Response of Potassium Humate as Foliar Sprays on Growth Parameters, Chlorophyll content, Yield and Quality of Cowpea

ABSTRACT

Aim–: Humic substances plays a vital role in soil fertility and plant nutrition. Application of humic substances within a fairly wide range of concentration are highly beneficial to plant root development. Humic acid is excellent foliar fertilizer carrier and an activator. The present investigation was conducted to study the response of foliar application of potassium humate extracted from good quality Farm yard Manure (FYM), on growth parameters, chlorophyll content, yield and quality of cowpea.

Study Design–: Completely Randomized Design with three replications and seven treatments.

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

Methodology–: Good quality FYM was used to extract potassium salt of humic acid. The extracted potassium humate was used as foliar application (at two different growth stages) at different concentrations (100, 200, 300, 400 and 500 ppm) along with the General Recommended Dose of Fertilizers (GRDF), comprising seven treatments that were laid in a completely randomized design with three replications.

Results–: The results indicated that two foliar applications of potassium humate @ 400 ppm + GRDF (T_6) to cowpea plants significantly increased growth parameters *viz.* average number of seeds per pod (18.0), 100 seed weight (9.59 g), seed yield (91.10 g pot^{-1}) and dry straw yield (113.88 g pot^{-1}), total chlorophyll content and

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protein content ~~of cowpea as~~ compared to absolute control (T_1) and GRDF + water spray (T_2).

Conclusion: The study concluded that foliar applications of potassium humate @ 400 ppm + GRDF significantly improved growth parameters, total chlorophyll, yield and protein content (21.42%) of cowpea plants seed under pot culture condition.

Keywords~~-~~: potassium humate, foliar spray, yield, protein content, cowpea

1. INTRODUCTION

Organic matter is considered as the "Life of soil" due to its importance in maintaining the fertility of soil, it's become a major threat to food security in the years to come. Organic sources provide substantial quantitiesy of nutrient elements well as humus which helps in improving physical, chemical and biological properties of soil [1]. Since availability of good quality organic manure is declining now a day, use of humic substances extracted from locally available organic manure *viz.* FYM is a best option for chemical free and nutritious agricultural produce. Plant growth is influenced directly and indirectly by humic substances. Positive correlations between the humus content of the soil, plant yields and product quality have been published in many scientific journals. Foliar fertilizers containing humic acid in combination with N, P, K and various micro minerals have been demonstrated to be from 100 to 500 percent more efficient compared to application of similar fertilizer to soil. Foliar fertilizers are also more economical because smaller quantities of fertilizers are required to obtain significant plant response. Plant nutrients within foliar fertilizers are rapidly absorbed by plant leaves. Foliar fertilization can be absorbed from 8 to 20 times as efficient as ground application [2].

The estimated area ~~under~~ cultivated with cowpea in Maharashtra is 18.1 thousand hectares, with a production of 12 thousand tons with average productivity

of 663 kg ha^{-1} [4]. Considering today's trend of organic farming and food security for improving the quality of cowpea as well as productivity, the experiment was conducted with a view to study the response of potassium salt of humic acid as foliar sprays with GRDF for improving the chlorophyll, growth parameters, yield and quality of cowpea.

2. MATERIALS AND METHODS

2.1 Extraction of potassium salt of humic acid

The study was conducted at College of Agriculture, Karad. Well decomposed FYM having good quality and maturity parameters was used for the pot culture experiment as well as for extraction of humic substances with KOH (0.5 M) and analyzed for E_4/E_6 ratio of HA (Humic Acid), HA/FA ratio by adopting standard methods. Humic fractions extracted from FYM by following modified methods [5 and 6] with 0.5 M KOH extractant.

