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Comparative effects of poultry droppings and N.P.K. 15:15:15 on the growth and density of soil microbes

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ABSTRACT

Soil microorganism contributes immensely to the nutrient availability and decomposition of soil organic matter but little or no specific investigation is being carried out on the possible effects of all those nutrients fixing chemicals or substances on the survival and population distribution of various microbes. Due to usefulness of fertilizers whether organic or inorganic manures to increase the soil microorganisms in fastening the growth of plants either in forest produce or agricultural aspect, there is need to inspect the best fertilizer application that best suit the growth of the soil microorganism. This study investigates the comparative effects of poultry droppings and N.P.K 15:15:15 on the growth and population of soil microbes. The land was prepared and marked out with dimension of 1m x 1m and was divided into ten portions which consists four treatments and one control, these were replicated twice. Samples were collected from the land marked out for microbial analysis, so also analysis of the poultry droppings were carried out for microbial analysis. 20 and 30 grams each of the poultry droppings and N.P.K 15:15:15 were applied to the land portion marked out. The experiment was laid on in a Randomized Complete Block Design (RCBD) and was left for four weeks, after which soil samples in each portion were collected and subjected to another microbial analysis. The parameters assessed were total bacterial plate, total coliform, and total fungal count. The data collected were subjected to mean, bar chart representation and analysis of variance (ANOVA). The results revealed that T_2 (Poultry droppings at 20g) had the highest value of 4.4 while T_4 (N.P.K 15:15:15 at 20g) had the least value of 1.9 for total plate bacterial count. The analysis of variance (ANOVA) for total plate bacterial, total coliform and total fungal count showed that there is significant difference among the treatments at 0.05 level of significance. Therefore T_2 is considered the best to raise soil microbes in the soil being the treatment with the highest bacterial, coliform and fungi count.

1. INTRODUCTION

Soil microbes' work in our soil is incredibly complex. Plants are unable to take from the soil the nutrition they need without microbes working in the soil. Microbes are alive, and must have nutrition to survive, and that nutrition comes from organic matter. As they consume the nutrients they need, microbe creates foods like nitrogen, carbon, oxygen, hydrogen, phosphorus, potassium and trace minerals for our plants. It is the microbes that convert the NPK and minerals in the soil into a form our plants can use to grow and produce food flowers for us (Parr *et al. 1994*). Microbes are everywhere; they are in the air, in the rivers and oceans, in our drinking water, in the soil and our skin. Of course we know some microbes are bad, like salmonella and *Eumeria coli,* but more are considered beneficial and out-compete pathogens for survival in the soil (Higa, 1995). There are all kinds of microbes like algae, protozoa, bacteria and fungi with many others waiting to be discovered. Their population in soil are numerous as many as one billion of up to 13,000 species in a gram of soil (1 gram = 0.0022 pounds) (Dundas *et al*, 2002). Most microbes need organic carbon to live; they get this from eating wood chips, leaves, manures and other organic matter, they creates humus which increases soil structure, good for root penetration and development (compaction can nullify much of this action) (Parr *et al*., 1994). Microbes also get some carbon from the rhizosphere (the area immediately around plant roots) because roots gives off substances the microbes can use, like sugars and amino acids and then the microbes convert some of it back forms the plants can use, as minerals, vitamins, nitrogen's and amino acids. (Amino acids are building blocks of protein (Schulz and Jorgensen, 2001). Some microbes (like some bacteria and blue-green algae) are able to fix nitrogen from air and make it available to plants. Some plants and trees cannot grow if deprived of specific microbes (mycorrhizal fungi) around their roots. That's why some plants need a good shovelful of additional soil from around their roots for company when transplanting (Horneck, 1981). Researches are ongoing to select microbes that digest other toxins our soil (Landford, 2004). Microbes multiply, and if microbes population is low due to lack of organic matter, it can easily rectified by mending the soil with soil organic and allowing time for microbial growth (Kuruvilla *et al.,* 2009). Microorganisms are useful in eliminating problems associated with the use of the

