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Effect of Different Levels and Sources of Humic Acid Extracted from Organic Wastes on Soil Properties, Growth, Yield and Nutrient Uptake by Maize

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ABSTRACT

A pot culture experiment was conducted to assess the effect of different levels and sources of humic acid extracted from different organic wastes on soil properties, growth, yield and nutrient uptake by maize during *rabi* 2014. The response of maize increased with increase in the levels of humic acid application. Higher root dry weight (15.32 g plant^{-1}) and shoot dry weight (70.54 g plant^{-1}) was recorded with application of humic acid at 90 kg ha^{-1}, which was on par with application of humic acid at 60 kg ha^{-1}. Among the humic acid extracted from different organic wastes, humic acid of poultry manure (S_7) recorded higher root and shoot dry weight (71.43 and 15.42 g plant^{-1}, respectively) followed by humic acid of pressmud (S_3) (70.51 and 15.26 g plant^{-1}, respectively), coffee pulp (S_2) (69.89 and 15.11 g plant^{-1}, respectively) and urban compost (S_9) (69.34 and15.09 g plant^{-1}, respectively). A dry matter yield of 59.37 and 13.36 g plant^{-1} was recorded in pots which received only NPK+FYM and was on par with application of humic acid at 30 kg ha^{-1} level. Lower biomass yield of maize (47.99 and 11.53 g plant^{-1}, respectively) was recorded in treatment which received NPK alone. Similar was the trend with nutrient uptake. Higher NPK content in soil after harvest of maize was recorded @ 90 kg ha^{-1} of humic acid application (312.99, 105.82 and 299.43 kg ha^{-1}) and among the humic acid sources extracted from different organic wastes the build up of N (314.84), P (111.3) and K (299.48) kg ha^{-1} was high on application of poultry manure humic acid (S_7) compared to humic acid extracted from other organic wastes. Lower nutrient content in soil was recorded in only NPK treated soils (271.01, 87.48 & 276.85 kg ha^{-1}).

HUMIC acid (HA) is the main fraction of humic substances and it is the most active component of soil organic matter. It enhances the nutrient availability and improves the physical, chemical and biological properties of soil. The direct and indirect beneficial effects of humic acid on plant growth and development is their effect on cell membranes which leads to the enhanced transport of minerals, improved protein synthesis and plant harmones. It promotes photosynthesis, modifies enzyme activities, solubility of macro and micro nutrient elements, reduces active levels of toxic minerals and increases microbial population.

In view of the above benefits of humic acid a green house pot culture study was conducted during *Rabi* 2014 at Department of Soil Science and Agril. chemistry, UAS, GKVK, to study the effect of different levels and sources of humic acid extracted from different organic wastes on soil properties, growth, dry matter yield and nutrient uptake by maize.

The study was undertaken by filling 5 kg of air dried powdered 2 mm sieved soil (0-15 cm depth) collected from farmer's field of Harohalli village, Devanahalli Taluk, Bangalore Rural district. The soil was sandy clay loam in texture with slightly acidic reaction (6.61), normal electrical conductivity (0.49 dsm^{-1}) and high in organic carbon (0.81 %). The soil was medium in available nitrogen (293.68 kg ha^{-1}) high in phosphorus (91.53 kg ha^{-1}) and medium in potassium (284.68 kg ha^{-1}). The experiment consisted of ten sources of humic acid applied at three levels and three replications in factorial CRD. The pots were treated with three graded levels of humic acid (30, 60 and 90 kg ha^{-1}) extracted from 10 different organic wastes (Table I). All treatments received 100 per cent RDF (150: 75:40 kg ha^{-1}). The pots were maintained at field capacity and Hybrid maize variety HEMA was taken as test crop. The pots which received NPK alone and NPK+FYM were considered for comparison where in no humic acid was applied. The experiment was conducted upto 60 days and in each pot a single plant was maintained. At the end of experiment plant (shoot and root) and soil samples were collected and were dried, powdered and subjected to nutrient analysis by adopting standard procedures.

