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Evaluation of Poultry Waste Recycled For Vermicomposting and Its Response on Growth and Yield of Tomato Plant (Lycopersicum Esculent Mill.)

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***Abstract:** The aim of the present study is to convert the poultry waste into vermicompost using earthworm species Eudrilus eugeniae and to study its effect in tomato plant. The poultry waste was mixed with cow dung at different ratios such as 20:80, 40:60, 60:40, and 80:20 for vermicomposting. Field experiment was conducted using poultry waste with cow dung vermicompost treatments to determine their effects on the growth and yield of tomato plant. The maximum plant height, number of leaves, leaf area, number of fruitsand yield were observed in P_2V (40% poultry waste + 60% cow dung vermicompost) treated tomato plant compared to other treatment and control. The vermicomposting is a suitable technology for bioconversion of poultry waste into value-added vermicompost and reduction of solid waste pollution.*
***Keywords:** cow dung, Eudrilus Eugenia, poultry waste, tomato plant, vermicompost*

I. INTRODUCTION

Vermicomposting has its unique place in the organic waste management technique. The vermicomposting procedure is the bioconversion of organic waste into bio-fertilizer in the earthworms' gut which functions as a bio-reactor (Manyuchi and Nyamunokora, 2014). Vermicompost is considered as an invaluable product, since it is homogenous, bestowed with desired aesthetics, reduced levels of contaminants and has the propensity to hold more nutrients over a longer period without altering the environment (Suthar and Singh, 2008). The production of poultry waste in India is increasing day by day. Poultry waste is prominently organic in nature and contaminates water, air, and soil environment. Thus vermicomposting has become the most suitable alternative for the safe and hygienic cost-efficient means of disposal of this waste. Vermicomposting can prospectively add value to poultry waste. Vermicomposting through earthworms is an eco-biotechnological process that converts energy-rich and complex organic substances into stabilized vermicompost (Baptize et al., 2000). Poultry waste has higher protein content, nitrogen, and phosphoric acid compared to any other animal manure (Ronald and Donald, 1977). Although several studies have conducted on vermicomposting, which has revealed that numerous challenges confronted while vermicomposting of poultry litter. The concentration of high ammonia cal nitrogen, auto heating, and high bulk density are some of the major issues encountered while vermicomposting of poultry litter.

Vermicompost is a chief source of macro- and micro-nutrients and has a substantial potential for enhancing plant growth (Sahniet al., 2008). The present study was to convert the poultry waste into vermicompost using earthworm species Eudrilus eugeniae and its effect was evaluated on growth and yield of tomato plant.

II. MATERIALS AND METHODS

A. Collection of poultry waste, cow dung and earthworms

Poultry waste was collected from the poultry market in Batlagundu, Dindigul district, Tamilnadu, India. Poultry wastes include extra skin, viscera, foot and poultry litter. Cow dung was collected from the Mela Kovil Patti near Batlagundu. The mature earthworms *Eudrilus eugeniae* were collected from S.S Vermicompost farm, Pandiyarajapuram near Vadipatti, Madurai district, Tamil Nadu, India.

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B. Vermicomposting experiment

The collected poultry waste was minced into small pieces and air dried. The cow dung was dried and powdered. The poultry waste was mixed with cow dung at different ratios such as

1) P_1 = 20% poultry waste + 80% cow dung
2) P_2= 40% poultry waste + 60% cow dung
3) P_3 = 60% poultry waste + 40% cow dung
4) P_4= 80% poultry waste + 20% cow dung

The mixed substrates were transferred to separate plastic troughs (60×41×30cm size). Each plastic trough containing 10kg mixed substrate. Each treatment was maintained in triplicates. The required amount of water was added and mixed the substrates in all the experimental troughs for proper pre-composting. Poultry waste with cow dung was recomposed for 26.5±2.08 days. 500grams of earthworms *Eudrilus eugeniae* were inoculated in each trough after the pre-decomposition. Sprinkling water maintained the moisture content. The plastic troughs were covered on the top by a wet gunny bag to maintain the optimal moisture. The vermicompost has been harvested periodically from each trough and stored separately in polythene bags for physico-chemical analysis and the cultivation of tomato plant.