2.2 Treatments and Pot culture experimental procedure

The Inceptisol soil was used for pot culture experiment, collected from College of Agriculture Farm, Karad and was analyzed for initial soil properties by following standard methods of analysis. Pots were filled with 20 kg soil and imposed with seven treatments *viz.* T_1 (Absolute control), T_2 (GRDF (FYM 5t ha^{-1} + 25:50 $N:P_2O_5$ kg ha^{-1} + water spray)), T_3 (GRDF + Potassium humate foliar spray @ 100ppm), T_4 (GRDF + Potassium humate foliar spray @ 200 ppm), T_5 (GRDF + Potassium humate foliar spray @ 300 ppm), T_6 (GRDF + Potassium humate foliar spray @ 400 ppm), T_7 (GRDF + Potassium humate foliar spray @ 500 ppm). Treatment wise concentrations of potassium humate for foliar sprays were prepared from 1000 ppm stock solution of potassium humate. First foliar spray was applied at flower initiation and second at pod

formation stage. The experiment was conducted in completely randomized design (CRD) with three replications.

2.2 Data collection

Two healthy plants out of five kept in each pot were used to record the data on total chlorophyll content, growth contributing characters and post harvest observations as mentioned below.

2.2.1 Plant height

Plant height at 50% flowering and at maturity was recorded using a ruler.

2.2.2 Number of branches

After application of potassium humate foliar sprays, first at flower initiation and second at pod formation stage, number of leaves were counted and the data were recorded at 50% flowering and at maturity, respectively.

2.2.3 Total chlorophyll content

Total chlorophyll content at 50% flowering and at pod formation stage was determined and the data was reported.

2.2.4 Average number of seeds per pod

After harvest of cowpea plants ~~crop~~, the average number of seeds per pod were recorded.

2.2.5 Seed yield and 100 seed weight

Seed yield (g pot^{-1}) and 100 seed weight (g) of cowpea were recorded after harvest of cowpea plants ~~crop~~.

2.2.6 Straw yield

Fresh and dry straw yield of cowpea was determined and the data was recorded for further analysis.

2.2.7 Protein content in cowpea seed

The quality parameter of cowpea i.e. protein content was determined by following standard method. (ADD REFERENCES OF THE METHOD) OR DESCRIBED.

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2.2.8 Root length

After removal of above ground part of the crop at harvest, roots were removed from soil, washed with water and used to record the root length.

2.3 Data analysis

The data regarding each parameter were tabulated and analyzed statistically by applying standard method [7].

3. RESULTS AND DISCUSSION

3.1 Characterization of potassium humate and FYM

FYM used for extraction of potassium salt of humic acid, contained humic acid (HA) to the tune of 13.48 g $100g^{-1}$ organic matter with HA/FA ratio of 0.72 (Table 1). The extinction coefficient (E_4/E_6 ratio) of HA was 4.1, suggested that formation of high molecular weight substances during humification and aromatic in nature. Similar results were also reported by [8] and [9].

Table 1. Content and characteristics of humic substances extracted from FYM

1.	**Humic substances (g $100g^{-1}$ OM)**	Value
a	Humic acid (HA)	13.48
b	Fulvic acid (FA)	18.62
c	**HA/FAratio**	0.72
2.	E_4/E_6 ratio	
a	Humic acid	4.1
b	Fulvic acid	7.2

3.2 Initial soil fertility status of the soil used for pot culture experiment

The soil used for pot culture experiment was slightly alkaline with medium organic carbon content (0.57%), calcareous in nature with lowest available N (188.2 kg ha^{-1}), medium for P_2O_5 (16.5 kg ha^{-1}) and high in K_2O (608.2 kg ha^{-1}) content.

3.3 Effect of potassium humate as foliar application on growth parameters of Cowpea

3.3.1 Plant height

The application of different concentrations of potassium humate as foliar sprays along with GRDF significantly influenced the plant height of cowpea at 50% flowering and at maturity (Table 2). The significantly highest plant height at 50% flowering (40.66 cm) and at maturity (52.54 cm) noticed due to treatment T_6 (GRDF + potassium humate foliar sprays @ 400 ppm) over the absolute control (T_1) and treatment T_2 (GRDF + water spray) as well as rest of the treatments, however treatment T_6 was found at par with treatment T_7 (GRDF + potassium humate foliar sprays @ 500 ppm).

