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RESEARCH ARTICLE

Influence of Chemical fertilizers and Organic fertilizers on pH and available Nitrogen content of Vermicompost with earthworm *Eisenia foetida*

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Abstract

Intensive agriculture with the use of chemical fertilizer in huge amount has no doubt made possible manifold increase in the crop productivity but the adverse effect of these chemicals are clearly visible on the soil environment including soil physiochemical properties and inhabiting soil organisms .The present study is an attempt to find out the residual effect of inorganic and organic fertilizer input on selective soil parameter such as pH and available nitrogen which are crucial in terms of earthworm survival and abundance. Residual effects of applied organic and inorganic soil fertilizers on soil properties are found to vary based on different factors including type, rate and timing of fertilizer application and soil characteristics. Results of our investigation revealed changes in soil available nitrogen and soil pH leaving acidic effect on the vermicompost which predominantly affects earthworm survival.

INTRODUCTION-

Soil is an essential element of agriculture and the soil fauna, its intrinsic component, noticeably affecting its agricultural value (Gu *et al*., 2011; Santorufo *et al*., 2012; Keith *et al.*, 2012). Most soils are naturally moderate fertile however, to maintain this sometimes fertilizers are needed. Soil organic and inorganic fertilizers have become an integral part of agricultural economy as they boost the plant nutrient levels and facilitate them to support high yields. Organic and inorganic fertilizers as agrochemicals contain a range of nutrients in different proportion. The chemical fertilizers, no doubt are the chief sources, which can meet the nutrient requirements but their injudicious and constant use lead to environmental pollution and deterioration of soil physiochemical properties. The changes in soil quality are closely related to soil physical, chemical and biological fertility (Zhang *et al.* 2007, Brady and Weil 2002).

Earthworms constitute an important component of soil biota as they increase the soil fertility and plant performance. Earthworms are well known for their significant influence on nutrient cycling processes in terrestrial ecosystems (Lee 1985; Edwards and Bohlen 1996). The abundance of earthworms in soils represents the health of soil ecosystems and the level of environmental safety (Pankhurst et al. 1997). Inorganic fertilizers are an important management input to achieve good crop yields especially in systems where soil resources are nutrient deficient and the main goal is to increase crop productivity (Haynes et al., 1998). Inorganic fertilizers have largely replaced traditional practices such as recycling organic materials, and in many areas application of organic resources has been neglected or abandoned (Parr & Papendick 1983). Soil acidity is one property associated with decline in soil fertility and low productivity. pH of a soil can be altered by amendments and nutrient management practices. One important cause of soil acidity is the use of acid-forming inorganic fertilizers. The temperature, pH value and C:N ratio of organic wastes used in vermicomposting are also important factors influencing the growth and survival of earthworms (Hou et al., 2003). The soil pH sometime limits distribution, number and species that live in a particular type of soil. Most species prefer soil with a pH close to 7.0 (Edwards and Lofty, 1972).

Material and Methods-

***Eisenia foetida*:** Earthworms (*E. foetida*) were procured from the vermicomposting unit of Rajasthan College of Agriculture, Udaipur. They were maintained under laboratory conditions and acclimatized for 15 days prior to the experimental set up. Mature worms with well-developed clitellum were used in the experiment.

Chemical fertilizers used:

1. **Urea (46% N):** The widely used inorganic fertilizer Urea in the experiment was purchased from the local market. Once applied to the soil, urea is converted to ammonia, which reacts with water to form ammonium ions within two to three days.
2. **Diammonium phosphate (DAP):** Diammonium phosphate (DAP) is the world's most widely used phosphorus (P) fertilizer containing 18 % by weight of NH_4 – N and 46 % by weight of P_2O_5 (water soluble). DAP fertilizer is a good source of P and nitrogen (N) for plant nutrition. It is highly soluble and thus dissolves quickly in soil to release plant-available phosphate and ammonium.

Organic fertilizers used:

1. **'Kala Sona' (Humic Acid 95%): '**Kala Sona' is a commercially available brand of unique soil conditioner, a naturally occurring organic substance consisting primarily of humic acid and minor levels of minerals, gypsum and clays.
2. **'Micro – AD solution'- '**Micro-AD' is a yield enhancing formulation that contains bio stimulants and Biological Macromolecule chelated trace minerals. It is a liquid organic fertilizer which is commercially available.

