RESEARCH PAPER

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Formulation of a liquid fertilizer and a comparative study on its effect on the growth and yield of *Vigna radiata* (L.) Wilczek

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Green gram [*Vigna radiata,* (L.) Wilczek] is the third most important pulse in India. It is the protein rich staple food and it supplies the protein requirement of vegetarians of our country. To improve the productivity and yield of green gram crop a study was made to assess the different treatments on its growth and yield. Four different treatments were given namely a) LF-1(Liquid fertilizer formulated in our lab - 2 per cent humic acid extracted from vermicompost + 1 per cent anolyte water), b) LF-2 (Liquid fertilizer commercially purchased), c) 1 per cent anolyte water and d) vermicompost. Effect of the different treatments on physico-chemical parameters of the soil, germination rate, shoot length, root length, yield ratio, weight of 100 seeds and the biochemical contents of green gram crop were studied. The application of LF-1 (2 per cent humic acid in anolyte water) increased the macronutrient (N, P and K) and micronutrient (Cu, Fe and Zn) content of the soil, enzyme activity (urease, phosphatase and dehydrogenase) of the soil, growth, yield, 100 seeds weight, protein and vitamin C content of green gram crop. The micronutrient content (manganese) was maximum in the plants subjected to vermicompost and carbohydrate content was maximum in the plants treated with LF-2 (Liquid fertilizer commercially purchased).

Key words : Humic acid, Vermicompost, Green gram, Anolyte water

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INTRODUCTION

Green gram is one of the important pulse crops. It has been reported that green gram has been cultivated in India since ancient times. It contains 25 per cent of protein, which is almost three times that of cereals.

Vermicomposts originated from animal manures, food and paper mill sludge had been shown to contain large amount of humic substances (Arancon *et al*., 2006). Treating *A.rosea* with humic substances obtained from vermicompost increased the growth and induced the morphological changes similar to that of auxins (Muscolo *et al*., 1999).

Humic materials are very large and complex molecules extracted from organic matters such as composts and lignite coals (Mayhew, 2004). Humic materials have an abundance of carboxyl groups and weakly acidic phenolic groups, which contribute to their complications and ion-exchange properties. They exhibit both hydrophobic and hydrophilic characteristics and can bind to soil mineral surfaces. The humic substances in the soil have multiple effects. It plays dual role as direct and indirect effects to improve both soil and plant growth (Sangeetha *et al*., 2006). Soil aggregation, aeration, permeability, water holding capacity, micronutrient transport and availability were improved indirectly (Tan, 2003). Direct effects are those, which require uptake of humic substances into the plant tissue resulting in various biochemical effects (Chen *et al*., 2004).

The electro chemically activation (ECA) of solutions is a recently developed technology that is very suitable for water treatment. ECA is a relatively simple and completely eco-friendly method of producing a very potent mix of disinfecting and oxidizing molecules, ions and radicals from normal tap water and salt. ECA technology provides with the possibility of onsite production, can be very easily fitted into existing systems and the operation is completely safe. Two different activated solution of catholyte and anolyte water are produced in Envirolyte Reactor. http://www.envirolyte.com/oilandgas.shtml.

Anolyte water has the following uses such as prevention of soil born bacteria, fungi and viruses, controls root and fungal diseases, used in post harvest treatment for cut flowers, biological crop protecting agent

(alternative to chemicals) (Ongeng *et al*., 2006; El karim *et al*., 2007).

In the present study the use of 2 per cent humic acid extracted from vermicompost + 1% anolyte water improved the growth and biochemical contents (protein and vitamin C) of green gram.

RESEARCH METHODOLOGY

Vermicompost:

Vermicompost was purchased from TNAU, at Coimbatore.

