Impact of potassium humate on selected chemical properties of an Acidic soil

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Abstract
Potassium humates (KH) derived from lignite brown coal are alkaline, rich in carboxylic and phenolic groups, aromatic in nature provide favorable conditions for biological activity, chemical reactions and physical improvement of soil. They promote chemical reaction for cation exchange, increase pH buffering capacity of soils, bind and sequester phytotoxic elements and accelerate transport of nutrients to plants. A commercially available KH was used in this research to evaluate its effect on selected chemical properties of acid soil under laboratory condition. A soil was treated with different doses of KH (25, 50, 75, 100 kg ha^{-1} and control) along with P (control and 70 kg ha^{-1}) in the form of triple super phosphate (TSP). It was observed that when only P (T_2) was applied low pH values were found for this treatment. Whereas, the values of EC, pH, total carbon and effective CEC were significantly increased as the dose of KH increased over control, effect of T_6 (70 P_2O_5 and 100 KH kg ha^{-1}) was more pronounced. However no significant difference was found between T_5 and T_6 for EC, pH and effective CEC but there was a difference in total carbon. Results indicates that T_6 (70 kg P_2O_5 and 100 kg KH ha^{-1}) was a better treatment.

Key Words
Potassium humate, acidic soil, EC, pH, total C and Effective CEC

Introduction
Acidification of soil is a naturally occurring process. However, soil acidity is a major limitation to crop production on highly weathered and leached soils in both tropical as well as temperate regions of the world, (Sanches, 1976; Von Uexkull and Mutert, 1995). Main causes of acidification are leaching and nitrification due to excessive use of nitrogenous fertilization (Wild, 1988). Phytotoxicity of Al and Mn is often due to low pH of soil, and deficiency of Ca and Mg (Leeper and Uren, 1993).It has been proved that traditional liming treatments to be largely ineffective in short term duration because vertical movement of surface applied lime is slow (Pavan *et al.*, 1982; Richey, 1996), and costly (Cassel, 1980) especially within the root zone (Noble *et al.*, 1995; Bruce *et al.*, 1988).Organic materials which are rich in Ca like Fulvic and humic acid based treatment to subsoil acidity denoted some considerable promises (Vander Watt *et al.*, 1991; Noble *et al.*, 1995). Humic substances are the most active fraction of humus, (Hayes *et al.*, 1989). HA is oxidized lignite brown coal that is used in the production of humic substances also known as humates. However, oxidized lignites are used as soil and plant amendments often on account of their high content of humic acids (30 to 60%). In addition, humates may provide an alternative to liming, ameliorating the soil organic matter that is responsible for the generic improvement of soil fertility and improved productivity (Kononova, 1966; Fortun *et al.*, 1989). The objective of this study was to evaluate the potential of commercially available KH derived from lignite brown coal on an acidic soil under rice cultivation.

Methods
The acid soil used in the 60 days incubation experiment was taken from a rice field located in Alor Kedah, The texture of the soil is a silty clay loam and belongs to the Kangkong (Inceptisols) soil series. The soil was sieved to pass 2 mm and 25g of it was placed in a vial. The layout of the experiment was completely randomized design with three replicates and six treatments. KH (0, 25, 50, 75 and 100 kg ha^{-1}) and phosphorus (0 and 70 kg P_2O_5 ha^{-1}) in the form of triple superphosphate were applied on the surface of the soil before watering; water was applied at field capacity level. At 15 days of incubation, soil samples were analyzed for EC, pH, total carbon and effective CEC.

The KH used in this study is alkaline. It was produced from Chinese lignite brown coal and is commercially available in Pakistan where it is used as a soil conditioner. It contains 55% humic acid and 12 % potassium oxide. Soil texture was determined using the pipette method (Gee and Bauder, 1982), total carbon was determined using LECO CR-412,effective CEC by $BaCl_2$ method (Hendershot and Duquette,1986), electrical conductivity and pH at 1: 2.5 soil to water ratio (Chapman *et al*., 1961) were determined. Data were statistically analyzed using the Statistical Analysis System (SAS).

Results

The texture of the soil was a silty clay loam with pH, EC, total carbon and effective CEC typical of Kangkong series (Table 1). The N, C, S, H, O contents and C/N ratio of the potassium humate (KH) were 2.76 %, 38.44 %, 1.04 %, 3.40 %, 54.81 and 16.40, respectively. The phenolic, carboxylic, and total acidity were 194, 386 and 580 meq per100g, respectively (Table 2).

Table 3 1 shows that application of P alone (T_2) resulted in higher EC values in the 15-30 days incubation period compared to T_3 and T_4. T_6 increased the soil EC in comparison with the application of T_3, T_4 and T_5. Generally, the soil EC gradually increased with increase in incubation period. This observation is consistent with that of Albert *et al*. (2004).

