A preliminary study on dual role of humic acid in mulberry (*Morus alba* L.) cultivation

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Abstract: Humic acid (HA), the naturally occurring polymeric molecule establishes its importance for conditioning soil properties and influencing plant physiological activities. In the present communication, role of HA in reducing the fixation of phosphorus (P) and potassium (K) by soil clay has been investigated in terms of differential fixation of both the elements by clay and clay-humate complex (CHC). Besides, favorable influence of HA administration on the root growth of mulberry (*Morus alba* L.) variety, S-1635, has also been ascertained.
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Key words: Clay, humic acid, mulberry, P/K fixation, root growth.

1. Introduction:

Humus is the ultimate product of organic matter decomposition and is widely distributed on the earth's surface, occurring in soils, lakes, and rivers and even in the sea. HA being the principal component of humus deserves attention partly due to its wide-ranging importance in soil forming processes as well as soil fertility (Piccolo *et al*., 1997), and partly due to its capability of exerting favourable influence on plant physiological activities.

HAs are nothing but polymers having molecular weights ranging from several hundreds to tens of thousands, amorphous, dark brown to black in colour, sparingly soluble in water, but disperses to form suspensions and exhibit characteristic features like poly-functional ion-adsorbing sites and coiled structure due to three dimensional configuration (Kar *et al*., 1995). It is worthwhile to mention that the presence of charge sites in HA molecule enables it to combine with clays, fertilizers, and different organic compounds (Stevension, 1982). On the other hand, clay, owing to its own charge sites, can form CHC through ionic interaction (Sanyal and Majumder, 2009), which, in turn, can influence the ionic ambience within the soil system and thus justifies initiating the present study on comparison between clay and CHC towards fixation of elements by the both.

Besides soil conditioning, HA molecule is also capable of influencing physiological activity of the plants directly or indirectly. These substances at dilute concentration exert favourable physiological influences in the areas of cell division and cell elongation by improving hormonal effect (Nikbakht *et al*., 2008). Such studies pertaining to mulberry is not at all available and thus the present experimentation has been initiated to explore the effect of metallic humate administration on the root growth and sapling height of the potted mulberry (var. S-1635) cuttings.

2. Materials and methods:

For extraction of humic materials from soil, the latter was treated with standard sodium carbonate and kept overnight (Banik and Sanyal, 2006). The extracted materials were centrifuged followed by acidification of the centrifugate with dilute hydrochloric acid to a pH 2.0. Acidification leads to precipitation of HA and the precipitated materials were dialyzed finally in distilled water. On the other hand for isolation of clay from soil, the latter was treated with 6% H_2O_2. The clay-sized particles were then separated by following the principle of settling velocities of the different sized particles in a liquid (water) medium (Chopra and Kanwar, 1982).

For experimentation on fixation of P and K, homo-ionic suspensions of clay and CHC were developed from the soil under mulberry vegetation following the standard analytical protocol (Sanyal and Kar, 1990). Then the homo-ionic suspensions of clay and CHC were equilibrated with graded concentrations of P/ K (in triplicate) separately for definite period of time at 300 ± 1^{O} K (Singh and Tomar, 1996). Amount of P/ K in the respective equilibrium solutions was estimated by standard analytical procedure. From the difference in amount of P/ K between added and equilibrium solution, amount of fixation of the same was computed and plotted against that of amount added.

To explore the effect of HA administration on mulberry growth, suitable formulation of metallic humate (0.01%) was prepared from the dialyzed HA material as mentioned earlier based on the potentiometric result (Kar *et al*., 1995). Viable cuttings of S-1635 mulberry (*Morus alba* L.) variety were soaked into 0.01% metallic humate while identical cuttings under control were soaked into water overnight and both were planted subsequently in the pots filled with the standard soil-manure mixture (Mukherjee and Sharma, 1971). Thirty cuttings each for the treatment and for the control were maintained. Data pertaining to root growth and sapling-height were recorded after three months of planting of cuttings.

3. Results and Discussion:

Influence of HA on fixation of P and K

Differential response of clay and CHC towards fixation of P/K exhibited quite interesting trend of findings (Figures I and II).