Extraction of crude humic acid from vermicompost:

The crude humic substances were extracted as described by International Humic Substances Society (Schnitzer and Skinner, 1982) with certain modification. 10 volumes of 0.5 mol L^{-1} NaOH was mixed with 1 volume of vermicompost stirred well at regular intervals. After 12 h the suspension was filtered into a new flask and acidified to pH 1.5 using 6 mol L^{-1} HCl to precipate the humic acid from vermicompost. The precipitation was allowed to stand overnight for complete settling of the humic acids which was then separated from solution by filteration using whatman filter paper. The separated solid portion was shade dried for further use.

Percentage of humic acid content and ash value (Gopal *et al*., 2010):

The humic acid content in the vermicompost was estimated by transferring the humic acid to crucible and heated at 815 ± 10ºC for 1 hour. The humic acid content in the vermicompost was determined by:

$$\text{Humic acid content}\,(\%) = \frac{100(m_1 - m_2)}{m}$$

where,

m_1 is the mass of dry humic acid in grams;

m_2 the mass of ash residue of humic acid in grams;

m the mass of dry solid substances taken for estimation of humic acid in grams.

Anolyte water:

Anolyte water was purchased from PWD office, Coimbatore.

Field study:

The field experiments were conducted in an agricultural farm at Mattapparai (Villupuram District) in Tamil Nadu. The soil type was red soil. The soil was well ploughed and a plot size of 3m x 4m was made as experimental plots in five replicates. For each treatment (20 seeds/ plot) of green gram seeds were sown. Irrigation was done by flow irrigation.

The plants were treated with 4 different fertilizers T_1- Control, T_2- LF-1: Liquid fertilizer formulated in our lab (2g of humic acid extracted from vermicompost + 100ml of anolyte water *i.e.* 2 per cent humic acid in anolyte water), T_3- LF-2 (Liquid fertilizer commercially purchased), T_4-1per cent anolyte water, T_5- vermicompost.

Foliar application of liquid fertilizer was done by diluting it 10 times and one litre was sprayed once in a fortnight in each plot. Vermicompost was amended at the rate of 1kg/ plot.

Physico-chemical characteristics of the soil:

The soil treated with different fertilizers were analyzed for the following important parameters. pH and EC (Jackson, 1973), analysis of macronutrients like nitrogen (Vogel, 1961), phosphorus and potassium (Jackson, 1973), analysis of micronutrient like copper, zinc, iron and manganese (Jackson, 1973) and analysis of soil enzyme activity like urease (Tabatabai and Bremner, 1972), phosphotase (Halstead, 1964) and dehydrogenase (Casida *et al*., 1964) were studied.

To study the growth parameters and biochemical content of green gram, the following experimental studies were carried out. The germination percentage, shoot and root length was measured at the end of the harvest, total yield and the weight of 100 seeds were measured after harvest and biochemical contents were estimated by the following methods *(i.e.)* protein by folin phenol method (Lowry *et al*., 1951), total soluble carbohydrate by anthrone method (Hedge and Hofreiter, 1962), and vitamin C (Harris and Ray, 1935).

RESULTS AND ANALYSIS

Per cent of humic acid extracted from the vermicompost was 2.26 per cent and its ash value was 13.2 per cent. The total amount of humic acid extracted from 1 kg of vermicompost was 22.6 g in crude form. This was used for the formulation of the liquid fertilizer along with anolyte water for the study.

T_1- Control, T_2- LF-1(Liquid fertilizer formulated in our lab *(i.e.)* 2% HA + 1 per cent anolyte water), T_3- LF-2(Liquid fertilizer commercially purchased), T_4- 1 per cent anolyte water and T_5- vermicompost.

From the results it was observed that the physico-chemical characteristics of the soil like macronutrient (N, P and K), micronutrient (Cu, Fe and Zn) and enzyme

activity (urease, phosphatase and dehydrogenase) were maximum in the plants subjected to T_2 treatment (2 per cent humic acid in anolyte water) (Table 1 and 2). Likewise the per cent of germination, shoot and root length, total yield, weight of 100 seeds and biochemical content (Protein and Vitamin C) of green gram showed a significant increase in T_2 treatment (2 per cent humic acid in anolyte water) (Table 3 and 4). The micronutrient content of manganese was maximum in T_5 treatment (vermicompost) and the carbohydrate content of green gram seeds were maximum in the plants subjected to T_3 treatment (liquid fertilizer commercially purchased).

