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EFFECTS OF POTASSIUM HUMATE AND CHEMICAL FERTILIZERS ON GROWTH, YIELD AND QUALITY OF RICE (*ORYZA SATIVA* L.)

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*Key words***:** Rice, Potassium humate, Chemical fertilizers, Growth, Yield and Quality

Abstract

A pot experiment was conducted in *Kharif* 2009 and 2010 to study the effect of potassium humate and chemical fertilizers on growth and yield attributes of rice (O*ryza sativa* L). Potassium humate was applied at the rate of 0, 5 and 10 mg/kg soil along with 100 and 75% recommended dose of fertilizers NPK (60, 30, 30 mg/kg) and 12.5 mg/kg zinc sulphate was also applied. Addition of 10 mg/kg PH along with 100% NPK fertilizers and 12.5 mg/kg zinc sulphate caused significant increase in plant height, number of tillers, panicle height, panicle length, test weight, straw yield and yield of rice as compared to 100 and 75% NPK alone.

Introduction

The restoration or maintenance of soil fertility is mainly dependant on the organic matter content of the soil. The integrated use of organic sources and inorganic fertilizers is promising for achieving sustainable productivity over a longer period under intensive cropping, besides maintaining a satisfactory nutrient turnover in soil-plant system.

Application of humic acids (HA) in agriculture as fertilizer and soil conditioner was tried on limited scale. Significant impacts of humic substances (HS) on soil structure and plant growth was reported (Fong *et al.* 2007, El-Razek *et al.* 2012, Ihsanullah and Bakhashwain 2013). Humic preparations are increasingly being applied as stimulators in plant breeding. HA in proper concentrations can enhance plant and root growth (Ahmed *et al.* 2013). Considering the potential of HA in agriculture various commercial humic acid based products were developed and these are widely marketed. The HA products are usually available in the form of inexpensive soluble salts, referred to as potassium humate (Fong *et al.* 2007).

Potassium humate is a highly concentrated form of humus in the naturally occurring lignite which is the brown coal that accompanies coal deposits. It is a peat material that has not been subjected to high pressures to turn it into coal, and from this potassium humate is produced. Reports on the utilization of humic acid in cereals crops are rare. Hence the effect of humic acid along with chemical fertilizers on growth, yield and quality of rice was investigated.

Material and Methods

A two year replicated experiment during 2009 and 2010 *kharif* seasons was conducted in net house of the Department of Soil Science and Agricultural Chemistry, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, India to evaluate the effect of potassium humate and chemical fertilizers on growth and yield attributes of rice. The experiment was arranged in factorial completely randomized design with three replications. Potassium humate was applied in soil at the rate of 5.0 and 10.0 mg/kg soil along with 100 and 75% recommended doses of fertilizers NPK (60, 30, 30 mg/kg) and 12.5 mg/kg zinc sulphate was also used. Bulk surface soil

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sample was collected from the research farm of the Institute. After collecting the soil, it was grounded and passed through 2.0 mm sieve and 8 kg of processed soil was filled in each polythene lined pot. Soil was puddled and 5 seedlings of rice (variety Malviya 36) transplanted in each pot. After establishment four plants were maintained. Potassium humate used for experimentation contained 70% humic acid and 10% potassium with 95% solubility. Soil collected from research farm for pot experiment was analysed for various physic-chemical properties. pH (7.9) and EC (0.211), organic carbon (0.43%), available N (185 kg/ha, available, P (17.25 kg/ha), available K (198.85 kg/ha) and available S (10.24 kg/ha) was analysed by standard procedure. The height of plant and number of tillers was recorded at tillering, panicle initiation and harvesting stages. At physiological maturity stage, the plants were harvested and grain yield pot^{-1} was recorded after harvesting of crop. All obtained data from experiment was statistically analyzed according to factorial CRD design. (Gomaz and Gomaz 1984).

Result and Discussion

Plant height was significantly higher under recommended dose of fertilizers (RDF) 100% over $RDF_{75\%}$ during all the growth stages in both the years of experimentation (Table 1). In potassium humate treatment, application of 10 mg/kg potassium humate (PH_{10}) recorded maximum plant height (113.18 in first year and 116 cm in second year) during tillering, panicle initiation and harvesting stages of rice. Similarly HA induced stimulation of plant growth were reported by Chen and Aviad 1990 and Arancon *et al.* 2002). These substances can have a direct effect through absorption of humic compounds by the plant and thus affecting the enzyme activities and membrane permeability (Nardi *et al.* 2002). Interaction effect of potassium humate with RDF and zinc was non-significant in plant height in both seasons.