chemical fertilizers and pesticides. They are widely applied in nature farming and organic agriculture (Higa, 1991; Par *et al*., 1994). Organic fertilizers are composed of natural ingredient from plant parts such as leaves and peanut hulls, and poultry droppings. Both organic and inorganic supplement the soil and feed plants with nutrients. Macronutrients are those nutrients that plants require in large amounts which include nitrogen, phosphorus and listed as percentage on the fertilizer bag (Reganold *et l.,* 1990). Inorganic fertilizers nearly are readily dissolved and unless added have few other macro and micro plant nutrient). Inorganic fertilizer nitrogen, phosphorus and potassium compounds are released from the complex organic compounds as the animal or plant matter decays. In commercial fertilizer, the same required compounds are available in easily dissolved compounds when water is applied. Inorganic fertilizers are usually much more concentrated with up to 64 % (18-46-0) of their weight being a given plant nutrient, compared to organic fertilizers that only provide nutrient (Stewart *et al.,* 2005). An integrated approach blends the use of both organic and inorganic fertilizers. A study by Kuruvilla *et al.,* and published in 2009 describes the benefits of an integrated system on rice fields in India. The authors found that a combination of organic and synthetics fertilizers resulted in yield that increased over five years. They concluded that an integrated approach improved the capacity of soil to supply nutrients. This study therefore seeks to determine the likely effects of poultry droppings and N.P.K 15:15:15 fertilizers on soil's microbial growth and populations.

2. MATERIALS AND METHODS

2.1 Experimental site

The experimental site is located within the premises of Federal College of Forestry, Jericho, Ibadan. The college is located within latitude 7^0N and Longitude 3^058^0E with an annual rainfall ranging from 1300-1500 m, the temperature is 37.2^0C and average relative humidity of about 80-75% (FRIN, 2008).

2.2 Materials used include:

i. Weighing balance
ii. Dry from of poultry dropping and N.P.K 15:15:15
iii. Metre rule, cutlass and hoe.
iv. Soil samples

A land was prepared and marked out with dimension of 1 m x 1 m. This was divided into ten portions which consist of four (4) treatments and one (1) control which was replicated twice. On the land marked out, soil samples were collected and taken for microbial analysis to assess the total amount and types of soil microbes present in the soil per (m^2) after which poultry dropping (battery cage) collected from the college farm were applied into two portion with variation of 30 grams, 20 grams and replicated twice. Then N.P.K15:15:15 fertilizer was applied into another two portions with variation of 30 grams, 20 grams and was replicated twice. The experimental site was left for four (4) weeks after which soil samples in each portion were collected and subjected for another microbial analysis. It was ensured that the land preparation was done on a flat terrain alongside with presence of furrow between the portions being demarcated to avoid it from leaching.

2.3 Experimental layout

The experiment was laid out in a completely randomized \ block design (CRBD) having four (4) treatments and one (1) control which was replicated twice making the total of 10 portions. The treatments are: T_0 – Control, T_1 - Poultry dropping at 30 grams, T_2 - Poultry dropping at 20 grams and T_3 - N.P.K 15:15:15 at 20 grams as shown in Table 1.

Table 1: Experimental layout

Treatment / Replicate	R_1	R_2
T_0	T_0R_1	T_0R_2
T_1	T_1R_1	T_1R_2
T_2	T_2R_1	T_2R_2
T_3	T_3R_1	T_3R_2

Population density (km^2) = $\frac{\text{Total population}}{\text{Total land area}}$

2.4 Data analysis

The data collected was subjected to standard deviation and Analysis of variance (ANOVA), results were also presented in form of bar charts.

3. RESULT AND DISCUSSION

Analysis of soil sample at initial stage was carried before the experiment in order to know the effects of the fertilizers applied. The results of the analysis are as shown in Tables 2 and 3.

