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Studies on the effect of greengram to potassium humate on soil fertilit

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Abstract: Field experiments conducted using potassium with greengram revealed the beneficial effect of potassium humate in enhancing the availability of nutrients to the plants. The treatments S_6 (30 kg ha^{-1}) at M_2 (Recommended dose of fertilizer) registered the highest carbon content of 0.53% in greengram with 9% percent more over the RDF (0.44%). Soil application of humic acid along with RDF exhibited a distinct improvement in the available N, P and K over RDF alone. The availability of secondary nutrients and micronutrients were also favourably influenced by the conjoint application of humic acid and mineral fertilizers.

Key words : Greengram, Potassium humate, Nutrients, Availability.

Introduction

A soil fairly rich in organic matter status will retain most of the residual nutrients and in due course inherent fertility of the soil will be built up appreciably. Organic manures addition will build up the organic matter. Although organic manures contain the plant nutrients in small amounts as compared to the fertilizers, the presence of growth promoting principles like enzymes and hormones besides plant nutrients make them essential for improving soil fertility and increasing crop yields. In recent times, the use of organic manures in crop production is meagre due to their low availability. Humic acid, an innovative product rich in organic form of nutrients developed from lignite is potassium humate. The present study aims to investigate the beneficial effect of pottasium humate to greengram in respect of availability of nutrients.

Materials and Methods

The field experiment was conducted at Sundapalayam village of Coimbatore district on Alfisol (Typic Haplustalf) of Somayanur series to evaluate the efficacy of different levels of humic acid with and without fertilizers on greengram var. Vamban GG2 during March-May, 2001. There were three main plot treatments namely no fertilizers (M_1), recommended dose of N and P (M_2) as fertilizers @ 25 and 50 kg ha^{-1} respectively (RDF) and 75 per cent dose of N and P (M_3) and seven sub plot treatments namely no humic acid, 0.1% foliar spray, 1% seed soaking and soil applicatio of 10, 20, 30 and 40 kg humic cid per hectare designated as S_1, S_2, S_3, S_4, S_5, S_6 and S respectively. The crop was grown to maturity The soil samples were collected at the vegetative flowering and post-harvest stages. The availability of major nutrients was assessed for the three stages of crop growth, while the content of secondary and micronutrients were estimated at harvest stage. The data were subjected to statistical scrutiny (Sukhatme and Amble, 1985).

Results and Discussion

Organic carbon (Table 1)

The organic carbon content of the soil was significantly increased by soil application of humic acid upto 30 kg ha^{-1} (0.45%) and beyond that there was no further improvement. The effect of humic acid was well pronounced in plots applied with mineral fertilizer N and P. The increase due to seed soaking (1.0%) and foliar spray (0.1%) was significantly higher than control but not as high as soil application of humic acid. The increased microbial activity on the large quantities of the left over crop residues might have led to the build up of organic carbon content in the fertilizer treated plots. The results of Hasmot Saikh (1999) revealed that the regions with high humic acid content recorded higher organic carbon status. This supports the resuls of the present study.

Application of humic acid beyond 30 kg ha^{-1} could not improve further the organic

Table 1. Effect of humic acid and fertilizers on the organic carbon status of soil (%)

Treatments	Organic carbon			
	M_1	M_2	M_3	Mean
S_1	0.22	0.35	0.31	0.29
S_2	0.26	0.41	0.32	0.33
S_3	0.29	0.38	0.35	0.34
S_4	0.33	0.43	0.38	0.38
S_5	0.33	0.46	0.46	0.41
S_6	0.36	0.53	0.53	0.45
S_7	0.38	0.52	0.52	0.45
Mean	0.31	0.44	0.39	
CD (P=0.05)				
M	0.01			
S	0.01			
MxS	0.02			
SxM	0.02			

carbon content. The increased microbial population observed at 40 kg ha^{-1} humic acid level as compared to the lower levels in the present study would have utilized more of carbon and thus arresting any further accumulation of organic carbon.