Application of humic acid as foliar spray to the green gram stimulated the growth and yield. The same results were given by many researchers in the increase in productivity, nutrient content and the macro and micronutrient of many crops (Varanini and Pinton, 1995; Adani *et al.,* 1998). Humic substance have been shown to increase in plant growth, yield and yield components of snap bean (El. Bassiony *et al.*, 2010), tomato (Pertuit

Table 1: Effect of different fertilizers on the physico-chemical characteristics of the soil

Treatments	Physical characteristics of the soil		Macronutrients (kg/ha)			Micronutrients (ppm)			
	pH	EC (dsm^{-1})	N	P	k	Cu	Fe	Zn	Mn
T_1	7.91	0.15	241	12.8	133	1.65	24.7	20.8	2.0
T_2	7.83	0.11	314	24.5	169	6.7	27.3	28.1	3.5
T_3	7.79	0.14	269	14.6	160	6.0	25.2	26.9	3.0
T_4	7.88	0.18	274	11.2	139	4.7	24.0	25.8	3.1
T_5	7.81	0.13	258	15.4	140	6.3	25.9	27.0	3.72

Table 2: Effect of different treatments on the soil enzyme activity

Treatments	Urease (µg NH_4 g^{-1} of soil hr^{-1})	Phosphatase (µg p-nitrophenol g^{-1} dry soil hr^{-1})	Dehydrogenase (µg TPFg^{-1} of soil hr^{-1})
T_1	3.49	8.87	1.68
T_2	4.39	14.27	1.81
T_3	3.71	10.57	1.68
T_4	3.94	11.87	1.74
T_5	3.97	12.17	1.78

Table 3: Effect of different treatments on the growth and yield parameters of green gram plants

Treatments	Germination rate (%)	Shoot length (cm)	Root length (cm)	Yield (g)	Weight of 100 seeds (g)
T_1	90.47^a	64.8^b	12.7^d	99.1^a	7.61^b
T_2	93.70^b	65.7^d	17.2^d	193.4^e	7.78^d
T_3	93.70^b	65.0^c	12.8^b	121.8^b	7.68^c
T_4	91.73^a	64.9^b	12.4^a	145.1^c	7.65^{bc}
T_5	93.20^b	64.0^a	16.8^c	176.3^d	7.55^a
SED	0.63	0.3	0.1	2.6	0.02
LSD (5%)	1.41	0.5	0.3	5.8	0.05
LSD (1%)	2.00	0.7	0.4	8.3	0.06

Observation values are mean of five replications, Means followed by common letter are not significantly different at 5% level by DMRT

Table 4: Effect of different treatments on the biochemical content of green gram seeds

Treatments	Carbohydrates (mg/g)	Protein (mg/g)	Vitamin C (µg/g)
T_1	12.0^a	20.4^a	13.0^a
T_2	19.13^c	25.4^c	21.3^d
T_3	20.13^d	23.3^b	13.4^a
T_4	17.10^b	22.5^b	18.6^c
T_5	17.40^b	23.3^b	16.9^b
SED	0.29	0.4	0.3
LSD (5%)	0.65	1.0	0.7
LSD (1%)	0.92	1.4	1.0

Observation values are mean of five replications, Means followed by common letter are not significantly different at 5% level by DMRT

et al., 2001; Atiyeh *et al.*, 2002), corn and oat (Celik *et al.,* 2008), forage turnip (Albayrak and Carnas., 2005) and spinach (Ayas and Gulser., 2005), black gram (Natesan *et al.,* 2006).

Conclusion:

The liquid fertilizer formulated in our lab *(i.e.)* humic acid (crude form) extracted from vermicompost in combination with anolyte water induced the growth and yield of green gram crop. As it is eco-friendly and cost effective, the increase in production and marketing of humic acid can be improved.

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