Table 2: Microbial analysis of soil sample at initial stage

Parameters	Value
Soil	
Total Variable Count	$1.7x10^5$
Organism Isolated	*Cacillus Spp., Pseudomona Spp., Staphylococcus Spp.*
Total Coliform Count	$1.1x10^3$
Organisms Isolated	*Enterobacter Spp.*
Total Fungal Count	$1.3x10^4$
Organism Isolated	*Aspergillus Spp., Penicillium Spp.*

Table 3: Result of soil analysis

Parameters		Value
pH (H_2O. 1:1)		7.13
Sand		804
Silt	Gkg^{-1}	88
Clay		10g
Exchangeable bases		
Na		0.47
K	(c mol kh^{-1})	0.88
Ca		4.41
Av. Phosphorus (mg kg^{-1})		8.47
% Org. Carbon		2.26
% Org. Matter		3.90
% N		0.23

Table 4: Mean Number of Total Bacterial count, Coliform count and Fungi count

Treatments	Organism	Microbial Load x 10^5	Microbial Isolated
T_0	Bacteria	2.2x10^5±0.22	*Bacillus Spp. Pseudomonas Spp. Staphylococcus Spp.*
		2.0x10^5±0.03	*Aeomonas spp. Enterobacter spp.*
	Fungi	1.9x10^5±0.09	*Penicillium Spp. Aspergillus Spp. Rhizopus.*
T_1	Bacteria	2.1x10^5±0.27	*Bacillus spp. Oseudomonas Spp. Staphylococcus Spp. Flavobacterium Spp.*
		1.8x105±0.12	*Aeromonas Spp. Enterobacter Spp.*
	Fungi	1.95x105±0.01	*Penicilium Spp. Aspergillus Spp. Rhizopus. Sacc Spp.*
T_2	Bacteria	4.4x10^5±0.76	*Bacillus spp. Pseudomonas Spp. Staphylococcus Spp. Flavobacterium Spp.*
		2.9x10^5±0.38	*Aeromonas Spp. Enterobacter Spp.*
	Fungi	2.7x10^5±0.34	*Penicilium Spp. Rhizopus*
T_3	Bacteria	2.9x10^5±0.09	*Bacillus Spp. Pseudomonas Spp. Staphylococcus Spp. Flavobacterium Spp.*
		2.0x10^5±0.03	*Aeromonas Spp. Enterobacter Spp.*
	Fungi	1.610^5±0.14	*Penicilium Spp. Aspergillus Spp. Rhizopus. Mucor*
T_4	Bacteria	1.9x10^5±0.36	*Bacillus Spp. Pseudomonas Spp. Staphylococcus Spp.*
		1.x10^5±0.21	*Aeromonas Spp. Enterobacter Spp.*
	Fungi	1.6x10^5±0.21	*Penicilium Spp. Aspergillus Spp. Rhizopus.*

The Table 4 shows that the microbial loads and isolated of the soil samples. Different bacteria and fungi were isolated. There was increase in the bacteria count as the level of organic and inorganic fertilizers were increased in which most of the bacteria are of great benefit such as Bacillus Spp while some have negative effect (e.g. Staphylococcus Spp.) to the soil by which they aid plants in absorbing nutrients and drastically reduce external inputs of pesticides, energy and fertilizer, at the cost of decrease yield (Pimentol *et al*., 2005).

