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Plant Growth Stimulation of Lignite Humic Acid *Part-II* Effect of Lignite Derived Ammonium Humate on Wheat (*Triticum aestivum*-V)Crop using Different Levels of Phosphate Fertilizer

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The effect of humic acids (ammonium humate) derived from Pakistani lignite on the growth and grain yield of wheat *(Triticum aestivum*-V*)* crop in the presence and absence of phosphate fertilizer and in combination with various levels of phosphate fertilizer was studied. Application of humic acids in all doses when applied alone and in combination with various levels of phosphate fertilizer (TSP) has significant beneficial effect on the growth and yield of wheat. An enhanced effect on the growth and grain yield was notified when Humic acids was added alone without using any fertilizer.

Key words: Wheat, Humic acid, Phosphate fertilizer, Grain yeild.

Introduction

Humic acids is a vital constituent and an intimate part of soil's organic structure. In soil system the organic constituents comprises 0.5 to 5% of the total mass. Humic acid has been required and used by many soil scientists, agronomists and farmers as an essential constituent of organic matter highly effective in improving soil conditions and for plant growth (Ladd and Butler 1969; Lee and Bartlett 1976). Due to its physico-chemical properties such as very high cation exchange capacity, excellent water holding capacity and retention of mineral ions through complexation etc. play an important role in plant growth (Vaughan and Macdonald 1976; Guminski *et al* 1983).

The importance of organic matter in soil is well recognized and is not a recent discovery. Unfortunately the soil in the wheat growing area as of pakistan contains less than 1% of organic matter wich is not sufficient amount for getting desired yield. In such soils where the organic matter is not in sufficient quantity, the addition of Humic acid can play a positive impact on soil fertility and improve plant growth. Fortunately, Pakistan has so many reserves of lignitic coals which contain sizeable amounts of Humic acids and can be utilized for enhancing the agriculture productivity (Mir *et al* 2002).

Now it is well understood that Humic acids exert a stimulatory soil conditioning/growth promoting effect when applied along with a chemical fertilizer like N-fertilizer, phosphate fertilizer etc. The effectiveness of this combination occurs through chelation. It has the capacity to hold the nutrient ions and release them as and when required by plants (Linchen 1978). In a similar way, Humic acids may play a key role in phosphate fixation. Soil phosphates are often immobilized through reaction with iron and aluminium. The Humic acids via chelating reaction can break iron or aluminium bond with phosphate releasing it in the solution, therefore, the addition of Humic acids increases the availability of phosphorus for the plant (Malcolm and Vaughan 1979; Hajra and Debnath 1987). In our earlier paper the effect of ammonium humate along with N-fertilizer on the crop of wheat was reported (Mir *et al* 2002).

The addition of Humic acids increased the size of grain, plant and leaves (Mir *et al* 2002). As we know that wheat is the staple food of Pakistan, which contributes 83% of the total cereal intake and provides 50% of the total calories and 60% of the proteins consumes by the population of Pakistan as a whole. It becomes very necessary to seek the ways for getting enhanced growth of grain by adopting new ways free from environmental hazards. The objective of this paper is to study the feasibility of reducing the use of phosphate fertilizer in Pakistan through incorporation of Humic acids. The addition of Humic acids along with phosphate fertilizer in the soil may help in reducing the pollution and the import of chemical fertilizer from abroad.

This paper describes the effects of Humic acids (ammonium humate) using different levels of phosphate fertilizer.

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Table 1
Ultimate and promixate analysis of Lakhra lignite and humic acids

Name of Material	C %	N %	H %	O(by difference) %	S %
Lakhra Lignite Coal	63.3	1.87	5.09	25.03	4.7
Humic Acids	57.30	6.86	4.43	30.17	1.24

Experimental

Material. Nitric acid (commercial grade), Ammonia (E.Merck), Sodium hydroxide (Commercial grade) were used without further purification. Lakhra lignite coal samples were obtained from Habibullah coal mines. (Table 1) N-fertilizer in the form of urea (Engro) and phosphate fertilizer in the form of TSP were used. Potash in the form of SOP was added in the soil as blanket application.

