BIBLIOGRAPHY

PALENG, LYNETH M. MAY 2011. Effect of Soil Amendments Against *Cercospora* Leaf Spot (*Cercospora fragariae*) and Crown Rot (*Fusarium oxysporum* f.sp. *fragariae*) of Strawberry (*Fragaria x ananassa Dutch*). Benguet State University, La Trinidad, Benguet.

Adviser: Asuncion L. Nagpala, PhD.

ABSTRACT

The experiment was conducted at Balili, La, Trinidad Benguet from November 2010 to March 2011 to determine the effect of soil amendments against *Cercospora* leaf spot (*Cercospora fragariae*) and crown root diseases (*Fusarium oxysporum* f.sp.*fragariae*) of strawberry (*Fragaria* x *ananassa Dutch*) and yield of strawberry variety Sweet Charlie.

Based on the results, plants applied with 1.8 and 2.4kg *Trichoderma* KA at spore concentration of $1x10^6$ and plants applied with 10 kg Vermi compost gave the lowest severity rating of *Cercospora* leaf spot. In terms of lesion size, plants applied with *Trichoderma* KA at 1.2kg and 2.4kg showed smaller lesion size of *Cercospora* leaf spots. Plants in the rest of the treatments produced bigger sizes of lesions with 1.51mm.

Similarly, those applied with 1.8kg and 2.4kg *Trichoderma* KA incurred the lowest crown rot infection that significantly differed from plants applied with 10 kg chicken manure, 10kg Vermi compost, and the untreated, including those applied with 10 kg chicken manure + 1.2 kg triple 14.

The highest yield of 16.34 tons/ha which was comparable with 14.61 and 13.72 tons/ha was produced by plants applied with 10 kg chicken manure and plants applied with 2.4 and 1.8 kg *Trichoderma* KA.

For the return of cash expenses, those applied with 2.4 and 1.8 kg *Trichoderma* KA gave the highest ROCE of 3.1 and 3.0. Plants applied with 10 kg chicken manure which also produced the highest yield of 16.34 ton/ ha gave a 1.6 return of expenses.

Having produced acceptable yield with the lowest leaf spot severity and small sizes of lesions and lowest crown rot infection but with the highest return of expenses, *Trichoderma* KA at 1.8 to 2.4 kg can be used to manage leaf spot and crown rot of strawberry.

INTRODUCTION

Trichoderma spp. species belong to a small family of beneficial fungi that are commonly found in soils nearly all parts of the world. Botanically, *Trichoderma* spp. species live on plant debris and organic matter in soil, while some strains are parasitic on other fungi.

Trichoderma KA are good biological control agents when abundant in population, they are established and maintained in the soil, they form a protective barrier to root pathogens (Nederhoff, 2001).

The modes of action of *Trichoderma* spp. when used as biological control agent include: competition and antagonism against pathogens, production of certain compound against pathogenic fungi and parasitism in pathogenic fungi of plants. In addition; *Trichoderma* spp. improves plant health and vigor and may perhaps stimulate nutritional uptake when abundant populations are established in the root zone. It has a protective and immunizing effect in the host plant and can survive in a long term within the host plant without causing any damage to the plant (Harman, 2004).

On the other hand, *Trichoderma* KA grow topically toward hyphae of other fungi, coil them in a lectin-mediated reaction, and degrade cell walls of the target fungi, this process limits growth and activity of plant pathogenic fungi (Harman, 2004). Moreover, certain isolates of *Trichoderma* spp. may serve as efficient bio-control agent in a naturally infested soil. A significant reduction in crop loss caused by pathogenic fungi may be obtained by maintaining low inoculums potential for several months. (Elad *et al.*, 1981)

Earlier studies showed that *Trichoderma* KA was able to protect garden pea against severe infection from *Fusarium* wilt infection (Nagpala, 1999). Similarly, Nuňez (2005) in her study demonstrated that soil application *of Trichoderma* KA before transplanting protected chrysanthemum against *Fusarium* causing root rot and wilt. In addition, Galian (2005) showed that *Trichoderma* KA applied in the soil improved the quality of pods of garden pea and reduced wilt incidences.

Fusarium crown and root-rot disease is caused by the fungus *Fusarium oxysporum*. *F*. sp. *fragariae* attacks practically all plants including strawberries. The early symptom includes downward curling of leaves and stipules; thickening of basal internodes and making the leaves and the stems brittle and more rigid compared to uninfected plants. Discolorations of root tissues develop as the diseases progresses. The lower leaves turn yellow from the base to the apex of the plant (Hermano, 1999).