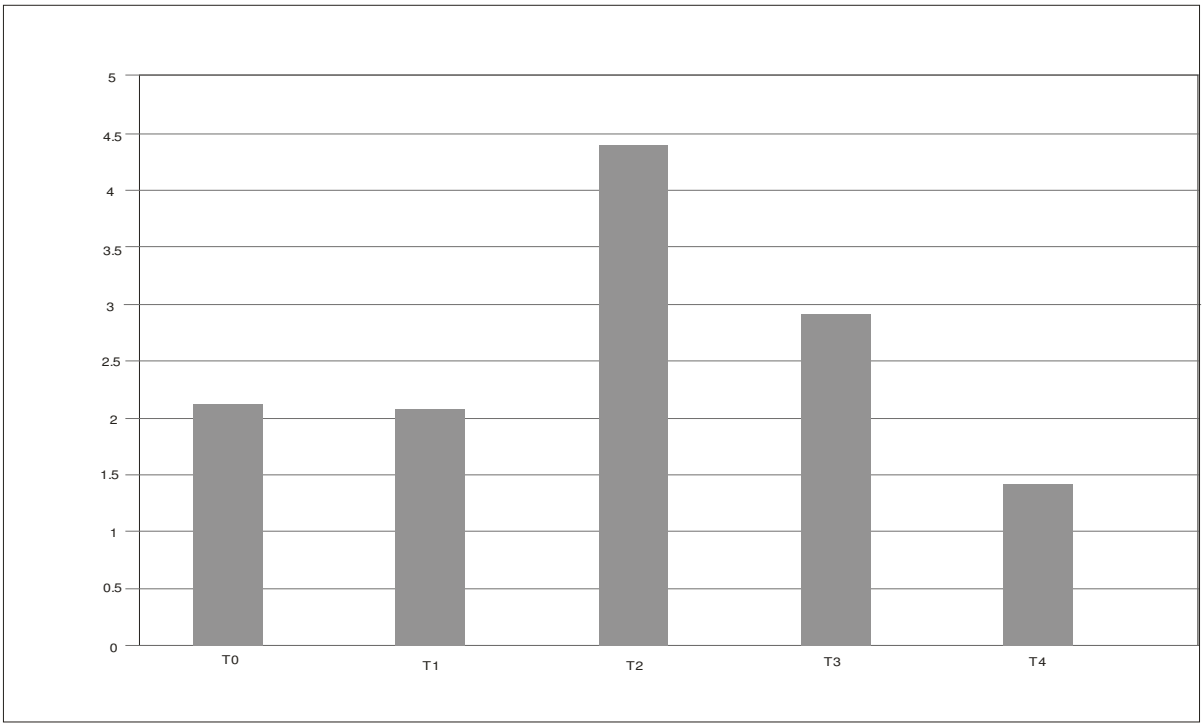

Figure 1: Total bacteria count (Microbial analysis of soil sample at final stage)

Table 4 and Figure 1 show that T_2 (Poultry dropping at 20kg) has the highest value of (4.4) followed by T_3 (N.P.K 15:15:15 at 30g) with the value of (2.9) which is closely followed by T_0 (which is the control at 0g) with the value of (2.2) and T_1 (Poultry droppings at 30g) had the value 0f (2.1) while T_4 (N.P.K 15:15:15 at 20g) had the least value of (1.9). Zubleona *et al.,* (2009) stated that organic from compost and other effective in which it increases the bacteria present in the soil leading to improvement or increase in the soil nutrient over a longer period of use. Table 5 shows that there is significant difference among the treatments with Fcal (5.42) being greater than Ftab (5.19) at 0.05 level of significance.

Table 5: ANOVA for total bacteria count

SV	DF	SS	MS	Fcal	Ftab
Treatment	4	18.22	4.56	5.42	5.19
Error	5	4.18	0.84		
Total	9	22.40			