Application of potassium humate (PH_{10}) resulted in a significantly increase in number of tillers/pot at tillering (22.05 tillers), panicle initiation (18.91 tillers) and harvesting stage (17.95 tillers) as compared to PH_0 (Table 1). It was reported that the application of humic acid increased the synthesis and activity of IAA, which played a significant role in promoting the plant growth. Mohammadipour, (2012) showed that the application of humic acid improved the plant growth parameters.

Panicle length is a very important parameter because of its association with other important yield components such as number of grains and 1000 grain weight. Potassium humate significantly affected panicle length at PH_{10} in both the years (Table 2). Bama and Selvakumari (2005) also reported that application of potassium humate @ 20 kg/ha recorded higher panicle length of rice crop. Panicle length was also increased significantly following application of 12.5 mg/kg zinc sulphate ($Zn_{12.5}$) over 0 mg/kg zinc sulphate (Zn_0) during the both the years of experimentation (Table 2). These results are in line with the findings of Maqsood *et al.* (1999) who reported that adequate supply of zinc to rice increased its panicle length. Interaction of potassium humate with RDF and zinc was found to be non-significant.

Application of 100% RDF recorded significantly higher 1000 grain weight over 75% RDF during both the years (Table 2). Significant effect of NPK fertilizer levels on 1000 grain weight was also reported by Ali *et al.* (2000). Among the humic acid treatments, (PH_{10}) produced highest mean value of 1000 grain weight 19.22 g during first year and 20.42 g during second year whereas lowest value was obtained by treatment PH_0. Patil *et al.* (2011) reported that yield characters were significantly affected by application of potassium humate. The interaction effect of RDF and potassium humate was found to be non-significant on test weight during both the years of experimentation.

Table 1. Effects of potassium humate and chemical fertilizers on plant height and number of tillers at various growth stages of rice.

Treatments	Plant height (cm)						Number of tillers per pots					
	Tillering (40 DAT)		Panicle initiation (70 DAT)		Harvesting (105 DAT)		Tillering (40 DAT)		Panicle initiation (70 DAT)		Harvesting (105 DAT)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Factor I RDF (%)												
RDF_{75}	108.95	111.11	131.55	132.79	132.52	134.28	19.56	21.56	17.04	18.64	16.05	17.22
RDF_{100}	111.25	115.69	135.38	136.59	136.69	138.18	21.49	23.17	18.52	19.26	17.72	17.86
SEm±	0.78	1.07	0.94	1.27	0.95	1.29	0.19	0.26	0.17	0.18	0.16	0.21
LSD (p = 0.05)	2.27	3.12	2.76	3.71	2.78	3.75	0.57	0.77	0.49	0.52	0.47	0.60
Factor II potassium humate (mg/kg)												
PH_0	107.36	109.79	128.48	131.38	128.90	132.28	19.60	22.00	16.74	17.63	16.08	16.92
PH_5	109.77	113.84	133.96	134.41	135.00	136.31	19.92	21.58	17.68	18.91	16.62	17.08
PH_{10}	113.18	116.58	137.95	138.28	139.91	140.10	22.05	23.50	18.91	20.31	17.95	18.62
SEm±	0.95	1.31	1.16	1.56	1.17	1.57	0.24	0.32	0.21	0.22	0.20	0.25
LSD (p = 0.05)	2.78	3.83	3.38	4.54	3.41	4.59	0.69	0.94	0.60	0.64	0.57	0.74
Factor III zinc sulphate (mg/kg)												
Zn_0	108.88	111.27	131.57	132.56	132.58	133.96	19.55	21.33	17.51	18.43	16.55	17.17
$Zn_{12.5}$	111.32	115.54	135.35	136.81	136.63	138.50	21.50	23.39	18.04	19.47	17.22	17.91
SEm±	0.78	1.07	0.94	1.27	0.95	1.29	0.19	0.26	0.17	0.18	0.16	0.21
LSD (p = 0.05)	2.27	3.12	2.76	3.71	2.78	3.75	0.57	0.77	0.49	0.52	0.47	0.60
Interaction	NS											

NS=Non-significant, RDF = Recommended doses of fertilizer (60 : 30 : 30 mg/kg corresponding to 120, 60, and 60 kg/ha of N, P_2O_5 and K_2O, respectively), PH = Potassium humate.

Table 2. Effects of potassium humate and chemical fertilizers on yields attributes of rice.