Table 4 shows that pH increased with increasing rate of KH. Soil pH was lower with the application of 70kg ha^{-1} P_2O_5 in comparison with the control. Similarly, soil pH was also influenced by variation in incubation periods. The incubation of the treatments for 60 days resulted in a higher increase in soil pH as compared to other incubation periods. Similar findings have been reported by Albert *et al*. (2004).

Total carbon content in the soil is shown in table 5. It reveals no significant difference between control and T2.There was a corresponding increase in total Carbon as KH rate increase. The incubation period also resulted in an increase in total carbon. The results are supported by findings of Melero *et al*. (2007).

Effective cation exchange capacity (ECEC) data are presented in Table 6 and show that T2, T3 T4, T5 and T6 had significant effects on ECEC. Further it was observed that there was no significant difference between T5 and T_6. The results are supported by findings of Obviza *et al*., 1989, Cooper *et al.*, 1998 and Mikkelson, 2005.

Table 1. Some chemical and physical properties of the acidic soil before conducting the experiment.

Soil property	Values
Texture	silty clay loam
pH (H_2O)	5.48
EC µS cm^{-1}	849
Total carbon % (w/w)	2.026
Effective CEC (cmol(+) kg^{-1})	9.44

Table 2. Elemental and functional group analysis of potassium humate (KH).

Nitrogen (N)	2.76 %
Carbon (C)	38.44 %
Sulfur (S)	1.04 %
Hydrogen (H)	3.40 %
Carbon nitrogen ratio (C/N)	16.40
Oxygen	54.81
Phenolic	194 meq 100g
Carboxylic	386 meq 100g
Total acidity	580 meq 100g

Table 3. Effect of potassium humate (KH) on EC (µS cm^{-1}) of an acidic soil.

Treatment	Incubation Period			
P_2O_5 + KH kg ha^{-1}	15 Days	30 Days	45 Days	60 Days
T_1 = 00 + 00	850d	849d	855d	852e
T_2 = 70 + 00	935a	944a	937b	932c
T_3 = 70 + 25	885c	892c	904c	921cd
T_4 = 70 + 50	898bc	910bc	929b	945c
T_5 = 70 + 75	910bc	918b	941b	961ab
T_6 = 70 + 100	921b	926b	962a	974a

Table 4. Effect of potassium humate (KH) on pH of an acidic soil.

Treatment	Incubation Period			
P_2O_5 + KH kg ha^{-1}	15 Days	30 Days	45 Days	60 Days
T_1 = 00 + 00	5.48d	5.49d	5.51d	5.50d
T_2 = 70 + 00	5.37e	5.41e	5.44e	5.48e
T_3 = 70 + 25	5.67c	5.70c	5.75c	5.76c
T_4 = 70 + 50	5.74b	5.80b	5.85b	5.89b
T_5 = 70 + 75	5.85a	5.89a	5.94a	6.01a
T_6 = 70 + 100	5.86a	5.91a	5.96a	6.03a

Table 5. Effect of potassium humate (KH) on total carbon of an acidic soil.

Treatment	Incubation Period			
P_2O_5 + KH kg ha^{-1}	15 Days	30 Days	45 Days	60 Days
T_1 = 00 + 00	2.025e	2.028e	2.029e	2.027e
T_2 = 70 + 00	2.033ed	2.036e	2.041e	2.038e
T_3 = 70 + 25	2.046d	2.055d	2.072d	2.084d
T_4 = 70 + 50	2.069c	2.083c	2.095c	2.120c
T_5 = 70 + 75	2.096b	2.119b	2.143b	2.177b
T_6 = 70 + 100	2.129a	2.153a	2.185a	2.213a

Table 6. Effect of potassium humate on ECEC (cmol(+)kg-1) of an acidic soil.

Treatment	Incubation Period			
P_2O_5 + KH kg ha^{-1}	15 Days	30 Days	45 Days	60 Days
T_1 = 00 + 00	9.488c	9.479c	9.522d	9.441e
T_2 = 70 + 00	10.814b	10.605b	10.397c	10.454d
T_3 = 70 + 25	10.834b	10.620b	10.824bc	10.911c
T_4 = 70 + 50	10.841b	11.046ab	11.226ab	11.326b
T_5 = 70 + 75	11.031ab	11.358a	11.393ab	11.596ab
T_6 = 70 + 100	11.111a	11.482a	11.567a	11.786a

Means in column with different with different alphabets indicate significant difference at $P \leq 0.05$ using Tukey's test.

Conclusion

The treatment with 100 kg KH and 70 kg P_2O_5 ha^{-1} had significant effects on EC, pH and ECEC, and maximum values for Total carbon occurred for T_6 (100 kg KH ha^{-1}).

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