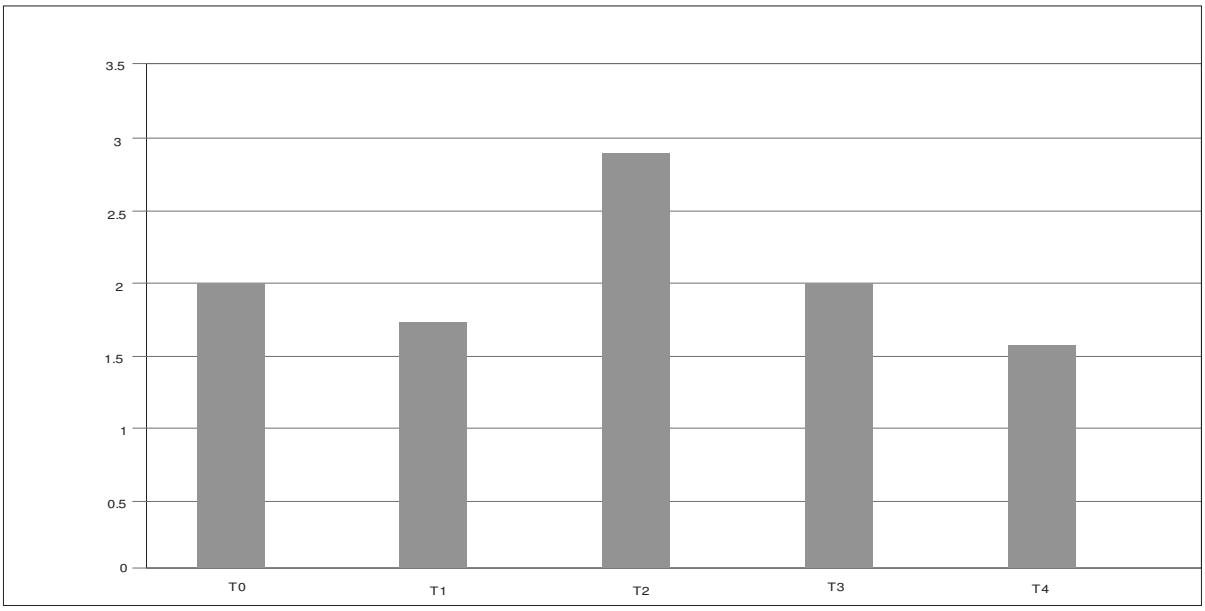

Figure 2: Total coliform count

Figure 2 reveal that T_2 (Poultry dropping at 20g) have the highest value of (2.9) followed by T_0 (which is the control at g) and T_3 (N.P.K 15:15:15 at 30g) has the same value of (2.0) followed but T_1 (Poultry dropping at 30g) has the value of (1.8) while T_4 (N.P.K 15:15:15 at 20g) have the least value of (1.6). This indicated that poultry manure at 20g have the highest mean value for total Coliform count in which Hornick (1992) reported that poultry manure (Organic manure) improves the soil and Rhizosphere micro flora can accelerate the growth of plants and enhance their resistance to disease and harmful insect by producing bioactive substance in this Table 6 shows that there is significant difference among the treatment since Fcal (13.26) is greater than Ftab (5.19) at 0.05 level of significance.

Table 6: ANOVA for total Coliform count

SV	DF	SS	MS	Fcal	Ftab
Treatment	4	10.61	2.65	13.26	5.19
Error	5	0.99	0.20		
Total	9	11.60			

Figure 2 also shows that T_2 (Poultry droppings at 20g) has the highest value of (2.7) followed by T_1 (Poultry dropping at 30g) which has the value of (1.95) and is closely followed by T_0 (which is the control at 0g) which has the of value (1.9) and both T_3 (N.P.K 15:15:15 at 30g) and T_4 (N.P.K 15:15:15 at 20g) had the least value of (1.6). This implies that there is much increase in the total fungal count in T_2 compared to other treatment. Mader *et al.,* (2002) report that organic nutrient increase soil organisms by providing organic matter and micronutrient for organisms such as fungal. Table 7 showed that there is significant difference among the treatment: Fcal (12.12) is greater that Ftab (5.19) at 0.05 level of significance.

Table 7: ANOVA for total fungal count

SV	DF	SS	MS	Fcal	Ftab
Treatment	4	9.21	2.30	12.12	5.19
Error	5	0.94	0.19		
Total	9	11.60			