Preparations of soil beds: The experiment was conducted as per method adopted by (Yasmin & D'Souza, 2007). Plastic tubs were used for preparations of soil beds for earthworm. Dried soil (from nearby farmland) was crushed and filtered through a fine mesh sieve. Weighed fine soil was then poured in each plastic tub and water was added to moistened the soil, then 500gm dried powdered cow dung (3 week old) was also added to each plastic tub to avoid starvation thus maintaining soil: cow dung ratio of 1:1.

Addition of Urea and Diammonium phosphate: Here, in our experimental set up the soil bed contained 1 kg of soil and cow dung mixture made in the ratio of 1:1. Four doses of Urea and DAP each were set, these were 0.75gm/ kg, 1.5gm/ kg, and 2.25gm/ kg and 2.75gm/kg soil. In addition to these, one control set without any treatment was also set parallel.

Addition of Kala Sona and Micro- AD: As per the respective quantity applied per hectare land area of the two organic fertilizers, approx. dose applicable to per kg soil was calculated and in addition to that dose, one higher dose was taken for carrying out the study. Thus, for 'Kala Sona' brand, the doses were 0.45gm/kg and 0.9gm/kg soil sample. For the liquid organic fertilizer, 0.2ppm and 0.4ppm was the treatment concentration to the soil.

Experimental set-up: 20 mature earthworms were added to each plastic tub of different dose treatment of the fertilizers in addition to the control set. Thus one control set and four experimental sets were prepared. Three replicates were used for each set to get an average value of each parameter under study. To maintain up-to 70 percent moisture level, water was supplied regularly till the end of experiment. The tubs were covered with wet muslin cloth, so that the essential moisture level needed by the worms is maintained and also it prevented them to crawl out of the tub. By the end of 60 days, the soil samples were drawn for analysis from each of the experiment tub excluding the earthworms and their cocoons and juveniles.

Determination of Soil pH: For determination of pH, soil suspension in the ratio of 1:5 was prepared. The suspension was stirred at regular intervals for 30 minutes and the soil pH was recorded by the digital pH meter.

Determination of soil available nitrogen: For determining available nitrogen in soil sample method described by Subbiah and Asija, (1956) was adopted.

Observations-

The values obtained for pH and soil available nitrogen content in various treatment sets of fertilizers in addition to that of control set has been shown in table 1 below.

Statistical Analysis- For the analysis of obtained data for pH and available nitrogen, two-way anova test was applied as statistical tool which is shown below in table 2 & 3 respectively.

pH values of the soil among control set, Organic fertilizers Kala Sona, Micro-AD, Chemical fertilizers Urea and DAP were analyzed. Test results show highly significant difference in the pH values of Control, Kala Sona, Micro-AD, Urea and DAP ($F=61.87$, $p<0.001$). pH range was found to be highest for Control and lowest for Urea. The range of pH was nearby for Kala sona and Micro-AD and in middle among them for DAP.

Available nitrogen was compared among control, fertilizers kala sona, micro-ad, urea and DAP. Test result shows highly significant difference in the available nitrogen among them ($F=5.31$, $p<0.01$). Available nitrogen content was highest in urea which was significantly higher than the amount of available nitrogen in other fertilizers as well as control group.

The graphical representation of variation in the pH and available nitrogen in the vermicompost treated with those of chemical fertilizers and organic fertilizers has been done in fig. (a) – for pH values and fig.(b) – for available nitrogen as shown-

Results and Discussion-

Table – 1

S.N	Soil Parameter	Initial Soil	Control	Urea 0.75gm	Urea 1.5gm	Urea 2.25gm	DAP 0.75gm	DAP 1.5gm	DAP 2.25gm	DAP 2.75 gm	Kala Sona 0.45gm	Kala Sona 0.9gm	M-AD 0.2ppm	M-AD 0.4ppm
1	pH	6.8	7.5	6.1	5.7	5.5	6.5	6.6	6.2	5.9	7.3	7.1	7	7.2
2	Avl N	0.026	0.085	0.095	0.102	0.126	0.083	0.088	0.082	0.096	0.087	0.1	0.105	0.08

Table – 2

pH

Group	N	Mean	SD	F	Result
Control	3	7.53	0.06	61.87	***
Kala Sona	6	7.18	0.15		
Micro AD	6	7.10	0.14		
Urea	9	5.76	0.27		
DAP	12	6.33	0.29		

Table – 3

Available Nitrogen

Group	N	Mean	SD	F	Result
Control	3	0.08	0.00	5.31	**
Kala Sona	6	0.09	0.01		
Micro AD	6	0.09	0.01		
Urea	9	0.11	0.01		
DAP	12	0.09	0.01		

