

## EFFECT OF HUMIC ACID ON SORGHUM VULGARE VAR. CSH-9

M. MALLIKARJUNA RAO, R. GOVINDASAMY and S. CHANDRASEKARAN

*Department of Soil Science and Agricultural Chemistry, Annamalai University, Annamalai Nagar 608 002, India.*

## ABSTRACT

Humic acid obtained from lignite was tried in a pot-culture experiment to find its effect on the growth and composition of sorghum (CSH-9) in a sandy soil (Psamment). Humic acid was found to be very effective in increasing the dry matter yields of root and shoot of sorghum. The dry matter yield of sorghum increased with an increase in the level of humic acid up to 30 kg ha<sup>-1</sup> and then declined. Addition of humic acid up to 30 kg ha<sup>-1</sup> resulted in higher root-shoot ratio. Humic acid beyond this level caused adverse effect on the growth and yield of plants. Plants treated with humic acid gave lower total phenol and higher ortho-dihydroxy phenol than the untreated plants. The retardation of IAA oxidase activity by higher ortho-dihydroxy phenols would promote the growth of plants resulting in higher dry weight.

## INTRODUCTION

HUMIC acid has been reported to influence the plant growth both directly and indirectly. The indirect effects of humic compounds have been attributed to the improvement of physical, chemical and biological conditions of soil. Its direct effect on plant growth has been attributed to the increase in chlorophyll content, the acceleration of the respiration process, hormonal growth responses, increasing penetration in plant membranes or a combination of these processes. Some workers also found that humic compounds affect the dry matter production and uptake of nutrients by plants. The present study was undertaken to find the effect of humic acid on the dry matter yield of sorghum (CSH-9).

## MATERIALS AND METHODS

A pot-culture experiment was conducted with a sandy soil (Psamment) using sorghum (CSH-9) as a test plant. This soil was found to have the following pro-

perties: pH (1:2.5) 8.4; E.C (1:2.5) 0.131 mmhos cm<sup>-1</sup>; organic carbon 0.13%; texture: sandy; available N, P and K: 38.2, 10 and 49 ppm respectively.

Ten kg of this processed soil was filled in each pot. N at 100 kg ha<sup>-1</sup> as urea (accounting the N in DAP), P at 50 kg of P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> as DAP and K at 75 kg of K<sub>2</sub>O ha<sup>-1</sup> as sulphate of potash were applied basally to all the pots. Humic acid was extracted by the fractionation procedure<sup>1</sup> from the raw lignite of Neyveli Lignite Corporation, Tamil Nadu and added as potassium humate solution to the soil in the pots at 0, 20, 30 and 40 kg ha<sup>-1</sup> and the treatments were replicated four times. Ten sorghum (CSH-9) seeds were dibbled in each pot and watered with rain water. After germination, the seedlings were thinned to two per pot for uniformity. Plant protection measures were taken during the crop growth. The plants were harvested on the 75th day of sowing, the data on dry matter yields of shoots and roots are given in table 1.

**Table 1** Effect of humic acid on the dry matter yield of sorghum (CSH-9)  
(Mean values in g pot<sup>-1</sup>)

Treatments	Dry matter yield		
	Shoot	Root	Root : Shoot ratio
T <sub>1</sub> : Control (no humic acid)	7.46 c	5.37 c	0.719 c
T <sub>2</sub> : Humic acid at 20 kg ha <sup>-1</sup>	17.89 b	15.68 b	0.878 b
T <sub>3</sub> : Humic acid at 30 kg ha <sup>-1</sup>	31.96 a	30.47 a	0.953 a
T <sub>4</sub> : Humic acid at 40 kg ha <sup>-1</sup>	21.25 b	18.72 b	0.884 b
'F' test	**	**	**
S.E.	1.55	1.44	0.002
C.D. (P = 0.05)	3.51	3.26	0.006

a, b, c - indicate the decreasing order of significance

The chopped plant material (4 g) was extracted with 80% ethanol as outlined by Chandramohan *et al.*<sup>2</sup>. The alcohol extract of the plant material was used to estimate the total and ortho-dihydroxy phenols. Total phenols were estimated by employing Folin-Ciocalteu, reagent<sup>3</sup> and ortho-dihydroxy phenols by employing Arnou's reagent<sup>4</sup>. The data on the total and ortho-dihydroxy phenols of sorghum plants are given in table 2 and represented graphically in figure 3.