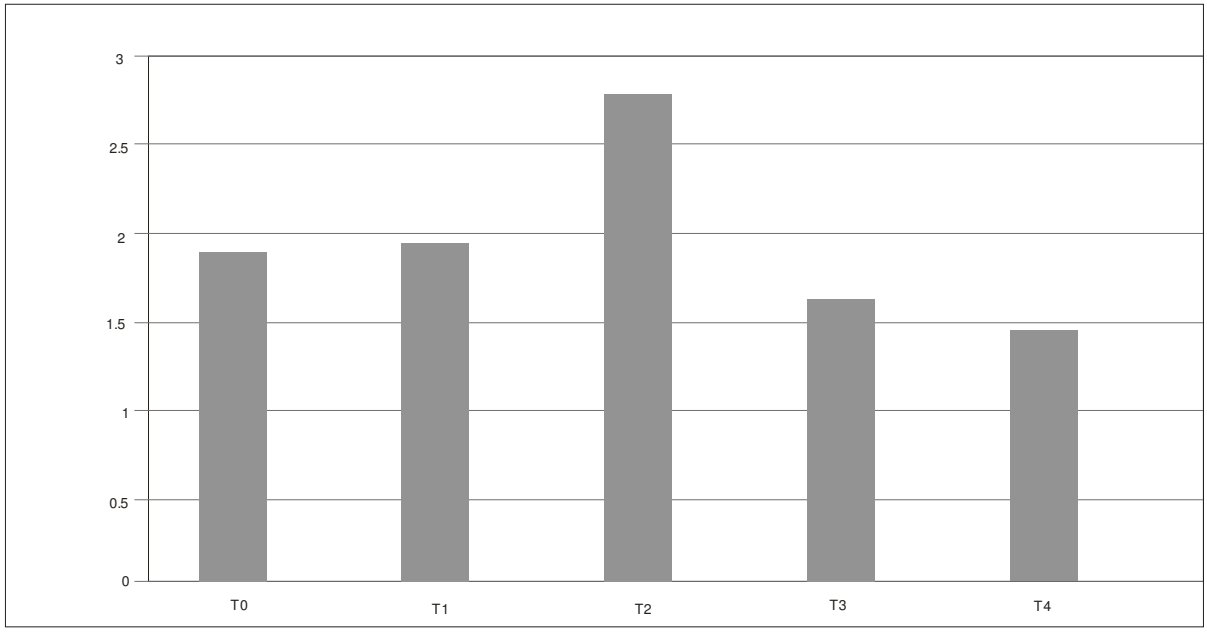

Figure 3: Total fungal count

CONCLUSION

From the results obtained in the study, it was observed that treatment two (T_2) of poultry dropping of 20 grams had the highest population of soil microbes. Moreover, since there is increment in population and growth of the soil microbes present in treatment two of 20 grams, it can be deduced that poultry dropping of 20 grams best suited to raise soil microbes in the soil. Also, organic fertilizers which composed of natural ingredients from plant parts such as leaves and peanut hull, and poultry dropping. I.e. compost when applied to the soil, gave increase in the total population density (Total plate count increase from 70.83 to 1116.70 km^2; Total Coliform count from 45.83 to 858.33 km^2 and total fungal count from 54.17 to 1216.70 km^2) of the soil microbes. Microbes make nutrients in the soil available to plants in a form the plants can use. Microbes create some of those nutrients; they resist disease better and tolerate environmental stress better. Microbe also improves soil structure by the humus they create while digesting organic matter, microbes also help in nitrogen fixing.

APPENDIX

Table 8: Poultry dropping analysis

Total Nitrogen %	1.3
	1.2
Phosphorus as PO_4- (mg/110g	160
	155
K^+ (mg/1100g)	42
	45
Ca^{++}(mg/100g)	140
	150
Mg^{++}(mg/100g)	37
	36
Sulphur as SO_4-((mg/100g)	25
	28

CEC - Cation exchange capacity, % C - Percentage organic carbon, Cmol/kg - Cent mol per kilogram, % N - Percentage Nitrogen

Table 9: Microbial analysis of soil sample at initial stage

Parameter	Value
Soil	
Total viable count	1.7×10^5
Organisms Isolated	*Bacillus Spp. Pseudonomas Spp. Staphylococcus Spp.*
Total Coliform Count	1.1×10^3
Organism Isolated	*Enterobacter Spp.*
Total Fungal Count	1.3×10^4
Organisms Isolated	*Aspergillus Spp, penicillium Spp.*