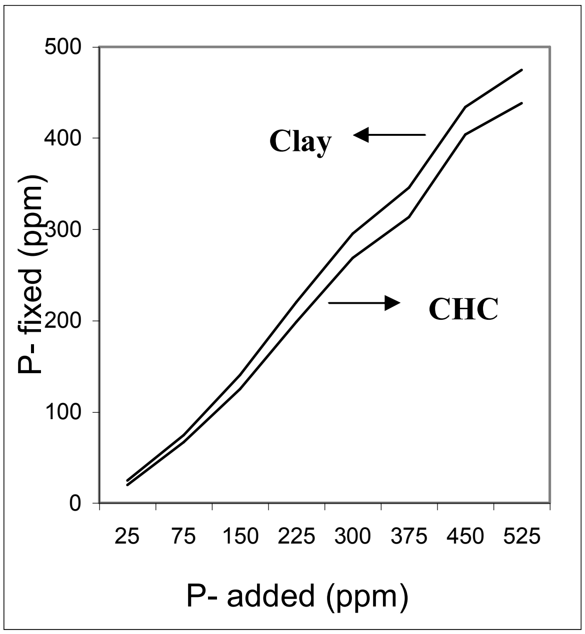

Fig.-I P-fixation by clay and CHC

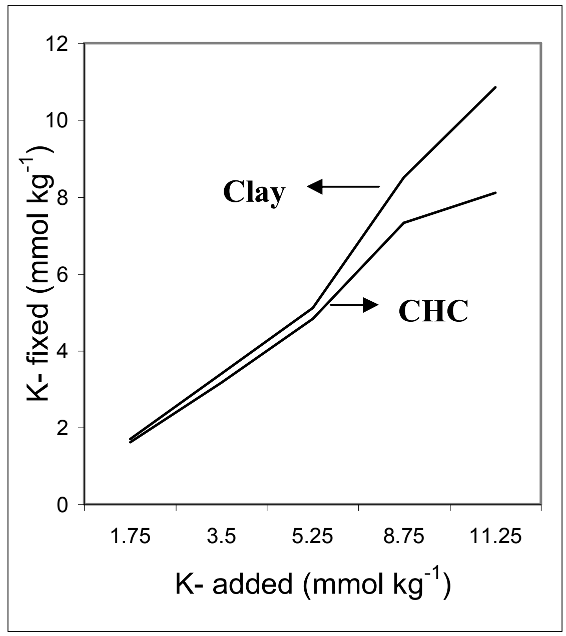

Fig.-II K-fixation by clay and CHC

The initial run of the curves exhibited a linear relationship between P/ K added and fixed while a buffering tendency was observed for the higher values of P/ K addition. The finding is quite likely and is due to the limited availability of active sites or surface after a certain amount of respective ion is fixed. It was also evident that increased amount of P/ K was fixed by the clay with the removal of HA molecule. The finding might be explained in terms of the availability of surface and active spots, which was initially occupied by the humic fraction in association with clay (Kar *et al*., 2009). The regression analysis relating P/K-added (P_a/K_a) versus difference in fixation of P/K between clay and CHC ($\Delta P_f/\Delta K_f$) further substantiated the above postulation through the equations, $\Delta P_f = 4.856 + 0.064\ P_a$ ($R^2 = 0.952$**) and $\Delta K_f = -0.719 + 0.267\ K_a$ ($R^2 = 0.862$*).

Influence of HA on mulberry growth

Effect of HA administration on different parameters pertaining to the root growth of mulberry is conspicuous from the table 1.

Table 1: Effect of HA formulation on root growth and sapling-height of mulberry, var. S-1635.

Cuttings soaked into	Length of tap root ($m \times 10^2$)	Root volume ($l \times 10^3$)	Dry weight of root mass ($kg \times 10^3$)	Height of the sapling ($m \times 10^2$)
Water	25.80	3.18	1.09	45.8
0.01% metallic-humate	36.00**	6.04**	2.17**	61.8**

** Values significantly different at P = 0.01 when independently compared with water soaked cuttings using one-way ANOVA.

Soaking of mulberry (S-1635) cuttings in 0.01% metallic-humate improved length of the taproot by 39.53%, root volume by 89.94% and dry weight of root mass by 99.08% over control. Presence of polyamines in the HA formulation (Young and Chen, 1997) induced hormonal activity, which in turn, enhanced the root growth of mulberry cuttings. Elongation of root length ensures deeper excavation of soil profile, which not only renders better anchorage to mulberry but imports nutrient ions from sub horizons too. On the other hand, enhancement of root volume stands for wider distribution of rhizosphere in the soil system leading to improvement of its physical properties (Hillel, 1980) in addition to wider utilization of soil nutrients. Moreover, it is apparent that higher dry weight of root is an aid to biomass. Adani *et al.*, (1998) reported such positive effect of HA formulation on the root as well as shoot growth of tomato plant in hydroponics culture. Enhancement in root growth ultimately exerted influence on the growth of mulberry above ground level registering 34.28% increase in height of the sapling over control.

From the foregoing discussion, preliminary information on the role of HA in reducing the fixation of P and K by soil clay and also in enhancing root growth of mulberry, var. S-1635 has been generated. Further studies may be carried out to explore the possibility of isolation and formulation of HA from alternative sources. Systematic study with the suitable formulation of the same may prove to be an alternative for the application of organic manure in mulberry cultivation. Besides, inconvenience due to bulk application of manure may be averted through précised application of HA as a component of fertigation. Moreover, capability of HA in influencing physiological activities of plant may be exploited to formulate suitable natural growth promoter for established mulberry plantation.

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