2SO_4 alone (Table 3). The maximum transpiration rate, stomatal and sub-stomatal conductance was noted in case of KCl blended press mud compost. However, the CO_2 assimilation rate was maximum with the application of KCl blended cow dung compost while KCl blended poultry compost resulted in the maximum chlorophyll contents. The minimum values were recorded with the application of KCl alone.

Potassium concentration and uptake was measured in shoot and roots parts of maize and a significant improvement was noted with the application of KCl blended composts compared to KCl and K_2SO_4 alone (Table 4). The maximum increase in shoot and root K concentration and shoot K uptake was recorded with the application KCl blended poultry compost while K uptake in root was the maximum with the application of KCl blended fruit and vegetable compost. The minimum K concentration and uptake in root and shoot was noted with the application of KCl alone.

During post-harvest soil analysis, treatment effects on different chemical properties and nutrient status were determined (Table 5). In case of pH, the maximum reduction was noted with the application of KCl blended press mud followed by KCl blended cow dung compost. An increase in soil pH was noted with the application of KCl and K_2SO_4 alone compared with pre-soil analysis and other treatments. In case of Cl^{-1} contents, a decreasing trend was noted with the application of different KCl blended composts compared to KCl and K_2SO_4 alone. However, the maximum decrease was observed with the application of KCl blended press mud compost and K_2SO_4 alone. In case of CEC, K and organic matter contents, a significant increase was observed with the application of different KCl blended composts compared to KCl and K_2SO_4 alone. The maximum increase in CEC and organic matter was recorded with the application of KCl blended cow dung compost while K contents were maximum with the application of KCl blended poultry compost.

Discussion

The combined application of KCl blended composts showed comparatively better effect on various growth parameters of maize compared to the sole application of KCl and K_2SO_4. Earlier, it has been found that the

Table 4: Effect of KCl blended with different sources of compost on chemical parameters of maize

Treatment	Potassium in shoot (%)	Potassium in root (%)	Potassium uptake in shoot (mg pot^{-1})	Potassium uptake in root (mg pot^{-1})
T_1	1.70^c (0)	0.86^f (0)	0.37^e (0)	0.015^c (0)
T_2	1.96 ^{b} (15)	0.98^e (14)	0.38^e (1)	0.015^c (0)
T_3	1.99^b (17)	1.10^d (28)	0.66^b (78)	0.040^a (167)
T_4	2.15^a (26)	1.20^a (39)	0.82^a (122)	0.035^b (133)
T_5	1.99^b (17)	0.99^b (15)	0.55^c (49)	0.032^b (113)
T_6	1.92^b (13)	1.00^c (16)	0.49^d (32)	0.031^b (107)

Note: T_1=MOP (muriate of potash); T_2=SOP (sulfate of potash); T_3=KCl blended with fruit and vegetable compost; T_4=KCl blended with poultry compost; T_5=KCl blended with press mud; T_6=KCl blended with cow dung compost
() = % increase from the control
Values having same letters in a column are statistically non-significant with respect to each other (* = significant at $p < 0.05$).

Table 5: Effect of KCl blended with different sources of compost on physicochemical parameters of soil recorded after the crop harvest

Treatment	pH	EC (dS m^{-1})	CEC (cmol$_c$ kg^{-1})	K (mg kg^{-1})	Cl^{-1} (mmol$_c$ L^{-1})	Organic matter (%)
T_1	7.9^a (0)	3.0^e (0)	11.9 (0)	102^d (0)	8.7^a (0)	0.71^c (0)
T_2	7.6^b (-4)	3.0^e (0)	11.7^d (-2)	92^e (-10)	4.5^d (-48)	0.72^c (1)
T_3	7.5^b (-5)	2.0^d (-33)	14.0^c (18)	107^c (5)	5.0^c (-42)	0.91^b (28)
T_4	7.4^{bc} (-6)	3.0^b (0)	15.0^b (26)	120^a (18)	5.5^b (-37)	0.95^b (34)
T_5	7.2^d (-9)	5.0^a (67)	14.5^{bc} (22)	114^b (12)	4.5^d (-48)	0.90^b (27)
T_6	7.3^{bc} (-8)	3.0^c (0)	16.0^a (34)	104^{cd} (2)	6.0^b (-31)	1.00^a (41)