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Table 10:

Sample Label	**Total Plate Count**	**Organism Isolated**
(T_0R_1)	1.2×10^5	Baccillus spp. Pseudomonas spp. Staphylococcus spp.
(T_0R_2)	3.2×10^5	Baccillus spp. Pseudomonas spp. Staphylococcus spp.
(T_1R_1)	1.2×10^5	Baccillus spp. Staphylococcus spp. Flavobacterium
(T_1R_2)	3.0×10^5	Baccillus spp. Pseudonomas spp.
(T_2R_1)	4.2×10^5	Baccillus spp. Pseudonomas spp. Flavobacterium spp.
(T_2R_2)	3.8×10^5	Baccillus spp. Pseudomonas spp. Staphylococcus spp.
(T_3R_1)	1.9×10^5	Baccillus spp. Pseudonomas spp. Flavobacterium spp.
(T_3R_2)	1.9×10^5	Baccillus spp. Pseudomonas spp. Staphylococcus spp,Flavobacterium spp.
(T_4R_1)	2.0×10^5	Baccillus spp. Pseudomonas spp. Staphylococcus spp.
(T_4R_2)	1.7×10^5	Baccillus spp. Staphylococcus spp. Pseudomonas spp.

Table 11:

Sample Label	**Total Count**	**Fungi Organism Isolated**
1. (T_0R_1)	1.4×10^4	*Aeromonas Spp. Enterobacter Spp.*
2. (T_0R_2)	2.6×10^5	*Enterobacter Spp.*
3. (T_1R_1)	1.0×10^5	*Aeromonas Spp. Enterobacter Spp.*
4. (T_1R_2)	2.6×10^5	*Aeromonas Spp. Enterobacter Spp.*
5. (T_2R_1)	2.0×10^5	*Aeromonas Spp. Enterobacter Spp.*
6. (T_2R_2)	3.8×10^5	*Enterobacter Spp. Aeromonas Spp.*
7. (T_3R_1)	2.2×10^4	*Enterobacter Spp.*
8. (T_3R_2)	1.8×10^5	*Aeromonas Spp.*
9. (T_4R_1)	1.7×10^5	*Enterobacter Spp.*
10. (T_4R_2)	1.5×10^4	*Aeromonas Spp.*

Table 12:

Sample Label	Total Count	Coliform Organism Isolated
1. (T_0R_1)	1.8 x 10^4	*Penicillium Spp. Aspergillus Spp. Rhizopus.*
2. (T_0R_2)	2.0 x 10^4	*Penicillium Spp. Aspergillus Spp.*
3. (T_1R_1)	1.1 x 10^4	*Rhizopus. Aspergillus Spp. Penicillium Spp*
4. (T_1R_2)	2.8 x 10^4	*Aspergillus Spp. Sacc Spp.*
5. (T_2R_1)	2.2 x 10^4	*Rhizopus. Penicillium Spp*
6. (T_2R_2)	3.2 x 10^4	*Rhizopus.*
7. (T_3R_1)	1.4 x 10^4	*Penicillium Spp. Rhizopus. Mucor*
8. (T_3R_2)	1.8 x 10^4	*Aspergillus Spp. Mucor Spp.Rhizopus*
9. (T_4R_1)	1.6 x 10^4	*Aspergillus Spp. Penicillium Spp*
10. (T_4R_2)	1.3 x 10^4	*Aspergillus Spp. Penicillium Spp Rhizopus Spp.*

Table 13: Result of soil analysis

Parameters		Value
pH(H2O. 1:1		7.13
Sand		804
Silt	Gkg-1	88
Clay		108
Exchange bases		
Na		0.47
K	(c mol kg-1)	0.88
Ca		4.41
Av. Phosphorus (mg kg-1		8.47
%Org. Carbon		2.26
%Org. Matter		3.90
%N		0.23

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