Nutrient availability

Major nutrients (Table 2a, 2b, 2c)

Nitrogen, phosphorus and potassium availability was the highest in the plots receiving 100% RDF as against no fertilizer and 75% RDF. With regard to humic acid treatments, the availability increased gradually with increase in the levels of humic acid applied. The treatment M_2S_7 recorded the highest value of 258, 31.6 and 420 kg ha^{-1} for available N, P and K respectively. The increase in the available nitrogen might be due to the nature of humic substances to slow down the urease activity (Gonzalez *et al.* 1992) and also to inhibit the nitrification processes, thereby preventing the loss of N through major avenues such as leaching and volatilization. The increase in available nitrogen could be ascribed to the addition of N from mineralization of native N on account of enhanced microbial activity.

The increase in available P with increase in the amount of humic acid added might be due to the composite effect of several processes occurring at various levels of decomposition and humification as well as to the competition of humic acid for anion exchange sites thereby preventing the fixation of H_2PO_4 ion in the soil (Satishkumar, 1997). Humic acid from lignite added to soils might dissolve the phosphorus fixed by soils in the form of insoluble phosphates such as tricalcium phosphate and fluorapatite, thus making them slow contributing P fertilizer (Martinez *et al.* 1984).

Despite no addition of K through mineral fertilizer the available K content of the soil was found to be significantly high. The mineral N applied would have paved way for the occurrence of ammonium ions in large amounts which in turn would have resulted in the release of K from clay complex *via* exchange. There is possibility for the release of K from the mineals, as a result of reaction of soil particles with humic acid (Tan, 1980). Samiullah Khan *et al.* (1997) reported the possibility of increase of major nutrients because of the stimulating effect of humic acid on the microbial activities.

The vegetative stage recorded the highest value and thereafter decreased as the crop advanced to harvest. This might be due to the continuous absorption, assimilation and metabolism of nutrients, causing a reduction in its availability.

Table 2a. Effect of humic acid and fertilizers on available nitrogen status of soil (kg ha^{-1})

Treatments	Vegetative stage				Flowering stage				Post harvest			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	237	242	241	240	230	239	234	234	221	225	225	224
S_2	239	246	243	242	233	242	236	237	222	232	229	228
S_3	242	247	241	243	234	243	241	240	223	232	231	229
S_4	247	249	245	247	237	247	242	240	230	235	235	233
S_5	253	254	253	253	238	249	251	246	233	240	237	237
S_6	256	259	255	256	242	253	246	247	235	241	240	239
S_7	252	264	259	258	244	256	254	251	236	244	242	241
Mean	247	251	248		237	247	243		229	236	234	
CD (P=0.05)												
M		0.6				0.9				0.6		
S		0.8				0.6				0.5		
MxS		1.4				1.3				1.0		
SxM		1.4				1.1				0.9		

Table 2b. Effect of humic acid and fertilizers on available phosphorus status of soil (kg ha^{-1})

Treatments	Vegetative stage				Flowering stage				Post harvest			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	19.7	28.3	23.3	23.8	16.7	25.7	20.7	21.0	14.0	23.7	19.0	18.9
S_2	21.7	29.3	25.3	25.4	18.7	26.0	22.7	22.4	15.3	25.0	20.7	20.3
S_3	21.3	29.3	27.0	25.9	18.0	26.7	23.3	22.7	15.7	25.0	20.3	20.3
S_4	25.3	31.3	29.3	28.7	22.7	28.7	26.0	25.8	18.0	27.3	24.3	23.2
S_5	27.3	30.7	30.0	29.3	23.7	28.3	26.3	26.1	20.7	28.0	26.7	25.1
S_6	27.7	31.7	30.7	30.0	24.3	29.7	27.3	27.1	21.0	28.3	26.3	25.2
S_7	29.0	34.0	31.7	31.6	26.0	30.7	28.7	28.4	21.7	28.0	26.0	25.2
Mean	24.6	30.7	28.2		21.4	28.0	25.0		18.0	26.5	23.3	
CD (P=0.05)												
M		0.9				0.7				1.0		
S		0.9				0.6				0.7		
MxS		1.6				1.2				1.5		
SxM		1.5				1.0				1.2		

Secondary nutrients (Table 3)

The effect of humic acid on the increase of secondary nutrients was well pronounced. The treatment M_2S_7 recorded the highest value of exchangeable calcium (0.23%) and magnesium (0.09%). This increase might be attributed to the capability of humic substances in chelating these ions and retaining them in the exchangeable form. The very high ion exchange capacities of humates might have transformed the nutrients to available form. Foliar spray of humic acid was found to produce similar effect as that of soil application.