An incubation study was conducted to find out the release pattern of exchangeable  $\text{NH}_4\text{-N}$  and  $\text{NO}_3\text{-N}$ . Porcelain pots were filled with 1 kg of soil and the calculated amounts of urea, DAP and  $\text{K}_2\text{SO}_4$  were applied. Humic acid as potassium humate was added at two levels viz 0 and 30 kg ha<sup>-1</sup>. The soil was incubated at room temperature and water was added periodically to maintain field capacity condition. Soil samples from each pot were taken on 10th, 20th and 30th day after incubation and analysed for 1N KCl extractable  $\text{NH}_4\text{-N}$  and  $\text{NO}_3\text{-N}$ . The results are reported in table 3.

## RESULTS AND DISCUSSION

The data on shoot and root weights which collectively represent the total dry matter yield of Jowar are presented in table 1. The mean shoot weight of plants under different humic acid levels varied from 17.89 to 31.96 g pot<sup>-1</sup> compared to only 7.46 g pot<sup>-1</sup> under control where no humic acid was applied. Application of humic acid at 20 and 30 kg ha<sup>-1</sup> increased the shoot weight of the plant significantly (17.89 and 31.96 g pot<sup>-1</sup> respectively) over control (7.46). Although the highest level of humic acid application (40 kg ha<sup>-1</sup>) showed significant increase in shoot weight of the plant over control, it showed a significantly negative effect when compared with that of 30 kg ha<sup>-1</sup> level of humic acid application. Thus, the adverse effect of humic acid above 30 kg ha<sup>-1</sup> is quite evident. The humic acid level of 30 kg ha<sup>-1</sup> was optimum for the highest shoot weight of sorghum. Similarly, the mean root weight of sorghum plants under different levels of humic acid application increased signifi-

**Table 2** Effect of humic acid on the total phenol and ortho-dihydroxy phenols content of Sorghum (CSH-9)

Treatments	Total phenol content (catechol equivalent in mg/g of oven dry tissue)	Ortho-dihydroxy phenols	
		Content (catechol equivalent in mg/g of oven dry tissue)	Per cent increase over con- trol
T <sub>1</sub>	2.4030 a	1.009 d	—
T <sub>2</sub>	2.3905 c	1.150 b	13.97
T <sub>3</sub>	2.3845 d	1.386 a	37.36
T <sub>4</sub>	2.3965 b	1.036 c	2.67
'F' test	**	**	—
S.E.	0.0013	0.0035	—
C.D. (P = 0.05)	0.0029	0.0070	—

Total phenols and O.D. phenols in terms of catechol equivalents in mg/g of oven dry tissue; a,b,c,d — indicate the decreasing order of significance.

**Table 3** Effect of humic acid on 1N KCl extractable  $\text{NH}_4\text{-N}$  and  $\text{NO}_3\text{-N}$  content of soil during incubation (Mean values in ppm)

Treatments	Incubation period					
	10th day		20th day		30th day	
	$\text{NH}_4\text{-N}$	$\text{NO}_3\text{-N}$	$\text{NH}_4\text{-N}$	$\text{NO}_3\text{-N}$	$\text{NH}_4\text{-N}$	$\text{NO}_3\text{-N}$
Control (no humic acid)	72.22	19.97	59.12	24.97	47.32	23.87
Humic acid at 30 kg ha <sup>-1</sup>	60.45	24.95	61.15	33.90	61.90	52.52



cantly (from 15.68 to 30.47 g pot<sup>-1</sup>) compared to control (5.37 g pot<sup>-1</sup>). Though the increasing levels of humic acid up to 30 kg ha<sup>-1</sup> increased the root weight substantially, the highest level of 40 kg ha<sup>-1</sup> registered a short decrease in root weight (18.72 g pot<sup>-1</sup>) compared to the highest root weight of 30.47 g pot<sup>-1</sup> with 30 kg ha<sup>-1</sup> level of humic acid application. Thus, the adverse effect of humic acid application beyond 30 kg ha<sup>-1</sup> level was also felt in root growth. The results further indicate that the effects of different levels of humic acid were alike in respect of both shoot and root growth of sorghum.

The mean root-to-shoot ratio of sorghum as affected by humic acid application varied from 0.88 to 0.95 compared to 0.72 in control. Though the highest level (40 kg ha<sup>-1</sup>) of humic acid resulted in significantly lower root-shoot ratio (0.88) over the 30 kg ha<sup>-1</sup> level (0.95) it showed a significantly higher ratio over control. Thus, it could be concluded from these results that humic acid application showed greater beneficial effect on root growth rather than on shoot growth. More proliferated root system of plants under humic acid treatment further lends support to the root system being benefitted more than the shoot system (figures 1 and 2). Moreover, the high pH of the experimental soil might be the cause for reduced plant growth and the changes in physico-chemical properties of the soil brought about by the application of humic acid might be the reason for the increased shoot and root growths of the plants. These results agree with those reported by Flaig<sup>5</sup>.

