

## Original Research Article

### Response of Potassium Humate on Yield and Quality of Green Chilli

#### **ABSTRACT**

**Aim :-** In recent trend of organic farming, use of humic substances plays important role, as it act as biostimulants to boost the yield of crop. Humic substances can be easily obtained by locally available organic sources. Hence, three different organic sources viz. FYM, vermicompost, lignite were used for extraction of potassium salt of humic acid. The potassium humate extracted from these three sources were used as foliar application at different concentrations to study their effects on yield and quality of green chilli.

**Study Design:-** Completely Randomized Design with eleven treatments and three replications.

**Place and Duration of the Study:-** The research was conducted in *rabi* 2021 at College of Agriculture, Karad, Maharashtra, India.

**Methodology:-** Three organic sources viz. FYM, vermicompost and lignite were used for extraction of potassium salt of humic acid, with studying the physico-chemical quality parameters of organic sources and characteristics of humic substances namely humic acid and fulvic acid for HA/FA ratio and  $E_4/E_6$  ratio. The pot culture experiment was conducted comprising eleven treatments for the different levels of potassium humate (200 to 600 ppm), extracted from three sources and imposed on transplanted chilli for studying the yield and quality of green chilli, as foliar application at 30 and 45 DAT of chilli with general recommended dose of fertilizer (GRDF).

**Results :-** Among all three sources, the foliar application of potassium humate extracted from good quality vermicompost significantly increased the growth contributing

**Comment [D1]:** It is preferable to amend the title of the manuscript to specify foliar spraying with potassium humate only, as potassium humate can be used in the soil as well, and this was not used in this experiment.

**Comment [D2]:** Usually, the abstract is not divided into paragraphs, but rather includes the place and time of carrying out the experiment, the applied treatments, and the most important results.

**Comment [D3]:** This information is mentioned in the introduction and not in the abstract.

**Comment [D4]:** The study design should be stated in materials and methods.

characters, fresh and dry yield of chilli fruits and stalk yield, as well as significantly improved the ascorbic acid content in fresh green chilli fruits as compared to other concentrations of potassium humate extracted from FYM and lignite. This might be associated with degree of condensation of humic acid, status of aromaticity of the structure of humic acid reflected in higher absorption through foliage of chilli.

**Key words:** Organic sources, potassium humate, green chilli, yield and quality

## 1. INTRODUCTION

Humic substances comprised of the largest fraction of soil organic matter [1] which are most biologically active component of soil. Humic acid possess phytohormones like activities which are beneficial to both soil and plants [2]. Application of humic acid within fairly wide range of concentrations are highly beneficial to plant shoot and root development. They are excellent foliar fertilizer carrier and activators. Foliar application of humic acid are more economic because smaller quantities are required to obtain significant plant response and are rapidly absorbed by plant leaves actively growing plant tissues are more responsive to the foliar application of humic substances. Humic acid as carrier of nutrient uptake have great scope through foliar application for sustainable crop production. The polymerization and condensation of humic substances are associated with good quality organic sources. Hence, three organic sources *viz.* FYM, vermicompost and lignite were studied for their physico chemical properties and quality parameters to extract the humic acid in the form of salt of potassium humate. Considering today's importance of organic sources, their effect as foliar sprays of potassium humate at 30 and 45 days after transplanting on yields and quality as content of ascorbic acid in green chilli fruits were studied.

## 2. MATERIALS AND METHODS

### 2.1 Extraction of potassium humate from different organic sources

Fractionation of humic substances from three organic sources *viz.* FYM, vermicompost and lignite were worked out by using 0.5 M KOH solution, by following modified method [3, 4].

**Comment [D5]:** It would be more useful for the author to expand on the results of researches on the use of potassium humate on the growth and production of many crops globally.

## 2.2 Characterization of humic substances

Potassium salt of humic substances obtained from these three organic sources were analyzed for different physio-chemical quality parameters like pH, EC, C/N ratio, water soluble organic carbon and chemical properties *viz.* total organic carbon, total N, P, K, S and micronutrient cations (Fe, Mn, Zn, Cu), content of HA and FA, E<sub>4</sub>/E<sub>6</sub> ratio of HA and FA, HA/FA ratio by adopting standard methods.