C. Physico-chemical analysis of vermicompost

The physico-chemical properties of the poultry waste and vermicomposts prepared from poultry waste with cow dung in different proportions were analyzed at Laboratory, Department of Animal Behavior and Physiology, School of Biological Sciences, Madurai Kamaraj University, Madurai, Tamil Nadu. P Hand electrical conductivity were determined using the pH and conductivity meters (Jackson, 1973). The organic carbon was estimated using chromic acid wet digestion method (Walkley and Black, 1934). The total nitrogen was estimated using the Kjeldahl method (Jackson, 1973). The total phosphorus was estimated using ammonium phospho-molybdate method (Pemberton, 1945). The total potassium was estimated using the Flame photometry method (Stanford and English, 1949). The C/N ratio was calculated by dividing the percentage of carbon with the percentage of nitrogen calculated in the sample.

D. Field experiment

Field experiment was conducted during October 2013- February 2014 at test plots in a farmland in Batlagundu, Dindigul district, Tamil Nadu, India, to study the effects of poultry waste with cow dung vermicomposts on the growth and yield of tomato plant (Lycopersicum esculentum Mill.). The experimental design was a Randomized Block Design with three replications. The tomato seeds (variety PKM-1) were collected from the “Farm Aid” major agro inputs dealers, Madurai, Tamil Nadu, India. The tomato seeds are sown in prepared separate nursery beds and watered regularly. The healthy, uniform size, colour and weight of tomato seedlings of four weeks old were selected and transplanted in the experimental plots with a spacing of 60cm between row to row and 40cm between plant to plant. The treatments of poultry waste with cow dung vermicomposts were applied to the experimental plants. The treatment details are following

1) P_1V = 20% poultry waste + 80% cow dung vermicompost
2) P_2V = 40% poultry waste + 60% cow dung vermicompost
3) C = Control (Without treatment).

150 grams of vermicompost was applied to each experimental tomato plant with an interval of 10 days. Subsequent irrigation was given and the weeds were taken out from the experimental field. The plant height, number of leaves, leaf area, number of fruits and yield per plant were measured.

E. Statistical analysis

The results in this study were analyzed statistically. The data were analyzed by using two - way Analysis of Variance (ANOVA) and the level of significance was fixed at 0.05. Correlation analysis was used to evaluate relationships of the physico-chemical parameters against vermicomposts.

III. RESULTS AND DISCUSSION

The physico-chemical characteristics of the poultry waste and vermicomposts produced by Eudrilus eugeniae using poultry waste with cow dung in different proportions are depicted in Figures 1 and 2. The physico-chemical characteristics of vermicomposts varied according to the initial substrate.

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A. pH

The pH value decreased in the treatments related to their initial value. The maximum reduction was recorded in P_1V treatment and the minimum reduction was recorded in P_2V treatment (Fig. 1A). The pH was positively correlated with total nitrogen (r=0.99), organic carbon (r=0.98), electrical conductivity (r=0.93) and C/N ratio (r=0.92) and negatively correlated with total phosphorus (r=-0.58) and total potassium (r=-0.62).Suthar (2009) reported that the reduction in pH than the initial levels in vermicomposting of cattle wastes. Since, the production of CO_2 and organic acids by the combined action of earthworms and microbial decomposition at the time of vermicomposting reduces the pH value of substrates (Elvira et al., 1998).

B. Electrical conductivity

The electrical conductivity level decreased in the treatments related to their initial level. The maximum reduction was recorded in P_1V treatment and the minimum reduction was recorded in P_2V treatment (Fig.1B). The electrical conductivity was positively correlated with C/N ratio (r=0.99), organic carbon (r=0.97) and total nitrogen (r=0.91) and negatively correlated with total phosphorus (r= -0.23) and total potassium (r= -0.28). The reduction of electrical conductivity in vermicompost reveals the reduction of salinity considerably. The reduced level of salinity is the important character of good bio-compost which is better for the growth of crops (Karthikeyan et al., 2007).