Preparation of Humic acids. Humic acid was prepared by the oxidation of coal using strong acid as an oxidant by following the procedure given else where (Mir *et al,* 2002). The acid was then reacted with ammonia to obtain its salt. C, H and N from Coal salt were estimated by using LECO Model CHN-600 Elemental Analyzer. Sulfur was determined on LECO-Sulfur determinator Model SC-132 and LECO MAC-400. The ultimate and Proximate Analyses of Lakhra lignite and Humic acids are summarized in Table 1. FT-IR spectra of the salt and coal were recorded on Perkin Elmer FT-IR spectrometer model 1800 using Kbr disc. The max absorbency were observed as 3400 (S), 2960 (S), 2830 (m), 1720 (S), 1620 (m), 1550 (W), 1460 (W), 1340 (m), 1260 (m), 1175 (W), 1100 (W), 1040 (m), 920 (m), 670 (W), Cm^{-1} wave numbers.

Parameters of field for cultivation. The experiment was conducted on the soil of Hyderabad, Sindh. The soil had slit loan texture with pH 7.8 to 8.05 and 0.03% N. The entire field was divided into plots of equal size (1.60 X 5 M^2 each). The plot was divided into 8 rows. The row to row distance was kept 20 cm. Proper crop husbandry practices like hoeing, irrigation, pest control-Buctril-M (after first irrigation) were followed. Nitrogen 120 kg ha^{-1} in the form of urea and potash 75 kg ha^{-1} in the form of SOP were mixed to the soil as blanket application. Phosphate fertilizer in the form of TSP was applied. All TSP was applied before planting and incorporated in the soil thoroughly. Ammonium humate as Humic acids was used in the dry form/dilute solution in the dosages of 0.25, 0.5, 5.0 and

Table 2
Effect of ammonium humate on wheat crop using different levels of phosphate fertilizer

Ammonium Humate Kg ha^{-1}	Phosphate Fertilizer Kg ha^{-1}	NO. of Tillers ha^{-1}	1000 Kernel g	Grain Yield kg ha^{-1}
0.0	0	27,1000	37	3470
	50	33,00,000	37	3690
	100	36,60,000	38	6345
0.25	0	32,50,000	38	3625
	50	38,30,000	38	4095
	100	38,30,000	39	7625
0.50	0	31,80,00	39	3690
	50	39,70,000	39	4250
	100	39,70,000	40	7970
2.5	0	33,60,000	39	3800
	50	39,40,000	39	4600
	100	39,50,000	40	7840
5.0	0	34,70,000	38	3840
	50	39,20,000	38	4595
	100	39,30,000	39	7720
50	0	36,50,000	40	3970
	50	39,40,000	40	4470
	100	39,30,000	39	7720

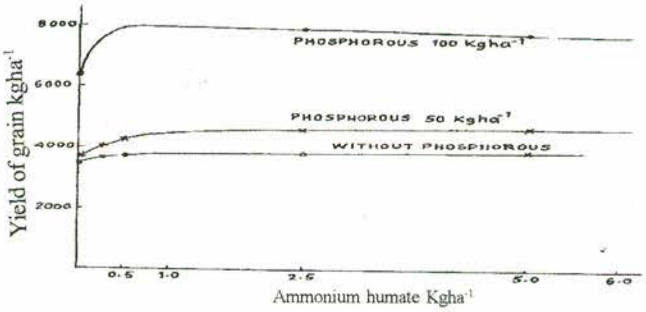

Fig 1. Effect of ammonium humate on yield of grain.

50 kg ha^{-1} (Mir *et al* 2002). The idea was to cover a minimum to a maximum dosages of Humic acids.