## 2.3 Treatments and Pot culture experimental procedure

The Inceptisol soil collected from College of Agriculture Farm, Karad was used for pot culture study and was analyzed for initial soil properties by following standard method of analysis. The pots were filled with 20 kg soil and general recommended dose of fertilizers (GRDF : FYM @ 20 t ha<sup>-1</sup> + N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O @ 100:50:50 kg ha<sup>-1</sup>) were applied to all treatments except absolute control. The study comprised of eleven treatments (Table 1) with three replications. The one month age chilli seedlings were transplanted in the pots keeping two plants in pots with Completely Randomized Design (CRD) at College of Agriculture, Karad during *rabi* season. Treatment wise concentrations of potassium humate extracted from different organic sources were used for first foliar spray at 30 days after transplanting (DAT) and second foliar spray at 45 DAT. The water spray applied at 30 and 45 days to the treatment T<sub>2</sub>.

**Table 1. Treatment details**

Tr. No.	Treatment details
T <sub>1</sub>	Absolute control (No GRDF + No spray)
T <sub>2</sub>	GRDF + Water sprays
T <sub>3</sub>	GRDF + 200 ppm potassium humate as foliar spray extracted from FYM
T <sub>4</sub>	GRDF + 400 ppm potassium humate as foliar spray extracted from FYM
T <sub>5</sub>	GRDF + 600 ppm potassium humate as foliar spray extracted from FYM
T <sub>6</sub>	GRDF + 200 ppm potassium humate as foliar spray extracted from vermicompost
T <sub>7</sub>	GRDF + 400 ppm potassium humate as foliar spray extracted from vermicompost
T <sub>8</sub>	GRDF + 600 ppm potassium humate as foliar spray extracted from vermicompost

<b>T<sub>9</sub></b>	GRDF + 200 ppm potassium humate as foliar spray extracted from lignite
<b>T<sub>10</sub></b>	GRDF + 400 ppm potassium humate as foliar spray extracted from lignite
<b>T<sub>11</sub></b>	GRDF + 600 ppm potassium humate as foliar spray extracted from lignite

**Note :** i) GRDF - (20 t ha<sup>-1</sup> FYM + 100:50:50 kg ha<sup>-1</sup> N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O)

ii) Two sprays at 30 and 45 days after transplanting

## **2.4 Data collection**

### **2.4.1 Physico chemical properties and quality parameters of organic sources**

Three organic sources used for the extraction of humic acid were analyzed for their physico chemical properties and quality parameters *viz.* pH, EC, water soluble organic carbon and C:N ratio.

### **2.4.2 Nutrient status of organic sources**

The nutrient content of these three organic sources used to extract potassium humate was also studied and the data were recorded.

### **2.4.3 Content and characteristics of humic substances extracted from organic sources**

The content and characteristics of humic substances obtained from these three organic sources *viz.* FYM, vermicompost and lignite were recorded.

### **2.4.4 Yield of fresh green and dry chilli fruits**

Fresh green chilli fruits harvested for six times were used to determine yield of green chilli fruits (g pot<sup>-1</sup>). After complete drying of these fruits, yield of dry chilli fruits were recorded.

### **2.4.5 Fresh and dry straw yield of chilli**

After harvesting of fresh fruits of green chilli at last picking, plants were cut at ground level, straw samples were used to record fresh and dry straw weight.

### **2.4.6 Quality in respect of ascorbic acid content**

After harvesting of fruits, sample from each treatment were used to estimate ascorbic acid by using standard method [5].

## **2.5 Data analysis**

The data regarding fresh and dry fruit yield, fresh and dry stalk yield and ascorbic acid content were tabulated and analyzed statistically by applying standard method [6].

### 3. RESULTS AND DISCUSSION

#### 3.1 Physico chemical properties and quality parameters of organic sources

Three organic sources viz. FYM, vermicompost and lignite collected from different locality were used for extraction of humic substances, analyzed for different physico chemical properties and quality parameters for degree of maturity (Table 2), The physico-chemical properties viz. pH, EC, water soluble organic carbon and C:N ratio considered as quality and

**Table 2. Physico-chemical properties and quality parameters of organic sources**

Sr. No.	Properties	FYM	Vermicompost	Lignite
1	pH (1:10) *	7.4	6.9	5.6
2	EC (dS m <sup>-1</sup> ) * (1:10)	0.4	0.31	0.68
3	Moisture content (%)	29.4	22.6	14.6
4	Ash (%)	35.6	33.33	33.24
5	Total organic carbon (%)	20.3	25.56	30.25
6	Total organic matter (%)	35.00	44.07	52.16
7	Water soluble organic carbon (%) *	0.95	0.76	0.43
8	C/N ratio *	25.06	18	39.80
9	C/P ratio	101.5	28.08	-
10	C/S ratio	61.51	7.26	15.59

