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Effect of humic acid on the yield and nutrient uptake of rice

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ABSTRACT

The response of humic acid (HA) on the yield and nutrient uptake of rice (ADT-39) was study. The application of humic acid upto 20 kg ha^{-1} along with 100 per cent (150:50:50 NPK ha^{-1}) recommended dose resulted in highest grain yield (4253 kg ha^{-1}) as well as highest total uptake of nitrogen (132.0 kg ha^{-1}), phosphorus (20.75 kg ha^{-1}) and potassium (86.98 kg ha^{-1}). The total N uptake significantly increased from 20.3 (control)) to 132.0 kg ha^{-1} to (100 per cent NPK + 20 kg HA ha^{-1})). The total P and K uptake also increased from 5.82 (control) to 20.75 kg ha^{-1} (100% NPK + 20 kg HA) and 28.97 (control) to 86.98 kg ha^{-1}(100% NPK + 20 kg HA) respectively.

Key words: *K – humate, Lignite, humic acid, rice and nutrient uptake*

Soil organic matter supports the plant nutrients through decomposition and mineralization. Humic acid, a component of soil organic matter has the ability to continue with metal ions so as to smoothly interact with clay minerals. Indiscriminate use of chemical fertilizers depletes the soil organic matter and humus content. Humic acid extracted from lignite could be added externally as a source of organic matter to enhance total NPK uptake. The present study was taken up to evaluate the response of rice to humic acid as K – humate.

A field experiment was carried out at the Central Farm, Agricultural College and Research Institute, Killikulam. The farm is situated in southern agro-climatic zone of Tamil Nadu (8° 46 N, 77° 42 E and 40 m attitude. The soil belongs to Manakkarai series with fine, non acid, kaolinitic, isomegathermic family of typic Rhodustalf.

Lignite comprising 25 – 65 per cent humic acid is available in the open mines at Neyveli, Tamil Nadu. The extracted humic acid was converted to potassium humate (K– humate) in Neyveli Lignite Corporation. This was added externally as a source of organic matter to evaluate its efficacy in enhancing the soil fertility and productivity of rice.

The initial soil properties were viz., pH 7.7, EC 0.3 dSm^{-1}, OC 6.20 g kg^{-1}, $KMnO_4$ – N -176.0 kg ha^{-1}, Olsen – P -19.0 kg ha^{-1} , NH_4OAc – K -160.0 kg ha^{-1} (Jackson, 1973). The experiment was conducted in split plot design with three replications. The main plot treatment consisted of M_1 – Control, M_2 – 75 per cent NPK and M_3 –100 per cent NPK. The subplots included eight treatments S_1 - No HA; S_2 - 10 kgha^{-1} HA as soil application (SA); S_3 - 20 kg ha^{-1} HA (SA); S_4 - 30 kg ha^{-1} HA (SA);S_5 - 40 kg ha^{-1} HA (SA); S_6 was S_2 + 0.1 per cent Foliar spray (FS); S_7 was S_2 + 0.3per cent Root dipping (RD) and S_8 was S_2 + 0.1per cent FS+ 0.3 per cent RD. The yield of rice was recorded at harvest. Grain and straw samples were analysed for NPK contents and their uptake was also computed.

The grain yield increased from 2667 kg ha^{-1} (control) to 3956 kg ha^{-1} (100 per cent NPK) and the straw yield increased from 4030 (control) to 5935 kg ha^{-1} (100 per cent NPK). The soil application of humic acid at different levels enhanced the yield compared to control but at20 kg HA ha^{-1} highest grain yield of 4253 kg ha^{-1} and highest straw yield of 6380 kg ha^{-1} was obtained.

Beyond 20 kg HA ha^{-1} there was a marginal decline in the yield. With regard to the mode of application of humic acid, it showed that the humic acid applied @ 10 kg ha^{-1} coupled with FS or RD or both

(S_6), registered a significant increase in the grain yield than in 10 kg HA ha^{-1} of soil application (Table 1.). The interaction of fertilizer with humic acid on grain yield was also significant. The highest grain yield of 4253 kg ha^{-1}was recorded with the combined application of 100 per cent NPK and 20 kg HA ha^{-1} (M_3S_3) which excelled among all the treatments.

Haripriya *et al.*, (2002) reported the increased yield might be due to the efficient utilization of nutrients, improved aeration and water holding capacity in the humic acid applied treatments. The favourable effect of foliar spraying of humic acid on increasing yield (Nair, 1995) was attributed to increased levels of chlorophyll in the leaves and enhanced photosynthetic activity and higher uptake of nutrients like P (Senthil kumar, 1995).

Fertilizer levels significantly increased the N uptake from 27.2(M_1) to 119.7 (M_3) kg ha^{-1}. The treatments receiving 0.1 per cent HA+FS or 0.3 per cent HA+RD alone or in combination recorded higher total N uptake of 82.5, 83.6 and 93.8 kg ha^{-1} in S_6,S_7 and S_8 separately (Table 2.). The interaction of fertilizer and humic acid was also significant with regard to N uptake. The N uptake increased from 20.3 (M_1S_1) to 132.0 kg ha^{-1}(M_3S_3). The combined effect of 100 per cent NPK and 10 kg HA ha^{-1} along with 0.1 per cent HA FS and 0.3 per cent HA RD (M_3S_8) recording 129.6 kg ha^{-1} yield was found statistically on par with the treatment receiving 100 per cent NPK and 20 kg HA ha^{-1}(M_3S_3) recording 132.0 kg ha^{-1} yield.