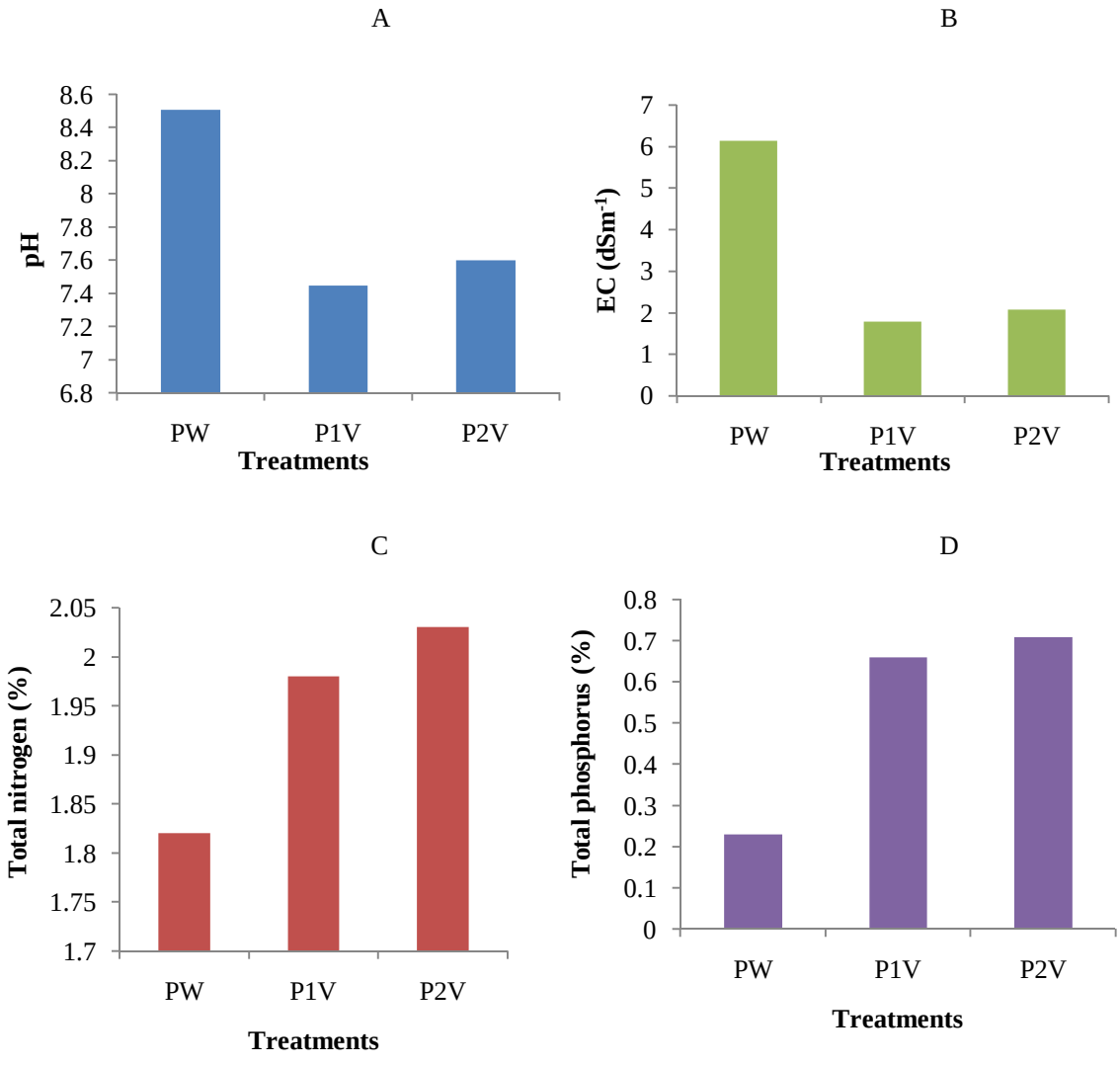


Fig.1A-DpH, electrical conductivity (dSm^{-1}), total nitrogen (%), total phosphorus (%) content of poultrywaste and vermicomposts. PW= Poultry waste (Initial), P_1V= 20% poultry waste + 80% cow dung vermicompost, P_2V = 40% poultry waste + 60% cow dung vermicompost.