Note: T_1=MOP (muriate of potash); T_2=SOP (sulfate of potash); T_3=KCl blended with fruit and vegetable compost; T_4=KCl blended with poultry compost; T_5=KCl blended with press mud; T_6=KCl blended with cow dung compost
() = % increase from the control
(-) = % decrease from the control
Values having same letters in a column are statistically non-significant with respect to each other (* = significant at $p < 0.05$).

application of organic fertilizers improves organic matter in the soil (Nelson and Oades, 1998) which ultimately improves physicochemical and biological properties of the soil especially soil structure as better soil structure ensures improved water holding capacity and ultimately improved availability of nutrients to the crop plants (Chamani *et al.*, 2008). So, instead of providing equal amount of nutrients in all the treatments, the improvement with the application of KCl blended composts might be due to the above-mentioned fact which resulted in improvement in growth parameters. This premise has also been supported by the fact that physiological parameters were significantly improved with the application of KCl blended composts compared to the sole application of KCl and K_2SO_4 (Table 3). Improvement in these parameters like CO_2 assimilation rate, transpiration rate, stomatal and sub-stomatal conductance and chlorophyll contents have resulted in better growth of the maize plants. Various researchers have also documented improvement in growth parameters of various crops with the application of organic fertilizers (Xu *et al.*, 1997; Agbed *et al.*, 2008; Baldi and Toselli, 2013; Ditta and Khalid, 2016).

In the present study, physiological parameters like CO_2 assimilation rate, transpiration rate, stomatal and sub stomatal conductance and chlorophyll contents were significantly improved with the application of KCl blended different composts compared to the alone application of KCl and K_2SO_4. The reason might be due to an increased supply of nutrients to the crop plants with the improvement in soil structure caused by the application of different composts. Moreover, during composting, organic acids e.g. humic and fulvic acids are released (De Bertoldi *et al.*, 1996). So, when a composted material is applied to the soil, it might result in decreasing the pH of microclimate and resulted in better supply of macro-and micro-nutrients like P, Fe, Mn, Zn, Cu and B which otherwise are less available at high pH (Marschner, 1995). Increase in physiological parameters was observed in pots treated with different levels of cow dung and poultry compost as compared to control which was suggested to be due to the improved supply of nutrients to the crop plants (Chamani *et al.*, 2008).

Higher K uptake in shoot and root resulted in improved concentration of K in shoot and root with the application of KCl blended poultry compost compared to alone application of KCl which might be due to improved soil conditions through organic fertilizer. Earlier, an improvement in soil and leaf N, P, K, Ca and Mg concentrations was recorded with the application of poultry manure at 7.5 t ha^{-1} (Agbede *et al.,* 2008). The addition of poultry compost might have increased organic matter in the soil which stimulated microbial activity and ultimately resulted in enhanced solubility of K containing minerals during breakdown of organic materials in the soil (Ros *et al.,* 2006). This premise has been supported by our post-harvest soil analysis which showed improved organic matter contents in the soil. Earlier, an improvement in K concentration in soil and plant samples was observed with the application of cow dung compost which ultimately resulted in improved growth and yield parameters of maize (Baldi and Toselli, 2013). The cumulative effect supports the observation that poultry manure added organic matter and nutrients to soil. Moreover, improvement in growth parameters resulted in increased nutrient use efficiency of crop (Agbede *et al.,* 2008).