Table 2. Effect of foliar application of potassium humate on growth parameters and total chlorophyll content of cowpea

Tr. No.	Treatment	At 50 % flowering		At maturity		Total chlorophyll content (mg g^{-1})	
		Plant height (cm)	No. of branches	Plant height (cm)	No. of branches	At flower initiation stage	At pod formation stage
T_1	Absolute control	29.73	5.33	37.97	8.00	1.06	1.00
T_2	GRDF (25:50 N:P_2O_5 kg ha^{-1} +FYM 5 t ha^{-1}) + water spray	31.33	5.50	41.50	9.33	1.18	1.22
T_3	GRDF + potassium humate foliar spray @ 100 ppm	33.27	5.83	43.20	10.33	1.22	1.25
T_4	GRDF + potassium humate foliar spray @ 200 ppm	34.37	6.17	48.03	11.67	1.23	1.25
T_5	GRDF + potassium humate foliar spray @ 300 ppm	35.73	6.33	47.93	13.67	1.24	1.26

T_6	GRDF + potassium humate foliar spray @ 400 ppm	40.66	6.50	52.54	15.33	1.35	1.38
T_7	GRDF + potassium humate foliar spray @ 500 ppm	40.03	6.67	50.69	14.67	1.32	1.34
	S.E. ±	1.09	0.30	1.3	0.58	0.036	0.032
	C.D. at 5 %	3.31	NS	3.96	1.75	0.110	0.100

(GRDF- General Recommended Dose of Fertilizers)

3.3.2 Number of branches

Regarding number of branches, similar trend was noticed at 50% flowering and at maturity. Treatment T_6 recorded a significantly higherst number of branches (15.33) at maturity as compared to treatment T_1 and T_2 having the values 8.00 and 9.33, respectively, however, the treatment T_6 found at par with treatment T_7 (Table 2). The trend of decrease in plant height and number of branches with increasing concentration of potassium humate above 400 ppm might be because of high molecular weight with aromatic structure hindered the absorption and its accumulation on leaf surface leads to toxic effect. The positive impact of foliar application of potassium humate might increased the metabolic activities resulted in more absorption of nutrients resulting in increasing plant height and number of branches up to the concentration level of potassium humate to 400 ppm. The results are in conformation with the results reported by [10] and [11].

3.3.3 Effect on total chlorophyll content of Cowpea

Significantly increased total chlorophyll content at flower initiation and pod formation stages over the absolute control (T_1) was noticed due to the– foliar application of different levels (100-400 ppm) of potassium humate along with GRDF (Table 2). The significantly highest total chlorophyll content was noticed due to the treatment T_6 at flower initiation stage (1.35 mg g^{-1}) and at pod formation stage (1.38 mg g^{-1}) over the

absolute control and rest of the treatments except, treatments T_7 which was found at par but the values of total chlorophyll content was found to be decreased, might be due to antagonistic effect of higher concentration (> 400 ppm) of potassium humate. Similar results due to humic acid application in leguminous crops was also reported by [12].

3.4 Effect on post harvest observations of cowpea

With increasing levels of concentration of potassium humate upto 400 ppm along with GRDF (T_6), significant improvement in post harvest observations of cowpea *viz.* average number of seeds per pod (18.00), 100 seed weight (19.59 g) and root length (22.40 cm) were noticed (Table 3) as compared to rest of the treatments except T_7, this might be due to ill effect of higher concentration (> 400 ppm) of potassium humate. This might be associated with the presence of number of functional groups in humic substances, both in the cyclic and side chain of the molecules, equips it to exert a specific physiological action on biological tissues such as root growth. The beneficial effect on shoot and root growth at concentration of 1000-2000 ppm was reported by [13]. The results are in conformity with the results reported by [11].

Table 3. Effect of foliar application of potassium humate on post harvest observations of cowpea.

Tr. No.	Treatment	Average number of seeds /pod	100 seed wt. (g)	Root length (cm)
T_1	Absolute control	11.33	13.57	12.63
T_2	GRDF (25:50 N:P_2O_5 kg ha^{-1} + FYM @ 5 t ha^{-1}) + water spray	12.67	15.86	13.53
T_3	GRDF + potassium humate foliar spray @ 100 ppm	14.33	16.12	15.34
T_4	GRDF + potassium humate foliar spray @ 200 ppm	15.00	17.10	18.87

