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Plant Growth Stimulation of Lignite Humic Acids. *Part-III:* Effect of Ammonium Humate on Seed Cotton Yield and Fiber Quality

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Effects of various concentrations of humic acids (as ammonium humate) ranging from 0.05 to 1.0 kg ha^{-1} on the cultivation of cotton at the slit loam soil without using any chemical fertilizer were accomplished. Results showed significant effects of humic acids on seed cotton yield, boll weight, seed/boll, bolls/plant and lint (%). Maximum yield of cotton was recorded at a dose of 1.0 kg ha^{-1} humic acids. The soil of Karachi already contains enough amount of phosphorous fertilizer for cotton cultivation. Encouraging effects of humic acids on fiber quality related parameters were also noted.

Key words: Humic acid, Ammonium humate, Fiber quality.

Introduction

Coal is a big organic complex. Structural studies have shown that these lignitic coals are composed on organic compounds including plant hormone with structures like that of auxin, indoles, kinins, zetain gibberellines and various heterocyclic compounds of great therapeutic values (O"Donnel 1973). These hormones cause the elongation of individual cells in the growing tips of plants. The lignitic coals due to their organic structure are successfully utilized world-over in the form of humic acids' salts, derivatives and complexes. Humic acids has in fact the same organic structure as that of present coal except with the addition of various functional groupings. Humic acid are a polymeric organic acids with condensed aromatic structure with the substitutions of hydroxyl and carboxyl groups. Through the conversion of this acid into its various salts, derivatives and complexes, a wide variety of utilization may be achieved and useful organic products of agricultural, industrial and pharmaceutical importance may be formed.

Research studies have shown (Mir *et al* 2002; Mir and Khan 2002) that the Pakistan's lignitic low rank coals contain sizable amount of humic acids. Pakistani soils are deficient in organic matter. A wide spread deficiency of the micro-nutrients is also observed in Pakistani soil (Katyal and Randhawa 1982). Thus to enhance agricultural growth and to overcome humic acids and micro-nutrients deficiency, large quantities of humic acids can be easily produced from lignitic coals and may be incorporated in the soil for increasing the soil fertility and plant growth.

The cotton yields in Pakistan are low as compared to other cotton growing countries. It is well recognized that optimum nutritional requirement are of primary importance to boost up the production. The importance of the soil organic matter in the soil is established since prehistoric times. Humic acids are the vital constituents of the soil organic matter which has multiple effects of not only providing micro-nutrients to the soil but it also holds the available micro-nutrients in an organic complex from and release them to the plant slowly whenever required (Mir and Khan 2000). It plays a key function in phosphate fixation and causes a slow relese of nitrogen to the soil and acts as a growth regulating hormone (Mukanava 1961; O'Donnel 1973; Malik *et al* 1990). The object of this study is to evaluate the effects of humic acids (ammonium humate) without using any chemical fertilizer (Like phosphorous nitrogen fertilizers).

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Experimental

Material: Humic acids was prepared from lignitic coal and characterized by standard methods (Mir and Khan 2002). It was used as ammonium humate. Elemental analysis of coal and humic acids are shown in Table 1. Soil samples were collected from 0-30 cm depth before sowing and chemically analyzed by standard methods. Soil analysis are summarized in Table 2. The metal nutrients present in humic acids are determined by atomic absorption spectroscopy and depiced in Table 3.

Procedure: All experiments were accomplished on the soil that had slit loam texture with pH 8.2 at Fuel Research Centre (FRC), PCSIR, Karachi in early June. The layout of the experiments were randomized complete block with four replicates. The entire field of area 5 m^2 each was divided at a spacing of 75 cm between row and 30 cm between plants in the row. The required quantity of ammonium humate as humic acids were dissolved in water and dilute solution was sprayed evenly with the help of a hand sprayer before sowing seeds. For comparison, four concentrations of ammonium humate (50, 100, 500, 1000 g ha^{-1}) were selected for present study. Crop received normal irrigation and production practices were kept free of pest through scheduled spray during the season. Fruit production measurements were taken at monthly intervals beginning from flowering to maturity. Seed cotton yield and its components were determined by harvesting the whole plots and the calculations were made on area basis.