Total phenolic contents in sorghum differed significantly with the application of humic acid. Addition of humic acid resulted in a decrease of total phenol in sorghum (figure 3). This decrease in the total phenol content of sorghum due to humic acid was maximum at 30 kg ha<sup>-1</sup> level.



Figure 2. Effect of humic acid on the root growth of sorghum.

On the contrary, the application of humic acid increased the ortho-dihydroxy phenols of sorghum plants. Maximum amount of ortho-dihydroxy phenols was observed in sorghum plants receiving 30 kg ha<sup>-1</sup> of humic acid.

Although there was some decrease in the total phenols content of sorghum due to humic acid application, there was a gradual increase in the ortho-dihydroxy phenols. The phenolic acids in the plant system are formed from the aromatic amino acids viz phenyl alanine which is the constituent of humic acid<sup>6</sup> and tyrosine by the action of two enzymes, phenyl alanine ammoniolyase and tyrosine ammoniolyase respectively<sup>7</sup>. It is quite possible that lower molecular weight substances from humus must have been taken up by the plants in this study as reported earlier<sup>8</sup>.

Higher amounts of ortho-dihydroxy phenols in plants are due to humic acid treatment. According to Schneider and Wightman<sup>9</sup> O-dihydric phenols are reported to retard IAA oxidase activity. The mechanism suggested by them is that the diphenols act as anti oxidants, thereby inducing a lag period in



Figure 1. Effect of humic acid on the shoot growth of sorghum.