Post-harvest soil analysis showed a significant improvement in various soil properties in the pots treated with different KCl blended composts compared to alone application of KCl and K_2SO_4 with respect to nutrient availability which ultimately resulted in improved growth and physiological parameters of maize. For example, pH, EC and Cl^- contents were decreased in the pots treated with KCl blended composts which resulted in improved availability of nutrients to the crop plants and ultimately improvement in growth and physiological parameters was recorded (Table 2, 3). However, this decrease was not prominent in the pots treated with KCl or K_2SO_4 alone. The decrease in pH might be due to the production of organic acids (amino acid, glycine, cystein and humic acid) during mineralization (amminization and ammonifcation) of organic materials by heterotrophs and nitrification by autotrophs (Walker et al., 2003). Moreover, production of NH_4^+ and CO_2 during composting have also been shown to reduce soil pH and EC (Albanell et al., 1988). Earlier, it was suggested that application of press mud compost decreased pH due to the removal of salts (Muhammad and Khattak, 2009). Moreover, decrease in Cl^- contents might be due to dilution effect of different composts application as less KCl was required to fulfill the requirement of the crop due to the presence of micro- and macro-nutrients.

In case of CEC, K and organic matter contents, improvement was noted in the pots treated with different KCl blended composts compared to alone application of KCl and K_2SO_4. This might be due to the addition of compost; the carbon contents of the soil were improved which ultimately resulted in increased organic matter content (Mucheru-Muna *et al.,* 2007) and CEC of the soil. Earlier, an increase in soil organic matter and exchangeable cations was recorded with the application of poultry compost (Agbede *et al.,* 2008).

Application of KCl blended poultry compost increased K contents in soil which might be due to its high organic matter contents which bind K in exchangeable and available form and prevent it from leaching. Earlier, it has been found that decomposition of organic matter increases nutrient contents (N, P, K, Ca and Mg) of the soil (Agbede *et al.*, 2008; Chamani *et al.,* 2008).

Conclusion

Application of KCl blended poultry compost could serve a better source of K compared to the application of KCl and K_2SO_4 alone as is clear from improvement in growth and physiological parameters of maize. However, further evaluation under field conditions are needed to achieve maximum yield potential of maize crop by integrating organic and inorganic fertilizers.

References

Abou El-Magd, M.M., M.F. Zaki and S.D. Abou-Hussein. 2008. Effect of organic manure and different levels of saline irrigation water on growth, green yield and chemical content of Sweet Fennel. *Australian Journal of Basic and Applied Science* 2: 90-98.

Agbede, T.M., S.O. Ojeniyi and A.J. Adeyemo. 2008. Effect of poultry manure on soil physical and chemical properties, growth and grain yield of sorghum in Southwest. *Journal of Sustainable Agriculture* 2: 72-77.

Akhtar, M.E., M.T. Saleem and M.D. Stauffer. 2003. Potassium in Pakistan Agriculture. Pakistan Agricultural Research Council, Islamabad-Pakistan. p. 9.

Albanell, E., J. Plaixats and T. Cabrero, 1988. Chemical changes during vermicomposting (*Eisenia Andrei)* of sheep manure mixed with cotton industrial wastes. *Biology and Fertility of Soil* 6: 266-269.

Analytical Software. 2005. Statistix 8.1 User’s Manual. Tallahassee, USA.

Baldi, E. and M. Toselli. 2013. Root growth and survivorship in cow manure and compost amended soils. *Plant, Soil and Environment* 59: 221-226.

Cakmak, I. 2005. The role of potassium in alleviating detrimental effects of a biotic stresses in plants. *Journal of Plant Nutrition and Soil Science* 168: 521-530.

Chamani, E., D.C. Joyce and A. Reihanytabar. 2008. Vermicompost effects on the growth and flowering of *Petunia hybrida* ‘Dream Neon Rose’. *American-Eurasian Journal of Agriculture and Environ Sciences* 3: 506-512.

De Bertoldi, M., P. Sequi, B. Lemmes and T. Papi. 1996. The Science of Composting. Chapman & Hall, London.

Ditta, A., M. Arshad, Z.A. Zahir and A. Jamil. 2015. Comparative efficacy of rock phosphate enriched organic fertilizer vs. mineral phosphatic fertilizer for nodulation, growth and yield of lentil. *International Journal of Agriculture and Biology* 17: 589-595.