Results and Discussion

The elemental analysis of Lakhra coal and humic acids are summarized in Table 1. It shows that humic acids prepared from Lakhara coal was found to contain C, N, H and S as 57.3%, 6.86%, 4.43% and 1.24% respectively. The percentage of sulfur is decreased (1.24%) due to the oxidation of coal. Table 2 shows the analysis of slit loam texture soil of Karachi. The pH of the soil was found to be as 8.2 whereas the available phosphorous and potassium were estimated as 11 ppm and 300 ppm respectively. Besides, the exchangeable Na^+, Ca^{++}, Mg^{++} ions and electrical conductivity were found in the normal range. Table 3 shows important data of micro and macronutrients in humic acids. The concentration of macronutrients are calcium (500 ppm) and magnesium (300 ppm) whereas micro-nutrients like iron (5099 ppm), copper (11.9 ppm), chromium (34.69) and manganese (5.9 ppm) were found available in the humic acids. These nutrients certainly help in the growth of plant. Table 4 shows the observations obtained from seed cotton response to different doses of humic acids (ammonium humate). The various doses of humic acids have significantly affected the seed cotton yield, bolls per plant, weight of bolls, lint and seed per boll. Maximum yield was recorded at a dose of 1Kg ha^{-1} humic acids.

The plots shown in Fig. 1, indicates that seed/boll, bolls/plant, seed cotton yield, weight of boll and lint (%) increase with increasing doses of humic acids. The seed cotton yield at 0 dose of humic acids was recorded as 1140 kg ha^{-1}, whilst the yield at doses 0.05, 0.1, 0.5 and 1.0 kg ha^{-1} humic acids were obtained as 1340, 1700, 2860 and 3290 kg ha^{-1}. From these observations, it is obvious that increase in yield as compared with '0' dose was achieved as 189% (1.0 kg ha^{-1}) 151% (0.5 kg ha^{-1}), 49% (0.1 kg ha^{-1}) and 17.5% (0.05 kg ha^{-1}). It shows that the dose 1 kg ha^{-1}gives maximum yield of cotton seed. Similar results concerning the effect of humic acids on the cotton growth were also reported by other workers (O'Donnel 1973).

It was reported that humic acids act like a plant hormone and is required in small quantities by the plant and the effective requirement of humic acid varies with different plants. It is easy to conclude from the results that for cotton humic acids in small doses have a significant effect and 1.0 kg ha^{-1} dose of humic acids is the most effective concentration for the optimum seed cotton yield and its various components like seed/boll, bols/plant, weight of each boll and lint (%). Besides the dose concentration, various micro and macronutrients (see Table 3) present in humic acids and the micronutrients holding capacity of humic acids (Linchen 1978; Lalarhini *et al* 1988) meet the criteria of sustained release and help in achieving greater seed cotton yield and optimum growth. Humic acids is known to play a key role in phosphate fixation and in the slow release of nitrogen. It shows that plants are able to utilize the available soil phosphorous and nitrogen effectively even without the addition of chemical fertilizer, i.e. phosphorous, nitrogen to the soil. It also reveals that for cotton, low level of phosphorous is enough for its proper growth (Gardener and Tuckart 1983; Malik *et al* 1990).