The humic acid extracted from different organic wastes were subjected to elemental analysis. The elemental composition of humic acid used for pot experiment is presented in (Table I). The carbon content was found to be higher in humic acid compared to that of oxygen and hydrogen followed by nitrogen. Among different organic wastes higher carbon content (61.04 %) was noticed in HA extracted from biofuel waste whereas nitrogen content (6.07 %) was higher in HA extracted from poultry manure. Which was related to the dominant proteinaceous composition of this material. With respect to hydrogen higher value (8.29 %) was recorded in HA from biofuel waste and lower value (4.08 %) was observed in HA from poultry manure. The oxygen content was high (52.31 %) in HA extracted from sludge followed by FYM (52.19 %). The results of molar ratios of elements suggest stoichiometric relationship that exists among the elements. The N/C (0.13) and O/C (0.99) ratios were considerably high in HA extracted from poultry manure (S_7) followed by press mud (S_3), coffee pulp (S_2) and urban waste (S_9). This indicated that the acid insoluble nitrogen content increased considerably which might have enriched the humus. Further lower H/C ratios in humic acids of these organic materials suggest that polymerization or condensation takes place more, due to presence of carboxylic functional groups and oxidation of phenolic compounds with methoxy groups or aliphatic side chain in humic acid (Vila *et al*., 1982).

Increasing the levels of HA application resulted in increase in shoot and root yield. Application of HA @ 90 kg ha^{-1} recorded significantly higher dry weight of shoot (70.45 g plant^{-1}) and root dry weight (15.32g plant^{-1}) which was on par with application of HA @ 60 kg ha^{-1} with shoot dry weight of 68.04 g plant^{-1} and 15.08 g plant^{-1} of root dry weight followed by application of HA @ 30 kg ha^{-1}. However among the HA extracted from different organic wastes, poultry manure (S_7) recorded significantly higher shoot and root dry weight (71.43 and 15.42 g plant^{-1}, respectively) followed by pressmud (S_3) (70.51 and 15.26 g plant^{-1}, respectively). Significantly lower biomass yield (47.99 and 11.53 g plant^{-1}, respectively) was recorded with application of NPK alone. Increase in biomass yield could be attributed to direct or indirect effects of HA on plant growth and development. Humic acid stimulates root growth and affects root morphology by exudation of organic acid, which leads to increase in nutrient uptake and consequently improves the growth of crop (Canellas *et al.,* 2008). However higher nitrogen (6.07 %) recorded in HA of poultry manure (S_7) also correlated for higher biomass yield compared to other sources.

Application of HA resulted in positive effect interms of increasing the nutrient content and uptake by root and shoot of maize. Higher concentration of N (0.82 and 1.80 % in root and shoot respectively), P (0.18 and 0.57 %) and K (0.99 and 2.11 %) was recorded in HA extracted from poultry manure (S_7). However, lower concentration of N (0.60 and 1.08 %), P (0.09 and 0.38 %) and K (0.73 and 1.56 %) was recorded in treatment receiving NPK alone.

Wide variation in nutrient content and uptake was associated with different sources and levels of HA application. Generally uptake increased with increasing levels of HA (Fig 1, 2 and 3). Application of HA @ 90 kg ha^{-1} resulted in increased nutrient uptake (61.64, 18.10 and 69.94 kg NPK ha^{-1}, respectively). Increased uptake of nutrients with application of higher level of HA may be due to the fact that humic substances stimulates higher microbiological activity (May hew, 2004) and thereby enhances nutrient uptake and also biomass yield.