The increase in nitrogen uptake by humic acid application was noticed upto 20 kg ha^{-1}. Humic acid might have influenced the plant growth directly through its effects on ion uptake or by the effects on the plant growth regulators. (Satishkumar 1997).

The perusal of the data on P uptake showed that the fertilizer application significantly increased the P uptake from 6.87 to 18.97 kg ha^{-1}. The highest P uptake of 16.05 kg ha^{-1} proved the superiority of treatment receiving 20 kg HA ha^{-1} as soil application. The treatments S_6, S_7 and S_8 receiving 0.1 per cent HA FS or 0.3 per cent HA RD alone or in combination besides 10 kg HA ha^{-1} recorded higher P uptake of 14.13, 14.29 and 15.62 kg ha^{-1}(Table 2) respectively. The combined application of 10 kg HA ha^{-1} along with 0.1 per cent HA FS and 0.3 per cent HA RD (S_8) were statistically on par with the soil application of 20 kg HA ha^{-1} alone. The uptake of P in the presence of organic and inorganic sources of nutrients was reported by Mishra and Srivastava (1988).

The fertilizer application exerted a significant increase in total K uptake from 31.98 (M_1) to 83.62

Table 1. Effect of humic acid and fertilizers on yield of rice

Treatment	Grain yield (kg ha^{-1})				Straw yield (kg ha^{-1})			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
	Control	112.5:37.5: 37.5 NPK	150:50:50 NPK		Control	112.5:37.5: 37.5 NPK	150:50:50 NPK	
S_1 -No humic acid	2337	3127	3786	3083	3506	4691	5679	4625
S_2 -10 kg ha^{-1} as soil application humic acid	2407	3482	3907	3265	3611	5223	5861	4898
S_3 -20 kg ha^{-1} as soil application humic acid	2897	3767	4253	3639	4346	5651	6380	5459
S_4 -30 kg ha^{-1} as soil application humic acid	2850	3558	4038	3482	4275	5337	6057	5223
S_5 -40 kg ha^{-1} as soil application humic acid	2623	3362	3887	3290	3935	5043	5831	4936
S_6 – S2+0.1% foliar spray	2705	3458	3803	3322	4058	5187	5705	4983
S_7 –S2+0.3% root dip	2733	3487	3850	3357	4100	5231	5775	5035
S_8 –S2+0.1% foliar spray+0.3% root dip	2781	3717	4118	3539	4412	5591	6192	5398
Mean	2667	3495	3956	3373	4030	5245	5935	5070

	SEd	CD (P = 0.05)	SEd	CD (P = 0.05)
M	34.00	94	56.76	157
S	52.06	105	35.99	72
M at S	90.06	193	81.38	194
S at M	90.18	182	62.34	125

Table 2. Effect of humic acid and fertilizers on total N, P and K uptake (kg ha^{-1}) of rice

Treatment	N				P				K			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	20.3	85.4	96.8	67.5	5.82	16.18	17.04	13.01	28.97	74.36	79.31	60.88
S_2	23.8	99.8	110.9	78.2	6.15	16.99	17.86	13.67	30.66	76.09	81.13	62.63
S_3	32.6	124.2	132.0	96.3	8.18	19.22	20.75	16.05	34.89	82.05	86.98	67.97
S_4	30.7	120.0	128.9	93.2	7.42	18.89	19.52	15.28	33.52	81.04	85.01	66.52
S_5	29.3	116.7	123.9	90.0	7.11	18.48	18.96	14.85	32.54	79.44	84.39	65.46
S_6	26.0	105.3	116.2	82.5	5.99	17.82	18.59	14.13	31.22	77.02	82.46	63.57
S_7	25.5	107.8	117.6	83.6	6.37	17.97	18.54	14.29	31.78	78.00	84.41	64.73
S_8	30.6	121.3	129.6	93.8	7.8	19.99	20.54	15.62	32.26	79.73	85.26	65.75
Mean	27.2	110.3	119.7	85.6	6.87	18.40	18.97	14.75	31.98	78.47	83.62	64.69
		SEd		CD (P = 0.05)			SEd	CD (P = 0.05)		SEd	CD (P = 0.05)	
M		0.60		1.7			0.04	0.10		0.61	1.69	
S		1.80		3.6			0.13	0.27		1.46	2.96	
M at S		2.97		6.1			NS	NS		NS	NS	
S at M		3.11		6.3			NS	NS		NS	NS	

(M_3) kg ha^{-1}. The soil application of humic acid @ 20 kg HA ha^{-1} proved to be most effective than in rest of the treatments with regard to K uptake (67.97 kg ha^{-1}) in $M_3 S_3$. The treatments S_6, S_7 and S_8 recorded higher K uptake of 63.57, 64.73 and 65.75 kg ha^{-1} (Table 2.) respectively.

Rice, being a monocot, could have taken up more amount of K by virtue of its high root CEC (Tisdale *et al.*, 1997). This might be the reason for the marked increase in K uptake with the increase in the fertilizers dose from 75 per cent NPK (M_2)to 100 per cent and (M3)upto 20 kg HA ha^{-1} ($M_3 S_3$).

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