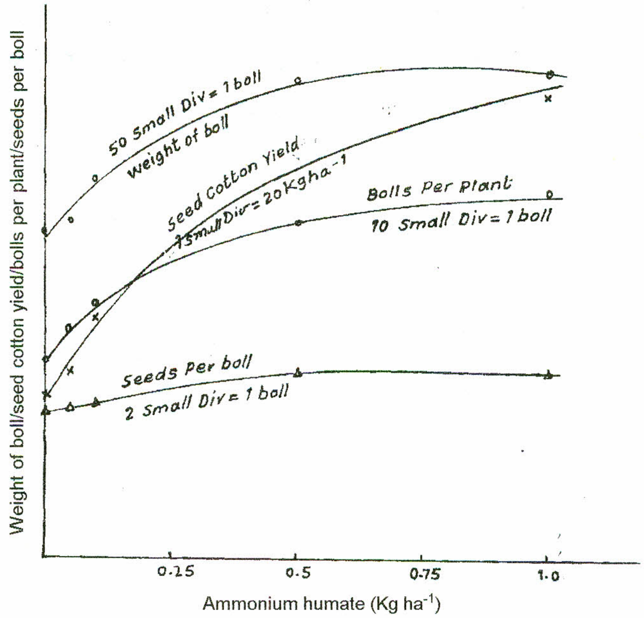

Fig 1. Effect of ammonium humate on seed cotton yield, weight of boll, bolls in plant and seeds per boll.

Table 5 includes fiber quality data for different doses of humic acids treatment. It shows that the spray of dilute solution of humic acids (as humate) on the soil enhances the

Table 1
Analysis of Lakhra coal and humic acids

Name of material	C %	N %	H %	S %
Lakhra	63.31	1.87	5.09	4.7
Humic acids	57.30	6.86	4.43	1.24

Table 2
Analysis of slit loam texture soil of Karachi

S.No.	pH	8.2
1	Electrical conductivity	1.9
2	Available phosphorous	11 ppm
3	Available potassium	300 ppm
4	**Soluble, exchangeable**	
	(a) Na^{+}	2200 ppm
	(b) Ca^{++}	28500 ppm
	(c) Mg^{++}	1500 ppm

Table 3
Micro and macro-nutrient present in humic acid

S.No.	Kind of nutrient	Concentration (ppm)
1	***Macro-nutrient***	
	(a) Calcium	500
	(b) Magnesium	300
2	***Micro-nutrient***	
	(a) Iron	5099
	(b) Copper	11.90
	(c) Chromium	34.69
	(d) Mangenese	5.9

Table 4
Seed cotton yield response to different doses of humic acid (ammonium humate)

Dose of humic acid kg ha^{-1}	Seed cotton yield kg ha^{-1}	Bolls per plant	Weight of boll (g)	Lint %	Seed per plant
0.0	1140	7	2.3	31.8	26
0.05	1340	8	2.4	34.5	26
0.10	1700	9	2.7	32.7	27
0.50	2860	12	3.4	32.1	28
1.00	3290	13	3.5	31.5	28

fiber length, strength, % of the maturity and micronutrient as compared to control showing that humic acids for some unknown reasons has a positive effect on the fiber quality. On the other hand Nelson (1980) reported in his review article that phosphorous fertilization usually has no effect on fiber quality. This supports the fact that the enhancement in the values of quality parameters is certainly due to the addition of humic acids in the soil.

In brief when the dilute solution of humic acids (as humate) is sprayed on the soil it complexes with the essential minerals ions (macro and micro-nutrients) present in the soil and release these ions slowly to plant required. It makes good soil structure and saves the soil from leaching effect. Further, the addition of humate improves root development, seed germination and stimulate beneficial microbial activity and root growth. Enrichment of quality parameters of fiber is self explanatory (Table 5). Hence humic acids is a good soil conditioner/plant hormone for cotton seed cultivation and may be used without addition of any phosphorous or nitrogen fertilizer.

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Table 5
Fiber quality for different concentrations of humic acids (ammonium humate) treatments

S.No.	Dose of humic acids kg ha^{-1}	Fiber length (digital fibrograph) 2.5 % Span	50% Span	Uniformity ratio %	Floating fiber (F.F.I. 50)	Strength lb $inch^{-2}$	Micro-naire reading μ $inch^{-1}$	Maturity %
01	0.00	28.2	12.8	45.4	29.4	87.8	4.1	77.9
02	0.05	27.1	12.5	46.0	28.2	91.5	4.2	78.4
03	0.10	28.4	13.6	47.8	21.8	93.0	4.6	80.4
04	0.50	27.9	12.7	45.7	28.8	92.0	4.5	79.9
05	1.00	28.4	13.4	47.1	23.8	92.6	4.4	79.4

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