Soil analysis (after crop harvest) indicated that soil NPK content significantly increased with the different levels and sources of HA application (Table III). Among the different levels of HA, application of HA @ 90 kg ha^{-1} resulted in significantly higher concentration of NPK in soil, (6.38, 13.5 and 4.92 % more NPK) compared to initial value. Similar results were also reported by Sharif *et al,* (2002). Among the different sources of HA higher available N content (314.84 kg ha^{-1}) of soil was observed in treatment receiving HA from poultry manure (S_7) and was probably due to high N content. Vaughan and Ord (1991) found that inhibition of urease activity by humic acid led to reduced N losses thereby increased N concentration in soil. The available P content of soil has increased significantly with different sources of HA and build up of soil P (104.45 kg ha^{-1}) was observed @ 90 kg ha^{-1}. Humic acid has the ability to reduce P

TABLE I

Elemental composition and molar ratio's of humic acid (HA) extracted from different organic wastes

Sources		Contents of elements (%)				Molar ratios elements		
		C	N	H	O	H/C	N/C	O/C
S_1	Coco peat	50.91	3.05	5.8	40.24	0.11	0.06	0.79
S_2	Coffee pulp	47.1	5.07	4.40	43.43	0.09	0.11	0.92
S_3	Pressmud	46.4	5.37	4.35	43.88	0.09	0.12	0.95
S_4	Biofuel waste	61.04	3.01	8.89	27.06	0.15	0.05	0.44
S_5	Distillery bio compost	48.48	4.09	4.91	42.52	0.10	0.08	0.88
S_6	Sludge	40.35	2.95	4.39	52.31	0.11	0.07	1.30
S_7	Poultry manure	45.06	6.01	4.08	44.85	0.09	0.13	0.99
S_8	Vermi compost	44.54	2.84	5.06	47.56	0.11	0.06	1.07
S_9	Urban compost	46.57	4.95	4.39	44.09	0.09	0.11	0.95
S_{10}	FYM	40.02	2.32	5.47	52.19	0.14	0.06	1.30

TABLE II

Influence of different sources and levels of humic acid application on dry matter yield (g plant^{-1}) of maize after 60 DAS

Treatments (Humic acid sources)	Contents of elements (%)				Root dry weight (g plant^{-1})			
	L_1	L_2	L_3		L_1	L_2	L_3	
S_1	54.28	64.42	66.45	61.72	12.64	14.62	14.82	14.03
S_2	61.00	73.27	75.39	69.89	13.63	15.75	15.94	15.11
S_3	61.33	74	76.19	70.51	13.7	15.96	16.11	15.26
S_4	53.36	62.87	65.13	60.46	12.32	14.18	14.48	13.66
S_5	54.71	65.88	68.32	62.97	12.7	14.87	15.02	14.19
S_6	54.09	64.5	67	61.86	12.65	14.67	14.91	14.08
S_7	61.97	74.25	78.07	71.43	13.83	16.01	16.4	15.42
S_8	54.51	64.75	66.83	62.03	12.65	14.39	14.9	13.98
S_9	60.30	72.54	75.17	69.34	13.6	15.74	15.93	15.09
S_{10}	54.07	63.92	65.98	61.33	12.59	14.57	14.72	13.96
Mean L	56.96	68.04	70.45	-	13.03	15.08	15.32	-
	S.Em.+	CD (p=0.05)	-		S.Em.+	CD (p=0.05)	-	-
L	1.00	2.84	-	-	0.16	0.45	-	-
S	1.83	5.18	-	-	0.29	0.82	-	-
L X S	3.17	NS	-	-	0.5	NS	-	-
NPK only	47.99	-	-	-	11.53	-	-	-
NPK + FYM	59.37	-	-	-	13.46	-	-	-

L= Levels, S= sources, L_1=30 kg Humic acid, L_2=60 Kg Humic acid, L_3=90 Kg Humic acid

S_1= Coco peat, S_2= Coffee pulp, S_3= Pressmud, S_4= Biofuel waste, S_5= Distillery bio compost, S_6= Sewage sludge, S_7= Poultry manure, S_8= Vermi compost, S_9= urban compost and S_{10}= Farmyard manure