\* (Standard Quality parameter properties [7]).

maturity parameters, these parameters were reported and also reviewed by [8] and compared with data reported for these organic sources which reflected the amount of extraction of humic substances. The FYM showed the good quality and maturity for pH (7.4), EC (0.4 dS m<sup>-1</sup>) and water soluble organic carbon (0.95%) but found poor for C:N ratio (25.06) indicated less formation of humic substances. The vermicompost recorded good quality and maturity

**Comment [D6]:** Paragraphs 3.1- 3.2- 3.3- 3.4 must be included in the materials and methods, because they specify the characteristics of the materials used and the soil of the experiment before starting, and they are not results, Attention must be paid to the scientific methodology in writing the manuscript, as this data is used in interpreting the results after spraying with potassium humate extracted from organic sources.

parameters in respect of pH (6.9), EC ( $0.3 \text{ dS m}^{-1}$ ), water soluble organic carbon (0.76 %) and C:N ratio (18.0), while, most widely used organic source as lignite for extraction of humic substances showed poor quality for C:N ratio (39.80%) and pH (5.6) while good quality for the properties like EC ( $0.68 \text{ dS m}^{-1}$ ) and water soluble organic carbon (0.43 %) content. [7, 9, 10] reported similar results for FYM and vermicompost.

### 3.2 Nutrient status of organic sources

The three organic sources were analyzed for nutrient status as macro and micronutrients content and data presented in Table 3 reported that the higher content of all nutrients were noticed for vermicompost followed by FYM and least content in lignite, indicated more mineralization of

**Table 3. Nutrient status of Organic sources**

S.N.	Nutrients content	FYM	Vermicompost	Lignite
<b>1</b>	<b>Macronutrients (%)</b>			
i)	Total N	0.81	1.42	0.76
ii)	Total P	0.2	0.91	Traces
iii)	Total K	0.98	1.27	Traces
iv)	Total S	0.33	0.38	1.94
<b>2</b>	<b>Micronutrients (<math>\text{mg kg}^{-1}</math>)</b>			
i)	Iron	2200	2804	1058
ii)	Manganese	765	800	632
iii)	Zinc	214	246	118
iv)	Copper	157	188	98

vermicompost than the FYM and lignite. In vermicompost the percent content of total N, P, K, S to the tune of 1.42, 0.91, 1.27, 0.38 and micronutrient cations viz. Fe, Mn, Zn and Cu were 2804, 800, 246 and 188  $\text{mg kg}^{-1}$ , respectively. Similar trend of nutrients content was also observed in FYM. While, in lignite total N and total S was observed as 0.76 and 1.94 percent, respectively but the total P and total K content was in traces and micronutrient cations content were also low as compared to vermicompost and FYM organic sources (Table 3). Similar

trends of observations in respect of lignite, FYM and vermicompost was also reported by [11, 12, 8] might be associated with composition of residue and climatic condition with time.

### 3.3 Content and characteristics of humic substances extracted from organic sources

The data pertaining to humic acid and fulvic acid in the form of potassium humate and potassium fulvate by using 0.5 M KOH solution extracted from FYM, vermicompost and lignite are presented in Table 4, revealed that highest humic acid ( $54.27 \text{ g100 g}^{-1} \text{ OM}$ ) extracted from lignite followed by vermicompost ( $13.20 \text{ g100 g}^{-1} \text{ OM}$ ) and least by FYM ( $11.48 \text{ g100 g}^{-1} \text{ OM}$ ) while, fulvic acid content ( $27.62 \text{ g100 g}^{-1} \text{ OM}$ ) found highest due to lignite followed by FYM ( $21.10 \text{ g100 g}^{-1} \text{ OM}$ ) and least in vermicompost ( $18.70 \text{ g100 g}^{-1} \text{ OM}$ ), indicated high degree of humification and polymerization in lignite than the vermicompost and FYM leads the formation of high molecular weight humic substances [13, 11]. While, in respect to vermicompost and FYM the extraction of humic substances were quite low up to 30 percent. These results are in conformity with the findings [1, 12].