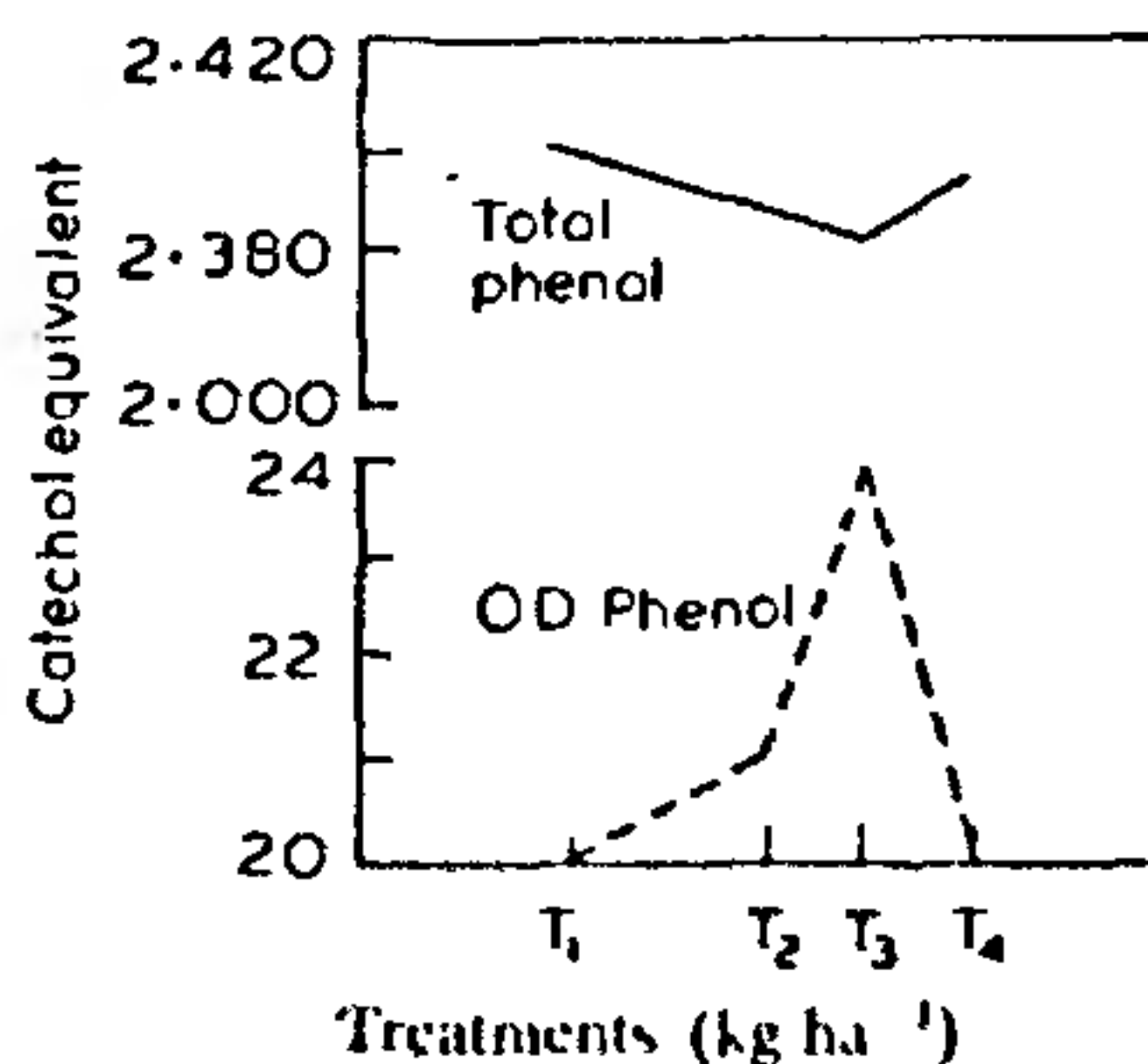


Figure 3. Effect of humic acid on the phenolic contents of sorghum.

the oxidation of IAA. Prolonged persistence of IAA might promote plant growth.

Table 3 indicate that 1N KCl extractable ammoniacal nitrogen in control (without humic acid) decreased with days of incubation while the nitrate nitrogen content increased. With the days of incubation, there was a slight increase in the 1N KCl extractable ammoniacal nitrogen and a marked increase in the nitrate nitrogen in this humic acid-treated soil, while there was decreasing trend in the available nitrogen in control.

The more efficient utilization of applied nitrogen by the plants in the presence of humic acid could be attributed to the slow release of nitrogen due to the formation of nitrogen-organic complexes, thus contributing to the promotion of growth.

12 June 1987; Revised 21 September 1987

1. Stevenson, J., In: *Methods of soil analysis*, part-2, (ed.) C. A. Black, Am. Soc. Agron., Wisconsin, USA, 1965, p. 1409.
2. Chandramohan, D., Mahadevan, A. and Rangaswami, G., *Indian Phytopathol.*, 1967, 20, 109.
3. Bray, H. C. and Thorpe, W. V., *Neth. Biochem. Anal.*, 1954, 1, 27.
4. Johnson, C. and Schall, L. A., *Phytopathology*, 1957, 47, 253.
5. Flaig, W., *FAO Soil Bull. (Rome)*, 1975, 27, 31.
6. Alexander, M., In: *Introduction to soil microbiology*, 2nd edn, John Wiley, New York, 1971, p. 14.
7. Sridhar, R. and Mahadevan, A., *Acta Phytopathol. Hung.*, 1979, 14, 49.
8. Flaig, W., In: *Organic matter and rice*, IRRI, Manila, 1984, p. 73.
9. Schneider, E. A. and Wightman, F., *Annu. Rev. Plant Physiol.*, 1974, 25, 487.

---

## NEWS

---

### CHROMOSOME LINK WITH TUBEROUS SCLEROSIS IDENTIFIED

A team of U.K. medical researchers has discovered a link between tuberous sclerosis (TS) and chromosome 9.

The disease, which is found throughout the world, is inherited and affects about one in every 15,000 in the U.K. It is a single-gene disorder and best known for its combination of neurological and dermatological features. It leads to mental retardation in about 50 per cent of all patients and can lead to epileptic attacks, intracerebral tumours and skin disorders. Other organs can also be affected, including the kidneys, heart, lungs and bones.

The discovery followed a study of 14 three-generation families and five two-generation families throughout the U.K. "We determined the chromosomal location of the TS gene by means of a linkage study of blood groups, plasma proteins and red cell enzymes," said Dr. John Osborne, a member of the research team at Bath's Royal United Hospital in southwest England. "Medical history records were

studied and clinical examinations were also undertaken."

The disease can be transmitted from parents with no apparent signs of the disease to their children, sometimes with devastating effects. "We discovered that the TS gene is close to the gene in the ABO blood group," said Dr. Osborne.

He continued: "The blood group does not cause the disease, but the manner in which the blood group is passed from parent to child will be an indication of the way in which the disease is passed on. For example, if a woman who has the disease is pregnant, it will now be possible to test her unborn baby and discover what blood group it has. If the disease is associated with the B group in the family and the baby is also group B, then there is a 90 per cent possibility that the baby will also have TS. (*Spectrum*, British Science News, 1987/No. 207/12; Published by British High Commission, New Delhi 110 021).