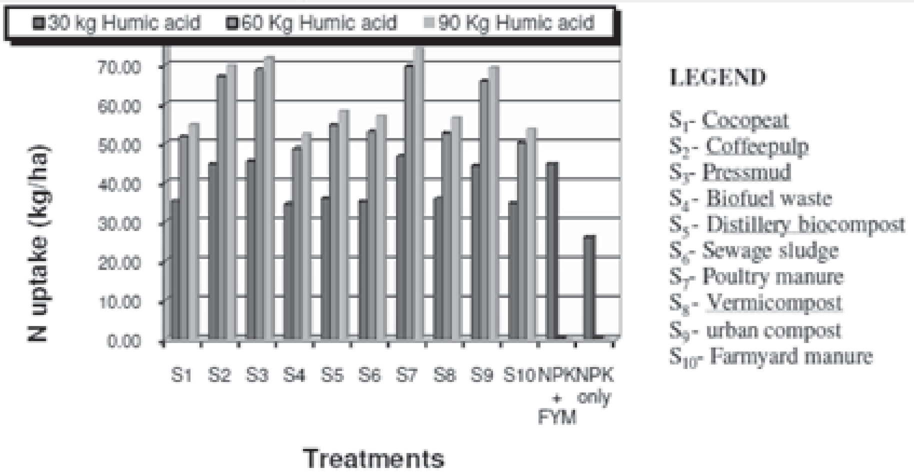

Fig. 1 : N uptake (kg/ha by maize as influenced by different levels and sources of humic acidn extracted from

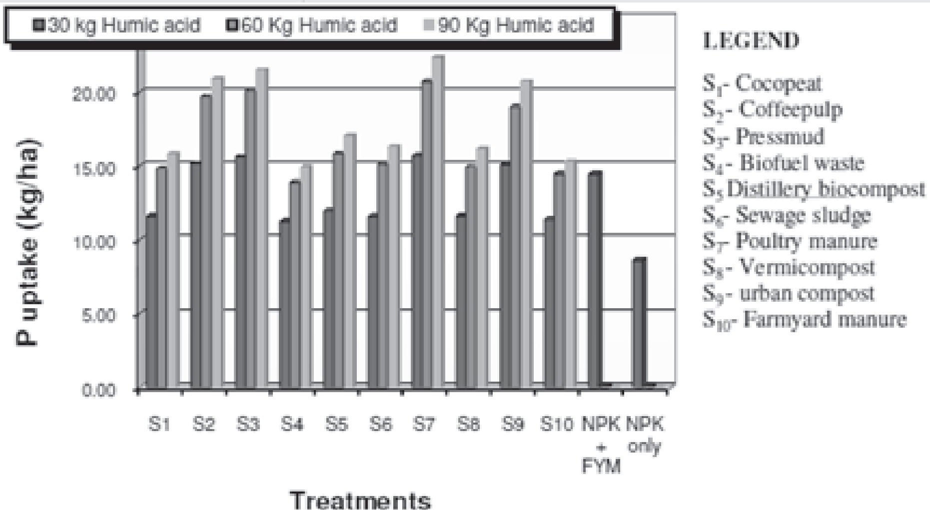

Fig. 2 : P uptake (kg/ha by maize as influenced by different levels and sources of humic acidn extracted

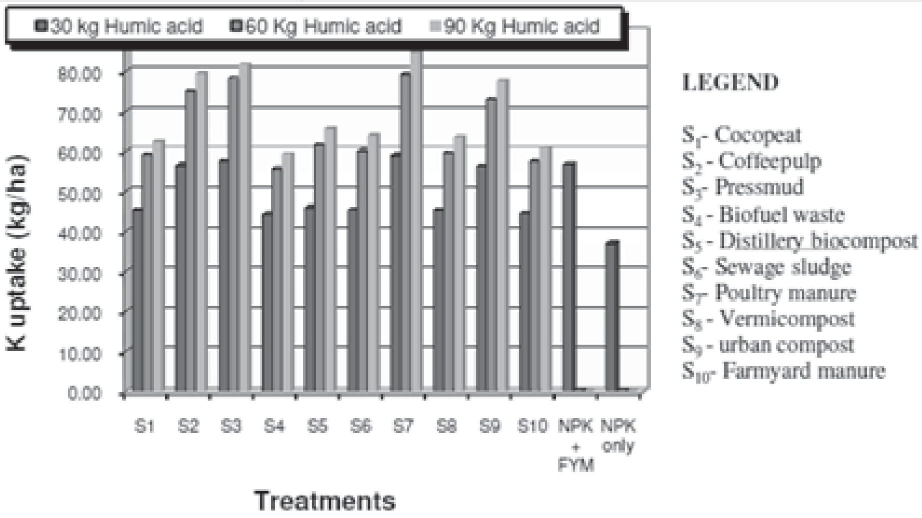

Fig. 3 : K uptake (kg/ha by maize as influenced by different levels and sources of humic acidn extracted

