RESEARCH PAPER:

Formulation of a liquid fertilizer and a comparative study on its effect on growth and yield of *Arachis hypogaea* L.

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SUMMARY

Groundnut (*Arachis hypogaea* L.) is one of the world's most important oil seed crop. Experiments were designed to evaluate the effect of humic acid extracted from vermicompost and compared with other fertilizers. For the study, four different treatments were given (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, to determine the effect of different fertilizers on physico-chemical parameters of the soil, germination rate, shoot length, root length, yield, weight of 100 seeds and the biochemical contents. The application of 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, germination rate, shoot length, yield, weight of 100 seeds and the biochemical contents of the groundnut crop. The micronutrient content (copper) and root length was maximum in the plants subjected to treatment T_5 (vermicompost).The micronutrient content (manganese) of the soil was maximum in the plants treated with LF-2.

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Key Words :

Humic acid, Vermicompost, Groundnut, Anolyte water liquid fertilization

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Groundnut *(Arachis hypogaea* L.) plays an important role and has much importance in the national economy among the oilseed crops. Groundnut is not only used as the source of edible oil but also used in manufacture of soap and hydrogenated vegetable oil. The entire plant has an economical value like the kernels that are rich in vitamins, oil and protein content that is used as food, dry plant stalk used as fodder for animals, and the groundnut cake is the best source in organic fertilizer. Due to increase in population, the demand for vegetable oil in India has been steadily increasing more than 2 per cent per annum. All these factors make a demand for improving the yield of groundnut.

It is believed that dark coloured soils with high humus are more fertile than the light-coloured soils. Anywhere on the globe where there is soil or water associated with organic matter, humic substances are present. They cause the brownish tint often seen in natural streams, the darkness of dark soils and the dark brown colour of lignite coal and vermicompost is due to humus content (Mayhew, 2004). Humic substances are very effective on plant growth. Humic acid that was extacted from vermicompost increases the growth of crops grown when amended with planting media (Arancon *et al*.,2003; Atiyeh *et al*.,2002).

Humic substances play a multiple role to enrich the soil. The indirect effects are the adsorption of water, the amelioration of soil by drainage and aeration. The absorption of plant nutrient by plant roots influences direct effect on the physiological process of plant (Ohta *et al*., 2004; Chen *et al*., 2004).

Anolyte technology is a Russian patented technology that was initially spun off for the astronauts in space. This technology employs electro-activation of water along with natural salts like NaCl. As a result, reactive ions and free radicals are formed in the anolyte chambers of the envirolyte reactor. This electroactivated water collected from the anolyte chamber is called the anolyte water.

Anolyte solution is 100 per cent free of chemicals (Idris and Saed, 2002), eco-friendly, and degenerates after a short period into non-toxic, non-chemical and non-synthetic salty water (Leonov, 1999). Anolyte solutions containing a mixture of oxidizing substances demonstrate pronounced microbiocidal effectiveness against bacteria, viruses, fungi and protozoa (Prilutskii *et al*., 1996). This solution has been termed as super-oxidized water (Selkon *et al*., 1999). The anolyte water dipping treatment was found to be as effective as chlorinated solutions in controlling the growth of aerobic bacteria, molds, yeasts and coliform bacteria during the storage of fruits (Workneh *et al*., 2003; Workneh and Osthoff, 2010).

In the present study, a liquid fertilizer formulated in our lab *(i.e.)* humic acid extracted from vermicompost and dissolved in anolyte water was tested on the groundnut crop and compared with the effect of other fertilizers on the same crop. This kind of formulation was chosen because it was revealed from litreature that the humic acid content from vermicompost promotes increase in growth and yield of various crops (Chen and Aviad, 1990).

EXPERIMENTAL 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 compost 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 ± 10^0C for 1 hour. The humic acid content in the vermicompost was determined by:

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

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.

Test plants:

For the study, an oil seed crop (*Arachis hypogaea* L.) was chosen to find out the effect of different fertilizer on the growth, yield and biochemical contents.

Field:

The field experiments were conducted in an agricultural farm at Mattapparai, Villupuram district and the soil type was red soil. The soil was well ploughed and the soil samples were collected and analyzed for their physico-chemical characteristics. A small area of this field was chosen and plots of 3× 4m was made as experimental plots and then the groundnut (30 seeds) were sown per plot in five replicates. Irrigation was done by flow irrigation.

Treatments:

T_1- Control

T_2 LF-1: Liquid fertilizer formulated in our lab (2g of humic acid extracted from vermicompost + 100 ml of Anolyte water *i.e.* 2 per cent humic acid in Anolyte water)

T_3 - LF-2 (Liquid fertilizer commercially purchased)

T_4- 1 per cent Anolyte water (1ml of Anolyte water + 99 ml D. 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 the each plot. Vermicompost was amended at the rate of 1kg/ plot.

Physico-chemical characteristics of the soil:

The soil treated with different fertilizers was analyzed for important parameters *viz.,* 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 groundnut the following experimental studies were carried out. The germination percentage, shoot length 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 protein by Folin phenol method (Lowry *et al*., 1951), total soluble carbohydrate by anthrone method (Hedge and Hofreiter, 1962), lipids by (Folch *et al.,* 1957) and vitamin C (Harris and Ray,1935).