Marked increase in the availability of secondary nutrients due to humic acid application was in line with the finding of Gopalswamy (1970) who reported the positive effect of N

Table 2c. Effect of humic acid and fertilizers on available potassium status of soil (kg ha^{-1})

Treatments	Vegetative stage				Flowering stage				Post harvest			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	323	353	340	338	246	316	280	281	190	203	196	196
S_2	356	390	363	370	263	323	303	296	210	230	226	222
S_3	356	403	386	382	266	320	310	298	186	240	226	217
S_4	373	410	390	391	266	336	310	304	230	296	236	241
S_5	383	413	390	395	276	343	313	311	240	276	256	257
S_6	403	436	403	414	303	343	316	321	253	290	233	258
S_7	396	440	423	420	310	346	340	332	256	293	276	275
Mean	370	406	385		275	332	310		223	255	236	
CD (P=0.05)												
M		5				9				4		
S		6				6				6		
MxS		11				13				11		
SxM		10				11				11		

Table 3. Effect of humic acid and fertilizers on exchangeable calcium and magnesium status of soil (%)

Treatments	Calcium content				Magnesium content			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	0.12	0.18	0.15	0.15	0.02	0.06	0.03	0.04
S_2	0.15	0.18	0.16	0.16	0.03	0.08	0.04	0.05
S_3	0.15	0.20	0.16	0.17	0.04	0.06	0.06	0.05
S_4	0.18	0.21	0.18	0.19	0.04	0.08	0.06	0.07
S_5	0.16	0.21	0.18	0.18	0.07	0.07	0.05	0.06
S_6	0.18	0.21	0.19	0.19	0.08	0.08	0.07	0.07
S_7	0.18	0.23	0.20	0.20	0.09	0.09	0.07	0.07
Mean	0.16	0.20	0.17		0.07	0.07	0.05	
CD (P=0.05)								
M		0.01				0.01		
S		0.01				0.01		
MxS		0.01				0.01		
SxM		0.01				0.01		

in influencing the calcium availability. It may be ascribed that the nitrogen addition would increase the concentration of ammonium ions which eventually would displace calcium ions from their lattice position to the solution phase thereby causing an increase of calcium ions in soil solution.

Micro nutrients (Table 4a, 4b)

The micronutrients are of direct importance in enzymatic reactions, at times play an indirect role by substituting for, or by releasing elements that are more essential. Regarding the availability of micronutrients, the fertilizer applied plots showed significant increase in their availability

Table 4a. Effect of humic acid and fertilizers on iron and zinc status of the soil (ppm)

Treatments	Iron content				Zinc content			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	0.48	0.66	0.58	0.57	1.31	1.49	1.40	1.40
S_2	0.56	0.74	0.67	0.66	1.47	1.68	1.64	1.59
S_3	0.56	0.73	0.69	0.66	1.38	1.62	1.50	1.50
S_4	0.78	0.96	0.86	0.87	1.64	2.54	2.18	2.12
S_5	0.91	1.03	0.94	0.96	1.77	2.55	2.32	2.21
S_6	0.96	1.13	1.05	1.04	1.93	2.63	2.38	2.31
S_7	0.94	1.15	1.03	1.04	1.92	2.70	2.50	2.37
Mean	0.74	0.92	0.83		1.63	2.17	1.99	
CD (P=0.05)								
M		0.04				0.03		
S		0.03				0.03		
MxS		0.06				0.06		
SxM		0.06				0.06		

Table 4b. Effect of humic acid and fertilizers on copper and manganese status of the soil (ppm)