Results and Discussion

Humic acids by the oxidation of coal was characterized with the help of ultimate and proximate analysis, solubility and spectral studies. The elemental analysis of coal and Humic acids were illustrated in Table 1. It indicated that coal contains 63.31% C, 1.87% H, 5.09% N and 4.7% S whilst the product estimates C, H, N and S as 57.3, 6.86, 4.43 and 1.24% respectively. Ibarra and Juan (1985) had reported these values for their Humic acids as C=57% and H=4. 2% which are in good agreement with the values obtained in this study. The Lakhra coal is insoluble in water as well as in alkali like NaOH, KOH, NH_4 OH and similarly product is insoluble in water and soluble in alkali. This difference in solubility also supports the results of elemental analysis that the product is Humic acids. For further identification, FT-IR spectral studies were also undertaken. These studies also provided evidences to support above results. FT-IR spectrum of the product shows maximum absorption bond at 1720 cm^{-1} which is due to the carbonyl stretching vibration of the -COOH group being introduced through oxidation of coal. The absorption at 3400, 2960 and 2830, 1430 cm^{-1} are ascribed to H-bonded hydroxyl groups, aliphatic CH and CH_2 and CH_3 bending respectively. In the spectral zone of C-O stretching vibration the Humic acids shows absorption bend at 1040 cm^{-1} whereas the maximum absorption at 1100 cm^{-1} attributes to tertiary alcohol. The bend at 1260 cm^{-1} indicated C-O stretching in acryl ethers and at 1620, 920 cm^{-1} confirmed the presence of aromatic ring. The absorption bend at 670 cm^{-1} may be due to C-stretching monosubstituted benzene ring whereas the bending at 1340 cm^{-1} indicates C-H deformation and there is a weak bending at 1340 cm^{-1} indicates C-H deformation and there is a weak bending at 1175 cm^{-1} for phenolic groups. The spectrum of the product also showed maximum absorption at 1550 cm^{-1} which may be due to amide group associated with Humic acids (Bellamy 1954; Creswell *et al* 1975; Paul *et al* 1980;). Hence the FT-IR-spectrum of the product showed the product to be Humic acids.

The results obtained from the effect of different levels of phosphate fertilizer (TSP) on the grain yield, number of tillers and weight of 1000 kernel with and without using ammonium humate are summarized in Table 2. It indicates that in both cases (with or without ammonium humate) grain yield, No., of tillers and weight of kernel increased with the increasing level of phosphate fertilizer.

The addition of 0.25 kg ha^{-1} ammonium humate increased the grain yield from 3625 to 7625 Kg ha^{-1}. The number of tillers were enhanced from 325 to 383 x 10^4 ha^{-1}, whereas the weight of 1000 Kernel was increased from 38 to 39 g as the dose of phosphate fertilizer got increased from 0 to 100 kg ha^{-1} and the addition of ammonium humate at 0.5 kg ha^{-1} dose enhanced grain yield from 3690 to 7970 kg ha^{-1}, 1000 Kernel from 39 to 40 g and number of tillers from 318 x 10^4 to 387 x 10^4 ha^{-1} as the dose of phosphate fertilizer increased from 0 to 100 Kg ha^{-1}. Similarly addition of 2.5, 5.0 and 50 Kg ha^{-1} ammonium humate in Combination with three doses of phosphate fertilizer (0,50,100 kg ha^{-1}) increased the grain yield, number of tillers and weight 1000 Kernel appreciably.