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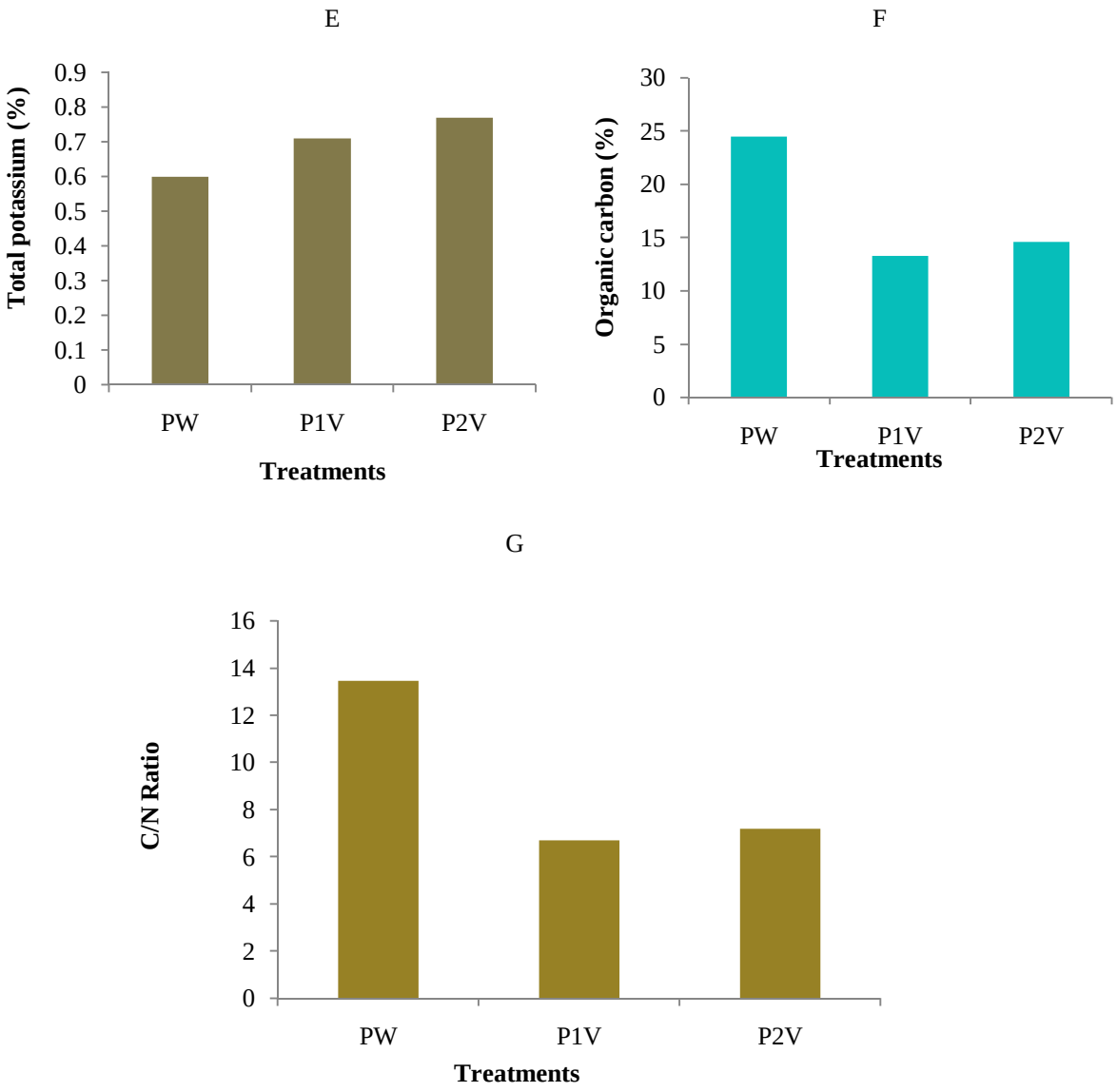


Fig. 2 E-GTotal potassium (%), organic carbon (%) and C/N ratio content of poultry waste and vermicomposts. PW= Poultry waste (Initial), P_1V= 20% poultry waste + 80% cow dung vermicompost, P_2V = 40% poultry waste + 60% cow dung vermicompost.

C. Total nitrogen

The total nitrogen increased in the treatments related to their initial level. The maximum increase was recorded in P_2V treatment and the minimum increase was recorded in P_1V treatment (Fig.1C). The total nitrogen was positively correlated with organic carbon (r=0.98) and C/N ratio (r=0.90) and negatively correlated with total phosphorus (r= -0.61) and total potassium (r= -0.65). Tripathi and Bhardwaj (2004) reported that the increase in nitrogen content was found in the final product in the form of nitrogenous excretory substances, mucus, enzymes and growth stimulating hormones from earthworms.

D. Total phosphorus

The total phosphorus increased in the treatments related to their initial level. The maximum increase was recorded in P_2V treatment and the minimum increase was recorded in P_1V treatment (Fig.1D). The total phosphorus was positively correlated with total potassium (r=0.99) and negatively correlated with organic carbon (r= -0.44) and C/N ratio (r= -0.22). Hait and Tare (2011) has explained that the increase in the total phosphorus content during vermicomposting was through mineralization, emission and mobilization of available phosphorus content of an organic waste of the earthworm gut phosphates.