Treatments	Copper content				Manganese content			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	1.43	1.53	1.47	1.48	2.12	3.14	2.81	2.69
S_2	1.42	1.53	1.48	1.48	2.27	3.29	3.13	2.90
S_3	1.47	1.48	1.48	1.48	2.71	3.93	3.60	3.42
S_4	1.50	1.62	1.57	1.56	3.34	4.43	3.80	3.85
S_5	1.58	1.66	1.64	1.63	3.50	4.72	3.91	4.04
S_6	1.62	1.66	1.55	1.61	4.21	5.28	4.85	4.78
S_7	1.66	1.69	1.68	1.68	4.83	5.81	5.52	5.39
Mean	1.51	1.60	1.55		3.28	4.37	3.95	
CD (P=0.05)								
M		0.04				0.02		
S		0.03				0.05		
MxS		0.06				0.09		
SxM		0.05				0.09		

when compared to no fertilizer (control). The available micronutrients (Zn, Cu, Mn and Fe) increased with increase in the amount of humic acid added. The treatment M_2S_7 recorded the highest value of 1.15, 2.7, 1.69 and 5.81 ppm of Fe, Zn, Cu and Mn. The increased availability might be attributed to the ability of humic substances to form chelating compounds (Elgala *et al.* 1978). These chelates are not precipitated and are in available form in soil (Shanmugam *et al.* 1989). The combined application of humic acid and fertilizers showed positive effect on available Fe and the reason would be related to the ability of the urea coated with humic acid to form complexes with metals particularly Fe and its further release on dissolution. This result was in line with that suggested by Banerjee and Basak (1978).

Application of N and P through mineral fertilizers had pronounced effect on enhancing the nutrient availability of soil. Addition of humic acid showed complementary effect on added mineral N. It would be infered that 100 per cent RDF with 40 kg ha^{-1} humic acid would be the best combination for maintaining the soil fertility as well as to meet the nutrient requirement of the crop. The seed soaking and foliar spray was better than control but the increase was not appreciable as compared to soil application treatments.

References

Banerjee, S.K. and Basak, R.K. (1978). Studies on ammonia and urea treated humic substances and their interaction with some heavy metal ions. *J. Indian Soc. Soil Sci.* **26**: 347-351.

Elgala, A.M., Metwally, A.I. and Khalil, R.A. (1978). The effect of humic acid and Na_2 EDDHA on the uptake of Cu, Fe and Zn by barley in sand culture. *Pl. Soil*, **49**: 41-48.

Gonzalez, C., Alvarez, R. and Coca, J. (1992). Waste kraft black liquors as raw material for the production of nitrogeneous humic fertilizers by an oxidation-ammoniation process. *Fert. Res.* **33**: 279-285.

Gopalswamy, A. (1970). Influence of fertilizer nitrogen on soil nutrients and on response of certain high yielding paddy strains in soils of Tamil Nadu. *M.Sc. (Ag.) Thesis*, Dissertation submitted to and approved by Madras University.

Hasmot Saikh (1999). Characterization of soil organic matter of some forest and cultivated soils of simlipal national park (Orissa). *J. Indian Soc. Soil Sci.* **47**: 542-544.

Martinez, M.T., Romero, C. and Gavilan, J.M. (1984). Solubilization of phosphorus by humic acids from lignite. *Soil Sci.* **138**: 257-261.

Samiullah Khan, M.A., Qureshi, Jaibir Singh and Ghzala Praveen (1997). Influence of Ni-(II) and Cr (III) humic acid (HA) complexes on major nutrients (NPK) status of the soil. *Indian J. Agric. Chem.* **30**: 1-5.

Satishkumar, B. (1997). Extraction and characterization of humic acids and their effect on the performance of soybean. *M.Sc.(Ag.)* Thesis, Annamalai University, Tamil Nadu, India.

Shanmugam, T., Aruljothi, M. and John, A.I. (1989). Preparation of micronutrients with lignite feed stocks. Proc. of National Seminar on "Humus Acids in Agriculture", Annamalai University. pp.303-307.

Sukhatme, P.V. and Amble, V.N. (1985). Statistical methods for agricultural workers. Rev. (Edn.) ICAR, New Delhi.

Tan, K.H. (1980). The release of silicon, aluminium, and potassium during decomposition of soil minerals by humic acid. *Soil Sci.* **129**: 5-11.

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