TABLE III

Available major nutrient status (kg ha^{-1}) of soil after harvest of maize as influenced by different sources and levels of humic acid (HA) application

Treatments (Humic acid sources)	N				P_2O_5				K_2O			
	L_1	L_2	L_3		L_1	L_2	L_3		L_1	L_2	L_3	
	30	60	90	Mean S	30	60	90	Mean S	30	60	90	Mean S
S1	302	306.07	310.7	306.26	92.83	95.64	102.17	96.88	286.63	289.48	296.15	290.75
S2	305.53	310.63	316.5	310.89	98.14	101.84	110.65	103.54	292.83	296.12	303.76	297.57
S3	306.2	311.47	317.1	311.59	98.28	102.1	111.03	103.8	293.38	296.86	305	298.42
S4	300.53	305.27	309.87	305.22	90.44	93.61	100.97	95.01	284.73	287.61	294.59	288.98
S5	302.9	307.4	311.83	307.38	94.15	97.38	104.92	98.81	287.73	290.95	297.89	292.19
S6	300.57	305.63	309.77	305.32	93.62	96.9	103.76	98.09	286.2	289.28	296.18	290.55
S7	308.8	314.53	321.2	314.84	99.16	102.9	111.3	104.45	294.37	297.83	306.26	299.48
S8	300.78	305.27	308.43	304.83	93.05	95.85	102.14	97.01	286.57	289.41	296.08	290.69
S9	305.87	310.17	316.03	310.69	98.52	101.73	109.79	103.35	292.63	295.66	303.06	297.12
S10	300.5	304.58	308.5	304.53	92.16	94.88	101.44	96.16	285.73	288.54	295.26	289.85
Mean L	303.37	308.1	312.99	-	95.03	98.28	105.82	-	289.08	292.17	299.43	-
	S.Em.+	CD(p=0.05)	-	-	S.Em.+	CD(p=0.05)	-	-	S.Em.+	CD(p=0.05)	-	-
L	0.87	2.45	-	-	0.81	2.3		-	0.89	2.52	-	-
S	1.58	4.47	-	-	1.48	4.2	-	-	1.63	4.6	-	-
L X S	2.74	NS	-	-	2.57	NS	-	-	2.82	NS	-	-
NPK only	271.01	-	-	-	87.28	-	-	-	276.85	-	-	-
NPK+ FYM	304.84	-	-	-	98.42	-	-	-	292.2	-	-	-

L= Levels, S= sources, L_1=30 kg Humic acid, L_2=60 Kg Humic acid, L_3=90 Kg Humic acid

S_1= Coco peat, S_2 = Coffee pulp, S_3= Pressmud, S_4 = Biofuel waste, S_5 = Distillery bio compost, S_6= Sewage sludge, S_7= Poultry manure, S8 = Vermi compost, S_9 = urban compost and S_{10}= Farmyard manure fixation and solubilize insoluble P there by resulted in increasing P concentration in soil (Sibanda & Young, 1986). Similarly, increased soil available K (299.48 kg ha^{-1}) observed in this study may be attributed to the reduced K fixation as well as release of fixed K by humic acid (Chenghua *et al,* 2005).

The study clearly indicates that HA extracted from poultry manure (S_7) was found to be superior compared to HA extracted from other organic wastes. Among the different levels of HA, application @ 90 kg ha^{-1} was found to be superior and was on par with application @ 60 kg ha^{-1} followed by 30 kg ha^{-1}. However there was a build up in soil nutrient status with increase in the levels of HA application upto 90 kg ha^{-1} and thereby resulted in increased biomass yield and nutrient uptake.

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