**Table 4. Content and characteristics of humic substances extracted from Organic sources**

1.	Humic substances ( $\text{g 100g}^{-1} \text{ OM}$ )	FYM	Vermicompost	Lignite
A	Humic acid (HA)	11.48	13.20	54.27
B	Fulvic acid (FA)	21.10	18.70	27.62
C	HA/FA ratio	0.54	0.70	1.96
2.	<b>E<sub>4</sub>/E<sub>6</sub> ratio</b>			
A	Humic acid	3.17	4.61	5.10
B	Fulvic acid	5.72	6.21	6.33

The HA/FA ratio found higher ( $>1.0$ ) in lignite (1.96) than vermicompost (0.70) and FYM (0.54), but the content of HA+FA found approximately similar in FYM ( $32.58 \text{ g100 g}^{-1} \text{ OM}$ ) and in vermicompost ( $31.90 \text{ g100 g}^{-1} \text{ OM}$ ). The  $E_4/E_6$  (Extinction coefficient) is the important characteristics of humic substances associated with molecular weight and degree of

humification. The humic acid extracted from FYM, vermicompost and lignite recorded  $E_4/E_6$  as 3.17, 4.61 and 5.10 indicated that during humification FYM and vermicompost form high molecular weight substances and was aromatic in nature. While, the humic acid formed in lignite might be low molecular weight compound and aliphatic in nature. While the fulvic acid formed under FYM, vermicompost and lignite were low molecular weight aliphatic compounds because all organic sources showed  $>5 E_4/E_6$  ratio. The results are in conformity with results reported by [11, 12, 13, 14].

### 3.4 Initial soil fertility status of the soil used for pot culture experiment

The soil used for pot culture experiment was slightly alkaline (pH-7.7), medium in organic carbon content (0.62%), calcareous in nature (5.5 %). The available N, P and K content of the soil was low ( $200.7 \text{ kg ha}^{-1}$ ), medium ( $17.7 \text{ kg ha}^{-1}$ ) and very high ( $560.4 \text{ kg ha}^{-1}$ ) respectively. The soil was sufficiently supplied with DTPA extractable Fe ( $6.8 \text{ mg kg}^{-1}$ ), Mn ( $12.2 \text{ mg kg}^{-1}$ ), Zn ( $1.12 \text{ mg kg}^{-1}$ ) and Cu ( $2.8 \text{ mg kg}^{-1}$ ).

### 3.5 Effect of foliar application of potassium humate extracted from different organic sources on yield of fresh green and dry chilli fruits

The foliar application of different concentration of potassium humate (200-600 ppm) extracted from FYM, vermicompost and lignite along with GRDF significantly improved the fresh green chilli fruit yield ( $74.78$  to  $94.75 \text{ g plant}^{-1}$ ) as compared to the GRDF + water sprays ( $T_2$ ) ( $68.22 \text{ g plant}^{-1}$ ) and absolute control ( $T_1$ ) ( $66.65 \text{ g plant}^{-1}$ ) (Table 5). Among the different sources used for extraction of potassium humate, the application of 400 ppm potassium humate as foliar sprays extracted from vermicompost along with GRDF ( $T_7$ ) resulted in significantly highest yield of fresh green chilli fruits ( $94.75 \text{ g plant}^{-1}$ ) over the rest of the concentrations of the potassium humate extracted either from FYM, vermicompost and lignite except treatment  $T_8$  ( $90.19 \text{ g plant}^{-1}$ ), which found statistically at par with treatment  $T_7$ . Similar trend of observation in respect to dry green chilli fruits were also recorded due to same treatments. The

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positive effect of humic substances on plant metabolism and growth [15]. The studies conducted [9, 16, 17, 18] at different locations reported that foliar spray of humic acid increased the yield of chilli.

**Comment [D8]:** The method of writing references as numbers according to their order in the manuscript's reference list must comply with the terms of publication in the journal.

### 3.6 Effect of foliar application of potassium humate extracted from different organic sources on yield of fresh and dry stalk yield of chilli

**Table 5. Effect of foliar application of potassium humate extracted from different organic sources on yield and quality of green chilli**