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E. Total potassium

The total potassium increased in the treatments related to their initial level. The maximum increase was recorded in P_2V treatment and the minimum increase was recorded in P_1V treatment (Fig.2E). The total potassium was negatively correlated with organic carbon (r= -0.49) and C/N ratio (r= -0.27). Micro flora content in the gut of earthworms might have played a significant role in the mineralization process of organic wastes resulted in an increase in the levels of potassium in vermicomposts (Suthar, 2007a).

F. Organic carbon

The organic carbon decreased in the treatments related to their initial level. The maximum reduction was recorded in P_1V treatment and the minimum reduction was recorded in P_2V treatment (Fig.2F). The organic carbon was positively correlated with C/N ratio (r=0.97). The decrease in organic carbon after vermicomposting shows down organic matter stabilization in the substrate because of combined action of earthworms and soil microorganisms. It has been reported that the earthworms alter the substrate conditions, which in turn improved the carbon losses from the substrates through microbial respiration in the form of carbon dioxide (Aira et al., 2007).

G. C/N ratio

The C/N ratio decreased in the treatments related to their initial level. The maximum reduction was recorded in P_1V treatment and the minimum reduction was recorded in P_2V treatment (Fig.2G). The loss of carbon through the microbial respiration and mineralization with the simultaneous addition of nitrogen by earthworms in the form of nitrogenous excretory and mucus substances lowered the C/N ratio of an organic substrate (Suthar, 2007b).

H. Effects of vermicomposts on the growth and yield of tomato plant

The application of vermicompost (P_2V treatment) obtained from 40% poultry waste+60% cow dung recorded the highest plant height, maximum number of leaves per plant and maximum leaf area per leaf. Also maximum number of fruits and yield per plant was obtained at the same P_2V treatment than P_1V treatment and control. The minimum growth and yield parameters were recorded in control plants (Table 1). The Two-way ANOVA test clearly indicate that there were significant variations in the growth and yield parameters of tomato plant in the treatments of poultry waste with cow dung vermicomposts and control ($P<0.001$; $F_{4,14}= 106.49$). Nethraet al., (1999) noted the highest plant height and the maximum number of leaves of China aster (Callistephuschinensis) after the application of 10 t/ha of vermicompost. These increments in the height of the plants are attributed to the presence of growth promoting hormones auxins, cytokinins secreted by earthworms (Suhane, 2007).

Table 1 Effects of poultry waste with cow dung vermicomposts on the growth and yield parameters of tomato plant

Treatments	Plant height (cm)	Number of leaves per plant	Leaf area per leaf (cm^2)	Number of fruits per plant	Yield per plant (gm)
P_1V	61.78 ± 1.95	168.93 ± 3.60	26.93 ± 0.68	15.68 ± 2.00	529.16 ± 14.32
P_2V	63.57 ± 1.64	170.65 ± 5.08	28.17 ± 0.47	18.76 ± 1.83	632.25 ± 16.43
C	44.95 ± 2.43	115.72 ± 3.52	14.78 ± 0.77	10.43 ± 3.54	452.75 ± 9.32

P_1V = 20% poultry waste + 80% cow dung vermicompost
P_2V = 40% poultry waste + 60% cow dung vermicompost
C = Control (Without treatment).

Mubarak et al., (1998) reported that the application of vermicompost increases the number of leaves and flowers in plants. The application of vermicompost increased the leaf area in pepper plant (Norman et al., 2003). Ansari, (2008) found out that the yield of potato (Solanum tuberosum) by application of vermicompost. The overall yield of potato was significantly high (21.41 tons/ha) on vermicompost applied @ 6 tons/ha compared to the control which was 04.36 tons/ha of potato.

I. Earthworms' mortality

The total earthworms' mortality was observed in P_3 and P_4 treatments. The P_3 and P_4 treatments were unable to support growth of earthworm Eudrilus eugeniae. A high proportion of poultry waste was not accepted by the earthworm Eudrilus eugeniae as food indicating its toxic effects on earthworms and non-acceptance as food substrate. Dominguen and Edwards (2011) reported that the

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worms are very sensitive to ammonia and cannot survive in poultry waste containing a high level of ammonia. So, the P_3 and P_4 treatments were not conversion of poultry waste into vericompost produced by Euripus eugeniae.