Ditta A. and A. Khalid. 2016. Bio-organo-phos: A sustainable approach for managing phosphorus deficiency in agricultural soils. *In*: M. Larramendy and S. Soloneski. (eds.). Organic Fertilizers - From Basic Concepts to Applied Outcomes. InTech, Croatia. p. 109-136. doi: 10.5772/62473.

Elam, M, S. Ben-Ari and H. Magen. 1995. The dissolution of different types of potassium fertilizers suitable for fertigation. *In*: Proceedings *Dhalaia Greidinger* International symposium on fertigation. Technion, Haifa, Israel. pp. 165-174.

El-Missery, M.M.A. 2003. Effect of organic fertilization on yield and quality of some vegetable crops under saline conditions. M. Sc. Thesis, Faculty of Agriculture, Ain Shams University, Cairo, Egypt.

Engels, C. 1993. Differences between maize and wheat in growth-related nutrient demand and uptake of potassium and phosphorus at suboptimal root zone temperatures. *Plant and Soil* 150: 129-138.

Fixen, P.E., R.H. Gelderman, J. Gerwing and F.A. Cholick. 1986. Response of spring wheat, barley and oats to chloride in potassium chloride fertilizers. *Agronomy Journal* 78: 664-668.

Jackson, M.L. 1962. Soil chemical analysis. Prentice Hall, New York.

Marschner, H. 1995. Mineral Nutrition of Higher Plants. New York: Academic Press.

Marshall, B. and J.R. Porter. 1991. Concepts of nutritional and environmental interactions determining plant productivity. *In*: Plant Growth: Interaction with nutrition and environment. J.R Portar, D.W Lawlor. (Eds.). Cambridge university press, Cambridge, p. 99-124.

Mucheru-Muna, M.W., D.N. Mugendi, N. Kang'u, J. Mugwe and A. Bationo. 2007. Effects of organic and mineral fertilizer inputs on maize yield and soil chemical properties in a maize cropping system in Meru south district, Kenya. *Agroforestry Systems* 69: 189-197.

Muhammad, D. and R.A. Khattak. 2009. Growth and nutrient concentrations of maize in press mud treated saline-sodic soils. *Soil and Environment* 28: 145-155.

Nelson, A.A. and J.M. Oades. 1998. Organic matter, sodicity, and soil structure. p. 51-75. In: M.E. and R. Naidu (Eds.). Solid Soils. Summer. Oxford University Press New York.

Rengel, Z. and P.M. Damon. 2008. Crops and genotypes differ in efficiency of potassium uptake and use. *Physiologia Plantarum* 133: 624-636.

Ros, M., S. Klammer, B. Knapp, K. Aichberger and H. Insam. 2006. Long-term effects of compost amendment of soil microbial activity. *British Society of Soil Science* 22: 209-218.

Saleh, A.L., A.A. Abd El-Kader and S.A.M. Hegab. 2003. Response of onion to organic fertilizer under irrigation with saline water. *Egyptian Journal of Applied Science* 18: 707-716.

Steel, R.G.D., J.H. Torrie and D.A. Dickey. 1997. Principles and Procedures of Statistics: A biometrical approach. 3rd ed. McGraw-Hill, New York.

US Salinity Laboratory Staff. 1954. Diagnosis and Improvement of Saline and Alkali Soil, USDA Hand book No. 60, US. Govt. Printing Office, Washington DC, USA. 160 p.

Walker, D. J., R. Clemente, A. Roig and M.P. Bernal, 2003. The effects of soil amendments on heavy metal bioavailability in two contaminated Mediterranean soils. *Environmental Pollution* 122: 303–312

William, T. 2008. Potassium influences on yield and quality production for maize, wheat, soybean and cotton. *Journal of Plant Biology* 133: 670-681.

Xu, H.L., S. Kato, K. Yamada, M. Fujita and K. Katase. 1997. Soil root interface water potential in sweet corn plants affected by organic fertilization and effective microbes application. *Japanese Journal of Crop Science* 66: 110-111.

Zakir, A.M., B.S. Bajwa and S.M. Sjjad. 1997. Impact of gypsum and farmyard manure on saline water irrigation at different growth stages and yield of rice. *Current Agriculture* 22: 112-117.