EXPERIMENTAL FINDINGS AND DISCUSSION

In the present study the percentage of humic acid and ash content extracted from vermicompost was 22.6 per cent and 13.2 per cent, respectively (Table 1). The enhancement of humic acid content in the vermicompost may be due to large number of microbial population in the substrate material and due to the gut associated activity of the earthworm. The presence of high ash conent may be due to the high amount of available minerals in the compost (Kavitha *et al*., 2011).

Table 1: Per cent of humic acid and ash content of the humic acid extracted from vermicompost

Replicates	Humic acid extracted from vermicompost g/kg	Humic acid content (%)	Ash content (%)
Replicate 1	22.5	1.95	13.3
Replicate 2	22.6	2.0	13.0
Replicate 3	22.5	1.85	13.4
Replicate 4	22.6	2.0	13.0
Replicate 5	22.9	1.95	13.3
Mean	22.6	1.97	13.2

EC of the soil was raised to 0.22 dsm^{-1} when compared to that of initial level (Table 2). This increase may be due to the presence of activated sodium hypochloride (NaOH) in the anolyte water and it contain large amount of chlorine molecule (Aquastel, 2000). Macronutrient content (N,P and K) of the soil, micronutrient content (Fe and Zn) (Table 2), enzyme activity (urease, phosphates and dehydrogenase) of the soil (Table 3), germination rate, shoot length, weight of 100 seeds and biochemical content of groundnut seed recorded significant increase in LF-1(2 % humic acid in Anolyte water) treatment (Table 4). Whereas the micronutrient content (Cu) of the soil and root length was maximum in the plant subjected to T_5 (vermicompost)

Table 2: Effect of different fertilizers on the physico-chemical characteristics of the soil

Treat-ments	Physical characteristics of the soil		Macronutrients (kg/ha)			Micronutrients (ppm)			
	pH	EC (dsm^{-1})	N	P	K	Cu	Fe	Zn	Mn
T_1	7.92	0.17	218	3.5	109	1.25	11.6	16.1	2.21
T_2	7.75	0.11	291	15	194	4.8	14.1	25.4	2.92
T_3	7.82	0.18	246	5.60	102	3.95	13.0	22.7	2.97
T_4	7.81	0.22	224	2.9	97	4.2	12.8	24.3	2.82
T_5	7.85	0.09	230	11.2	104	5.81	13.35	24.6	2.92

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

treatment. The micronutrient content (manganese) of the soil was maximum in the plant treated with LF-2 (liquid fertilizer commercially purchased).

Table 3: 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	3.24	5.47	1.73
T_2	3.75	13.97	1.87
T_3	3.47	7.47	1.74
T_4	3.43	7.17	1.75
T_5	3.62	13.37	1.83

The increase in growth and yield of groundnut by humic acid may be due to the stable fraction of carbon in the humic acid that regulates the carbon cycle and release of macronutrients. This reduces the use of inorganic fertilizer for plant growth. Ayman, Ulukan, (2008) stated that the use of humic acid induces the plant growth by the

Table 4: Effect of different treatments on the growth and yield parameters of groundnut plants

Treatments	Germination rate (%)	Root length (cm)	Yield (g)	Weight of 100 seeds (g)
T_1	92.8^{a}	14.1^{c}	152.0^{c}	43.24^{b}
T_2	97.1^{b}	11.5^{a}	180.3^{e}	45.66^{b}
T_3	94.8^{ab}	11.5^{a}	141.0^{b}	45.64^{b}
T_4	93.9^{ab}	13.0^{b}	125.0^{a}	44.24^{b}
T_5	96.3^{b}	16.2^{d}	165.7d	44.44^{b}
SED	1.37	0.1	2.9	0.02
LSD (5%)	3.05	0.3	6.4	0.04
LSD (1%)	4.34	0.4	9.2	0.06

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

assimilation of major and minor elements, increases the protein synthesis and finally the activation of biomass production (Table 5). Application of humic acid increases the yield, weight and growth of various crops (Shuixiu and Ruizhen, 2001; Ayas and Gulser, 2005, Shaaban *et al*., 2009).

Table 5: Effect of different treatment on the biochemical content of groundnut seeds

Treatments	Carbohydrates (mg/g)	Protein (mg/g)	Lipid (%)	Vitamin C (µg/g)
T_1	18.6^{d}	17.7^{c}	40^{c}	5.1^{b}
T_2	20.2^{e}	22.6^{e}	46^{d}	7.0^{e}
T_3	17.2^{b}	16.6^{b}	42^{c}	5.9^{d}
T_4	14.3^{a}	14.5^{a}	38^{b}	4.6^{a}
T_5	18.2^{c}	20.2^{d}	34^{a}	5.6^{c}
SED	0.2	0.2	0.1	0.1
LSD (5%)	0.4	0.5	0.3	0.2
LSD (1%)	0.5	0.7	0.4	0.3

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

Conclusion:

Thus, the results of the present study has indicated that the application of the liquid fertilizer formulated in our lab (LF-1 *i.e.* 2 per cent humic acid in Anolyte water) as a trial had proved to be ideal for the growth and yield of the groundnut crop. This formulation can be tested in future on many more such crops, anticipating promising results, as it is eco-friendly and also cost-effective.

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