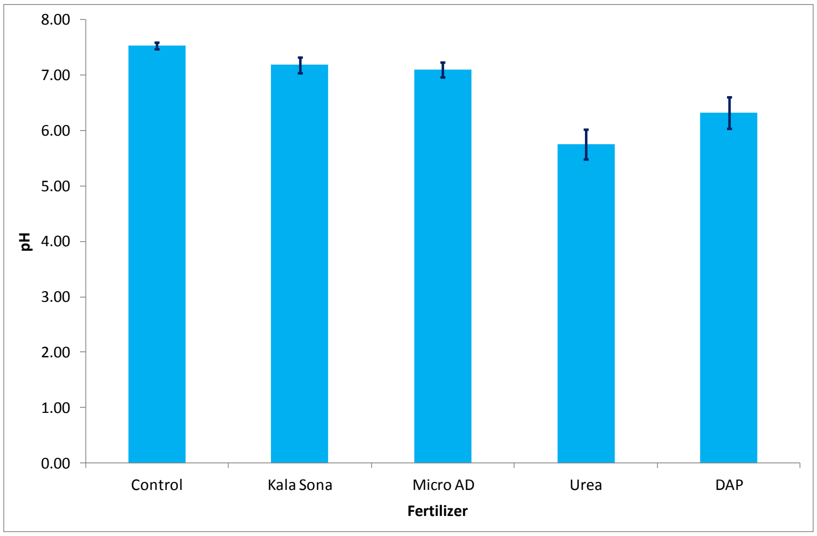

Fig. (a)

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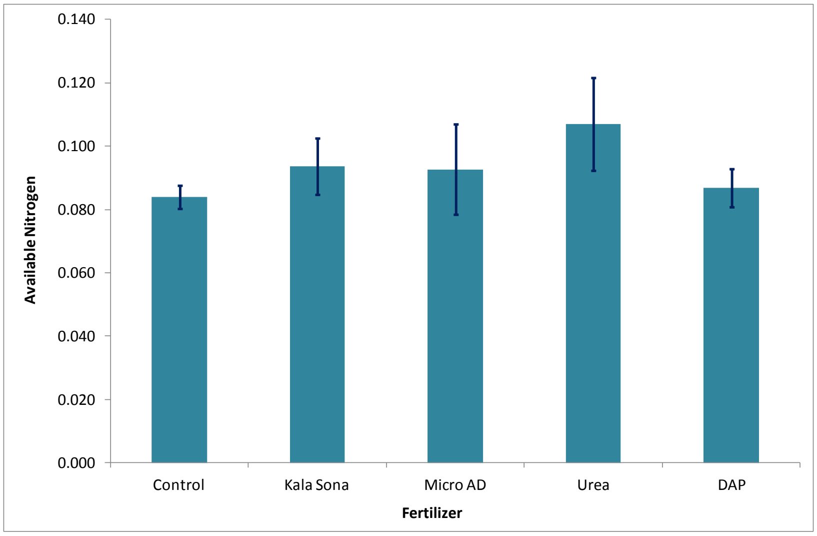

Fig. (b)

1. Effect of Chemical fertilizers & Organic fertilizers on Soil pH –

The initial value of pH of the soil used in the experiment was found to be 6.8. After 60days all the soil samples in the treated sets as well as that of control set i.e. the vermicompost was analyzed for pH ranges. Soil pH varied significantly with the treatments sets. The pH in the control set shifted to an increase with a value of 7.5. In the treated sets with Organic fertilizer 'Kala Sona' with dose 0.45gm and 0.9gm, the pH was noted to be 7.3 and 7.1 respectively. Similarly, in the other brand of Organic fertilizer viz. 'Micro-AD' the pH ranged as 7.0 and 7.2 in respective concentrations of 0.2ppm and 0.4ppm. But, sharp drop in the pH was seen in the soil under treatment with Chemical fertilizer Urea. Here, the pH showed decrease with 6.1, 5.7 and 5.5 respectively under the dose of Urea with 0.75gm, 1.5gm and 2.25gm. This was a record lowest pH value in our experiment among all the sets analysed, revealing acidic conditions of the soil substrata as a result of reactions of the chemical fertilizer. The soil sample with dose treatment of 2.75gm/kg Urea was not taken into consideration for analysis as the worms in this set were no longer alive by the end of experiment. Under the Chemical fertilizer Di-ammonium phosphate of dose 0.75gm, 1.5gm, 2.25gm and 2.75gm, the pH was found as 6.5, 6.6, 6.2 and 5.9 respectively. Thus here, in our experiment the highest value for pH was noted to be 7.5 under the control set whereas lowest value was recorded in Urea Exp. Set with dose of 2.25gm.