In Fig 1, plots compare the grain yield of wheat obtained due to the addition of different doses of ammonium humate (0 to 5.0 Kg ha^{-1}) in combination of various doses of fertilizer. It shows that the grain yield increased with all doses of ammonium humate when used alone or in combination with various levels of phosphate fertilizer. A maximum increase of 14.4% in grain yield was observed over control using ammonium humate dosage 50 kg ha^{-1} with 'O' level of fertilizer (See Table 1). Ammonium humate at 5 kg ha^{-1} in conjunction with helf level of fertilizer dose produced a maximum increase of 24.5% in grain yield over half fertilizer dose. Using 0.5 kg ha^{-1} of ammonium humate in combination with full phosphate fertilizer dose produced an increase of about 26% over the full fertilizer dose. Similar results were also obtained when N-fertilizer was used with ammonium humate instead of phosphate fertilizer. The addition of ammonium humate salt of Humic acid increase the size of grain, plant and leaves. The small dose of 0.5 kg ha^{-1} alone and in combination with half dose of N-fertilizer (60 kg ha^{-1}) is the optimum Concentration of growth stimulation in wheat in Sindh (Mir *et al* 2002). Other researehers also reported similar observation (Lee and Bartlett 1976; Malik and Azam 1985).

When ammonium humate is sprayed on the soil or mixed with the soil alone or with phosphate fertilizer, it exerts beneficial effects on the crop. These effects may be related to the phosphate fixation property of ammonium humate, which converts the insoluble soil phosphate into a soluble form through chelation (Linchen 1978; Malcolm and Vaughan 1979). The growth promoting effect of ammonium humate (Humic acids) can also be attributed to the efficient uptake of essential nutrient through chelate formation (Vaughan and Mcdonald 1976), an increased respiratory activity of root and an increase in the permeability of cell membrane resulting in an increased uptake of moisture and nutrient elements (Lee and Bartlett 1976). The results of this study indicated that to reduce the import of chemical fertilizer and to minimize the polluting effect of chemicals, ammonium humate may be substituted with a full fertilizer dose would greatly enhance the grain yield as compared when a full fertilizer level without ammonium humate. It may thus be concluded that the under-utilized lignitic coals of Pakistan may be utilized in the form of ammonium humate (Humic acids) to enhance the agricultural productivity of the Pakistani soils. The utilization of Humic acid can be very cost effective opening an avenue for the Pakistani under utilized lignitic coals exploitation. Furthermore, this studies also inform that the soil of Sindh is rich in humous material.

References

Bellamy L J 1954 The *Infrared Spectra of Complex Molecules.* Wiley New York.

Creswell C J, Runquist O A, Campbell M H 1975 *Special Analysis of Organic Compounds.* Longmans London.

Guminski S J, Sullex, Glabisew Ski 1983 Influence of sodium humate on the uptake of some ions by tomato seedling. *Acta Soc Bot Pol* **52** 149-164.

Hajra J N, Debnath N C 1987 Transformation of phosphorous in soil, effects of some chelating agents on the inorganic transformation of the added phosphorous in soil. *Indian J Agri Chem* **20** (1) 69-77.

Ibarra J V, Juan R 1985 Structural changes in Humic acids during coalification process. *Fuel* **64** 650-658.

Ladd J N, Butler J HA 1969 Inhibition and stimulation of proteolytic enzymes activities by soil Humic acids *Aust J Soil Res* **7** 253-261.

Lee Y S, Bartlett R J 1976 Stimulation of plant growth by Humic substances. *Soil Sci Soc Am Proc* **40** 876-879.

Linchen D J 1978 Humic acids iron uptake by plant. *J Plant and Soil* **50** 663-670.

Malcolm R E, Vaughan D 1979 Humic substances and phosphorus activities in plant tissues. *Soil Biol Biochem* **11** 253 295.

Malik K A, Azam F 1985 Effect of humic acids on wheat seedling growth. *Environment and Experimental Botany* **25** 247-252.

Paul C P, Synder R W, Pearson D E, Kwong J 1980 Fourier transfer infrared study of the variation in the oxidization of a cooking coal. *Fuel* **59** 282-285.

Mir S, Abbasi Y Z, Khan A Rasheed 2002 Plant growth stimulation by lignite Humic acids Part-I, Effect of ammonium humate on the growth of wheat. *Pak J Sci Ind Res* **45** (3) 157-160.

Vaughan D, McDonald I R 1976 Some effects of Humic acids on cation uptake by parenchyma tissue. *Soil Bio Biochem* **8** 415-521.