Tr. No.	Treatment	Yield (g plant <sup>-1</sup> )				Quality aspect ascorbic acid content (mg 100 g <sup>-1</sup> )
		Green fruit		Stalk		
		Fresh	Dry	Fresh	Dry	
T <sub>1</sub>	Absolute control (No GRDF + No spray)	66.65	13.42	109.13	27.34	76.0
T <sub>2</sub>	GRDF + Water sprays	68.22	14.26	112.23	29.36	80.0
T <sub>3</sub>	GRDF + 200 ppm potassium humate as foliar spray extracted from FYM	88.11	18.03	146.91	38.64	96.0
T <sub>4</sub>	GRDF + 400 ppm potassium humate as foliar spray extracted from FYM	83.95	16.85	128.27	33.27	96.0
T <sub>5</sub>	GRDF + 600 ppm potassium humate as foliar spray extracted from FYM	78.80	16.93	124.98	32.76	92.0
T <sub>6</sub>	GRDF + 200 ppm potassium humate as foliar spray extracted from vermicompost	86.97	18.43	145.43	36.31	100.0
T <sub>7</sub>	GRDF + 400 ppm potassium humate as foliar spray extracted from vermicompost	94.75	20.21	157.36	43.62	112.0
T <sub>8</sub>	GRDF + 600 ppm potassium humate as foliar spray extracted from vermicompost	90.19	19.88	153.13	42.93	104.0
T <sub>9</sub>	GRDF + 200 ppm potassium humate as foliar spray extracted from lignite	74.78	15.67	121.60	31.60	84.0
T <sub>10</sub>	GRDF + 400 ppm potassium humate as foliar spray extracted from lignite	85.12	17.54	130.30	33.35	88.0
T <sub>11</sub>	GRDF + 600 ppm potassium	84.12	17.85	136.17	34.16	84.0

	humate as foliar spray extracted from lignite					
	S.E. $\pm$	1.89	0.47	2.98	0.68	4.35
	C.D. at 5%	5.55	1.39	8.75	2.01	2.75

The application of different levels of potassium humate (0-600 ppm) extracted from FYM, vermicompost and lignite along with GRDF significantly improved the fresh stalk yield of chilli (121.60 – 157.36 g plant<sup>-1</sup>) as compared to the GRDF + water sprays (T<sub>2</sub>) (112.23 g plant<sup>-1</sup>) and absolute control (T<sub>1</sub>) (109.13 g plant<sup>-1</sup>) (Table 5). Among the different sources the foliar application of potassium humate @400 ppm extracted from vermicompost along with GRDF (T<sub>7</sub>) noticed significantly highest (157.36 g plant<sup>-1</sup>) fresh stalk yield as compared to the potassium humate extracted from FYM and lignite, but found at par with treatment T<sub>8</sub> (GRDF + 600 ppm potassium humate as foliar spray extracted from vermicompost) (153.13 g plant<sup>-1</sup>) as compared to GRDF + water sprays (T<sub>2</sub>) and absolute control (T<sub>1</sub>). Similar trend of observations were noticed in respect of dry stalk yield of chilli (Table 5).

### **3.7 Effect of foliar application of potassium humate extracted from different organic sources on quality in respect of ascorbic acid content in fresh green chilli fruits**

The foliar application of potassium humate (200-600 ppm) extracted from FYM, vermicompost and lignite along with RDF significantly increased ascorbic acid content (mg 100 g<sup>-1</sup> green fruit) over the GRDF + water spray (T<sub>2</sub>) and absolute control; (T<sub>1</sub>) (Table 5). The significantly highest (112.0 mg 100 g<sup>-1</sup>) content of ascorbic acid noticed under treatment T<sub>7</sub>, applied with two sprays of potassium humate @ 400 ppm with GRDF but found at par with treatments T<sub>6</sub> and T<sub>8</sub> applied with two sprays of potassium humate @ 200 ppm and 600 ppm extracted from vermicompost with GRDF, but at higher concentrations of potassium humate (600 ppm) the content of ascorbic acid declined, might be associated with effect on physiological activity during synthesis of ascorbic acid. The good quality of vermicompost enriched with biostimulants is helpful for enhancing the physiological activity at the site of cell. The

potassium humate extracted from FYM and lignite found beneficial for increasing ascorbic acid as compared to treatment (T<sub>2</sub>) GRDF + water spray and treatment (T<sub>1</sub>) absolute control.

The quality and maturity of organic sources play important role in degree of humification and polymerization of humic substances, as the vermicompost found to be good quality associated with high nutrient status, resulted in positive impact on absorption of nutrients than the poor quality of FYM and lignite for one or more quality parameters. These results are in conformity with [13] for FYM, [11] for lignite, while [19] for FYM and [12] for vermicompost.

#### 4. CONCLUSION

The foliar application of potassium humate @ 400 ppm for two times, extracted from good quality vermicompost significantly increased yield of green chilli fruits and ascorbic acid content (vitamin C) over the potassium humate extracted from FYM and lignite having poor quality for one more quality parameters as well as GRDF + water spray and absolute control under pot culture condition.

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