Treatment	Panicle length (cm)		Test weight (g)		Straw yield (g/pot)		Grain yield (g/pot)		Harvest index (%)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
Factor I RDF (%)										
RDF_{75}	23.89	24.41	17.93	18.49	48.59	49.32	35.94	36.97	42.39	42.68
RDF_{100}	24.67	25.18	18.68	19.51	51.03	52.09	40.84	42.13	44.47	44.69
SEm±	0.23	0.23	0.13	0.18	0.47	0.48	0.37	0.38	0.31	0.41
LSD (p = 0.05)	0.67	0.68	0.38	0.52	1.38	1.40	1.07	1.10	0.90	1.20
Factor II potassium humate (mg/kg)										
PH_0	23.49	23.18	17.48	17.73	43.05	43.60	33.45	33.63	43.63	43.46
PH_5	24.40	24.86	18.21	18.85	50.75	51.81	37.41	38.88	42.37	42.77
PH_{10}	24.94	26.34	19.22	20.42	55.64	56.70	44.31	46.14	44.29	44.82
SEm±	0.28	0.29	0.16	0.22	0.58	0.59	0.45	0.46	0.38	0.50
LSD (p = 0.05)	0.82	0.84	0.46	0.64	1.69	1.72	1.31	1.35	1.10	1.47
Factor III zinc sulphate (mg/kg)										
Zn_0	23.93	24.15	17.95	18.51	48.65	49.56	36.86	37.78	43.07	43.20
$Zn_{12.5}$	24.62	25.44	18.66	19.49	50.98	51.85	39.91	41.32	43.79	44.17
SEm±	0.23	0.23	0.13	0.18	0.47	0.48	0.37	0.38	0.31	0.41
LSD (p = 0.05)	0.67	0.68	0.38	0.52	1.38	1.40	1.07	1.10	NS	NS
Interaction										
RDF × PH	NS	NS	NS	NS	NS	NS	S	S	NS	NS
RDF × Zn	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
PH × Zn	NS	NS	NS	NS	NS	NS	S	S	NS	NS
RDF × PH × Zn	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS=Non-significant, RDF = Recommended doses of fertilizer (60 : 30 : 30 mg/kg corresponding to 120, 60, and 60 kg/ha of N, P_2O_5 and K_2O, respectively), PH = Potassium humate.

Table 3. Interaction effects of potassium humate and chemical fertilizers (RDF × PH) and (PH × Zn) on grain yield.

Treatments	Grain yield (g/pot)											
	2009		Mean	2010		Mean	2009		Mean	2010		Mean
	$RDF_{75\%}$	$RDF_{100\%}$		$RDF_{75\%}$	$RDF_{100\%}$		Zn_0	$Zn_{12.5}$		Zn_0	$Zn_{12.5}$	
PH_0	30.29	36.61	33.45	30.51	36.76	33.63	32.44	34.45	33.45	32.65	34.62	33.63
PH_5	34.59	40.23	37.41	35.36	42.40	38.88	36.38	38.44	37.41	37.64	40.12	38.88
PH_{10}	42.94	45.68	44.31	45.06	47.23	46.14	41.76	46.85	44.31	43.07	49.22	46.14
Mean	35.94	40.84		36.97	42.13		36.86	39.91		37.78	41.32	
RDF × PH	SEm±	LSD		SEm±	LSD	PH × Zn	SEm±	LSD		SEm±	LSD	
	0.63	1.84		0.65	1.90		0.63	1.84		0.65	1.90	

NS = Non-significant, RDF = Recommended doses of fertilizer (60 : 30 : 30 mg/kg corresponding to 120, 60, and 60 kg/ha of N, P_2O_5 and K_2O, respectively), PH = Potassium humate.

In case of application of different rates of humic acid and chemical fertilizers, in rice $RDF_{100\%}$ produced significantly higher mean value of grain yield over $RDF_{75\%}$ (Table 2). Among the potassium humate treatments, the highest grain yield (44.31 mg/kg) was obtained from treatment PH_{10} which was significantly higher than PH_5 and PH_0. Treatment PH_{10} produced 37.19% higher grain yield over PH_0 and 18.67% higher over PH_5. Interaction effect of potassium humate with RDF and zinc was also found to be significant (Table 3). The highest rice grain yield (45.68 g/pot) was obtained from treatment $PH_{10}\times RDF_{100\%}$ fallowed by $PH_{10}\times Zn_{12.5}$ (46.85 g/pot) whereas lowest value of grain yield (30.29 g/pot) was found with the treatment $PH_0\times RDF_{75\%}$ fallowed by $PH_0\times Zn_0$ (32.44 g/pot) (Table 3). Khan and Mir (2002) stated that humic acids derived from Pakistani lignite had a beneficial effect on the growth and yield of wheat. A number of workers have reported that humic amendments increased yields of tomato, cotton, and grape vines (Brownell *et al.* 1987).

Results embodying this paper suggest that humic acid extracted from the huge reserves of lignitic coal in India can be used as a low cost natural fertilizer for improving yields of crop.

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