T_5	GRDF + potassium humate foliar spray @ 300 ppm	15.67	17.59	19.43
T_6	GRDF + potassium humate foliar spray @ 400 ppm	18.00	19.59	22.40
T_7	GRDF + potassium humate foliar spray @ 500 ppm	17.83	19.12	22.00
	S.E. ±	0.70	0.66	0.67
	C.D. at 5 %	2.11	1.99	2.04

(GRDF- General Recommended Dose of Fertilizers)

3.5 Yield responses of Cowpea

Application of different levels of potassium humate as foliar spray improved fresh and dry straw yield (g pot^{-1}) significantly over the absolute control (Table 4). The significantly higherst seed yield (91.10 g pot^{-1}), fresh straw (379.53 g pot^{-1}) and dry straw yield (113.88 g pot^{-1}) were recorded due to the foliar application of potassium

Table 4. Effect of foliar application of potassium humate on seed and straw yield of cowpea.

Tr. No.	Treatment	Seed yield (g pot^{-1})	Straw yield (g pot^{-1})		Protein (%)
			Fresh	Dry	
T_1	Absolute control	75.04	312.67	93.80	18.56
T_2	GRDF (25:50 N:P_2O_5 kg ha^{-1} + FYM @5 t ha^{-1}) + water spray	82.03	341.80	102.54	19.60
T_3	GRDF + potassium humate foliar spray @ 100 ppm	82.63	344.33	103.29	20.33
T_4	GRDF + potassium humate foliar spray @ 200 ppm	83.02	345.93	103.78	20.52
T_5	GRDF + potassium humate foliar spray @ 300 ppm	84.53	352.23	105.67	20.56
T_6	GRDF + potassium humate foliar spray @ 400 ppm	91.10	379.53	113.88	21.42
T_7	GRDF + potassium humate foliar spray @ 500 ppm	90.97	379.03	113.71	21.23
	S.E. ±	2.07	8.63	2.59	0.28

	C.D. at 5 %	6.28	26.17	7.85	0.84

(GRDF- General Recommended Dose of Fertilizers)

humate @ 400 ppm with GRDF (T_6) as compared to the absolute control (T_1) and rest of the potassium humate concentrations. While, it was found at par with treatment T_7 showing numerically low seed yield (90.91 g pot^{-1}), fresh straw (379.03 g pot^{-1}) and dry straw yield (113.71 g pot^{-1}). The concentration of potassium humate ranging from 0 to 400 ppm reflected into increasing levels of the seed yield while, potassium humate concentration > 400 ppm inhibited the root and shoot growth. The presence of aromatic nature of potassium humate might contain~~ed~~ substantial amounts~~l number~~ of carboxylic, phenolic and alcoholic h~~y~~droxyls groups partially responsible for root initiation and increased the rate of nutrient uptake resulted in increased yield [14]. These results were in conformity with the results reported by [15] and [16].

3.6 Effect on protein content of Cowpea

As the food, ~~quality for human being~~ cow-pea plays an important role as source of protein. The different concentrations of potassium humate with GRDF significantly increased the protein content over the rest of the treatments and control. The significantly highest (21.42 %) protein content was noticed under treatment T_6 as compared to T_1 (18.56 %) but treatment T_6 found at par with treatment T_7 (21.23 %) with numerically lowered protein content at high concentration of potassium humate i.e. 500 ppm (Table 4). Similarly, the treatment T_2 supplied with GRDF + water spray found at par with treatment T_3 indicated lower concentration of potassium humate (100 ppm) showed negligible impact for increasing protein content. It was further noticed that the concentration of potassium humate > 400 ppm found to be detrimental for increasing the protein content in cowpea seed might be due to the higher concentration of aromatic nature of humic acid affected the physiological action on biological tissue. The concentration of potassium humate up to 400 ppm

with aromatic nature of potassium salts of humic acid found to be beneficial in increasing the protein content in cowpea seed. Similar results also reported by [17] and [12].

4. CONCLUSION

The resulted concluded that potassium humate extracted from good quality FYM with aromatic nature of potassium salt of humic acid when applied at different levels as foliar sprays to cow pea under pot culture condition significantly increased the growth parameters, total chlorophyll content as well as post harvest observations, yield and protein content in cow pea when potassium humate applied @ 400 ppm (two times) along with GRDF over the rest of concentrations.

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