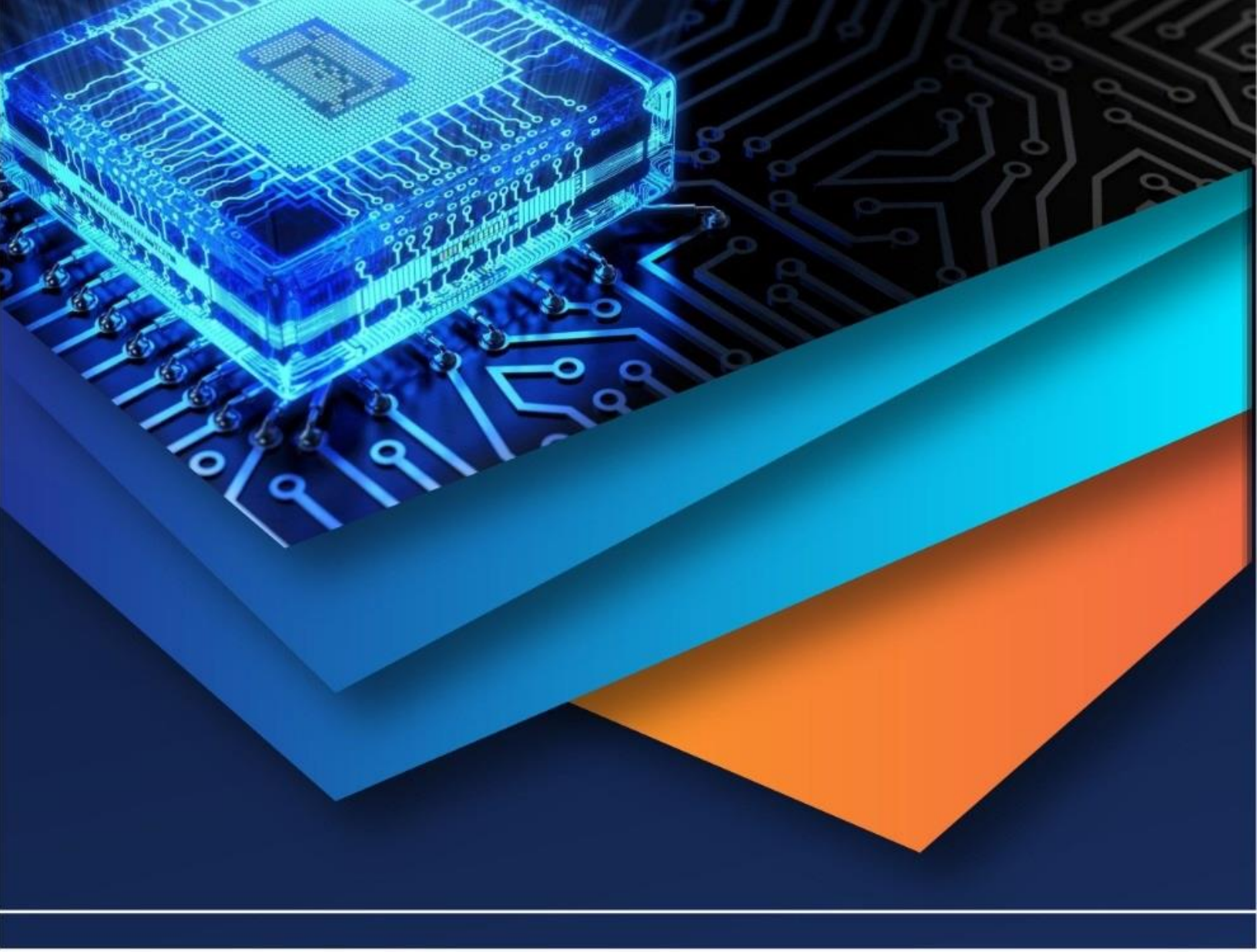
IV. CONCLUSION

The substrate combining the mixture of poultry waste and cow dung at 40:60 ratio provides the major nutrients in balanced proportion compared to other treatments. The application of vermicompost produced from this ratio has shown highest growth and yield in tomato plant. This can be used as low cost organic fertilizer in agriculture. The results from this study provide the sound basis that vermicomposting is a suitable technology for bioconversion of poultry waste into vermicompost and reduction of solid waste pollution.

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