Earthworms are very sensitive to pH, thus pH of the soil is sometimes a factor that limits the distribution, numbers and species of earthworms. Similar findings on application of nitrogenous fertilizers on pH were observed by Cakmak et al., (2010), T. Milosevic & N. Milosevic, (2009). Similarly, Ndegwa et al., (2000) pointed out that shifting of pH could be related to the mineralization of the nitrogen and phosphorus into nitrites/ nitrates and ortho phosphates and bioconversion of the organic material into intermediate species of the organic acids. The ability of nitrogen fertilizer to reduce soil pH depends on a variety of factors. These include the nature of the micelle, the base saturation of the soil, the ratio of the cations in the soil, and weather, particularly rainfall (Buckman & Brady, 1969). Several researches have stated that most species of earthworm prefer a pH of about 7.0 (Singh, 1997; Narayan, 2000; Pagaria and Totwat, 2007; Suthar, 2008; Panday and Yadav, 2009) although Edwards (1995) reported a wide range of pH (5.0-9.0) in organic waste management. The drop in pH may be due to the action of microorganisms on carbohydrate, the most labile fraction of organic matter leading to the release of organic acids (Fang et al., 2001). Our study also indicated that pH decrease as a result of application of chemical fertilizers affects the earthworm abundance and biomass which is also supported by the results of work done by M. Iordache, I. Borza, (2010). Earthworms are generally absent from very acid soils (pH< 3.5) and are scarce in soils with pH less than 4.5.

2. Effect of Chemical fertilizers & Organic fertilizers on soil available Nitrogen (AN)-

In the initial soil, the available soil nitrogen was 0.026%. By the end of our experiment, the soil in control set without any treatment, recorded with 0.085% available N. Among the two types of chemical fertilizer, AN under Urea dose 0.75gm, 1.5gm and 2.25gm calculated as 0.095%, 0.102% & 0.126% respectively. DAP treatment soil sets with 0.75gm, 1.5gm, 2.25gm and 2.75gm fertilizer showed an increase in AN to values of 0.083%, 0.088%, 0.082% & 0.096% respectively. AN calculated in 0.45gm and 0.9gm 'Kala Sona' fertilizer was 0.087% & 0.100% whereas, it was 0.105% and 0.080% for 0.2ppm and 0.4ppm 'Micro-AD' concentration of Organic fertilizer treatment. Thus, we found the highest value for AN in Exp. set of Urea 2.25gm and lowest value in 'Micro-AD' 0.4ppm treated Exp. set. The higher noted value in Urea treated set can be attributed to the nitrogenous nature of this chemical fertilizer. This fertilizer contains 46% N, so here this can be the source of this increased level of AN in our study. Also, work has been cited in this context of enrichment of soil nitrogen due to earthworm's excretion of nitrogenous metabolic products in the surrounding soil. This showed an substantial increase in N content these results are in line with finding of Bhardwaj and Omnawar (1994), Dubey et al., (2012) and Singh et al. (2009) who observed that available N content in soil increased significant with the use of recommended dose of fertilizer.

Several workers have reported an increase in total nitrogen and nitrate nitrogen in the soils having high populations of earthworms. Earthworms also have a great impact on nitrogen transformations in manure by enhancing nitrogen mineralization, so that mineral nitrogen was retained in the nitrate form (Ateyeh *et al*., 2000). Addition of nitrogen in the form of mucus, nitrogenous excretory substances, growth stimulating hormones and enzymes from earthworms has also been reported (Tripathi and Bhardwaj, 2003). The increased nitrogen may be due to nitrogenous metabolic products of earthworms which are returned to the soil through casts, muco-proteins and earthworm tissue (Umamaheswari *et al*., 2003). By means of mucus production, nephredial excretion, and form their dead tissue, earthworm contributes about 99-198 kg of nitrogen to the soil per hectare per year (Dash 1978). . According to Lee (1985), N-containing products of earthworm metabolism are returned to the soil in form of casts, urine, mucoproteins and dead earthworm tissues. These results are in line with finding of Bhardwaj and Oman war (1994) and Singh et al. (2009) who observed that available N content in soil increased significant with the use of recommended dose of fertilizer. While studying the effect of fertilizers scheduling on the yield of cereals and available NPK status, Sarma et al., (2007) observed significantly improved soil N & P status after harvest of wheat crop with application of 150kg N ha^{-1} + 10.0t farmyard ha^{-1}.

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