In strawberry, symptoms of root rot begin in the first fruiting year. The injury will be most noticeable in low or soil compacted areas of a field where drainage is poor. Strawberry plants with root- rot show a general lack of vigor with poor runner growth and small berries (Louws, and Wukasch, 2003).

The use of biological control agent is a good substitute of fungicides. They contribute in our environment by maintaining the soil fertility. There application does not cause hazard to human health as compared to fungicides.

Trichoderma spp. a non-polluting naturally occurring and self-perpetuating diseases control agents may provide longer disease control compared to repeated application of fungicides. Continues used of fungicide may induce the pathogen

(*Fusarium*) to develop fungicide resistant strains, destroy beneficial fungi such as *Trichoderma* spp. and may lead to environmental pollution (Paningbatan *et al*., 1992).

Further more, Shamag (2010) reported that Republic Act 10068 or the Organic Agriculture Act of 2010 encourages disease management that are safe and should be applied especially for crops that are immediately consumed after harvest.

The study aimed to:

1. verify the effect of *Trichoderma* KA and other soil amendments against *Fusarium* crown and root rot of Strawberry; and

2. determine the effects of the soil amendments on the yield.

The study will be conducted at Benguet State University, Balili Experimental Station, La Trinidad Benguet from November 2010 - March 2011.

REVIEW OF LITERATURE

The Crop

Strawberry is low growing herbaceous plants with a short crown where the leaves are produced closed together. The roots are numerous forming a fibrous mass that originated and grow at the base of the crown. Branch-crown and runners are produced in the axis of the leaves, which are normally trifoliate. The fruit trusses, which may have few or many flowers on branching stalks, are produced terminally. Each flower has ten sepals and five petals enclosing 30-40 stamens. Botanically, the berry is not a true fruit. It consists of swollen receptacle where the seeds are embedded. The berry, which is conical, is mostly self-pollinated because stamens are arranged through the stigma (Hermano, 1999). Strawberries are high valued export crop that are grown in the temperate areas of Western Australia.

Strawberry (*Fragaria x ananassa Dutch*.) belonging to the *Rosaceae* family is cultivated in temperate regions around the world. Hermano (1999) stated that the demand for strawberry is high among tourist and processing factories such as the Magnolia Dairy House products consolidated food Corporation (CFC), Selecta (RFM), Baguio Strawberry House including local jam and wine makers.

In Benguet 35% of farming populations engaged in strawberry industry. According to the Municipal Agriculturist Office (MAO) of the Municipality of La Trinidad, Areas planted to Strawberry in La Trinidad covers 74 hectares. The average Production per hectare in November 2005 to April 2006 was 18.5 metric tons, but declined to 14 metric tones on 2006 to2007. This decline in production was attributed to

improper growing practices of farmers, poor quality of planting materials, and the presence of pests and disease (Allatiw, 2009).

Management of the *Fusarium* Crown and Root-rot
Using *Trichoderma* KA

The use of Biocontrol agent is a good alternative to fungicide. It is the process of using microbial antagonist against pathogenic fungi. *Trichoderma* spp. is free-living organisms and is common in soil and root ecosystems. Recent discoveries show that they are opportunistic, virulent plant symbionts, as well as being parasites of other fungi. Some strains establish robust and long lasting colonization of root surface and penetrate into the epidermis and a few cell below. They produce a variety of compound that induced localized systemic resistance and this explains their lack of pathogenicity to plants (Harman *et al*., 2004). Moreover, the root microorganism association causes substantial changes to the plant proteome and metabolism. Plants are protected from numerous classes of plant pathogen by responses that are similar to systemic resistance. Root colonization by *Trichoderma* spp. also frequently enhances root growth and development of crop activity resistance to abiotic stresses and the uptake and use of nutrients.

Biology

Trichoderma KA is a genus of asexually reproducing fungi which nearly temperate and tropical soils contain 10^1-10^3culturable propagules per gram. These fungi colonize woody and herbaceous plant materials. They show a high level of genetic diversity and can be used to produce a wide range of products of commercial and ecological interest. They are prolific producers of extracellular protein and are best

known for their ability to produce enzymes that degrades cellulose and chitin. It was stated that mycelium of *Trichoderma* spp. can produce a wide variety of enzymes including cellulose (degrading cellulose) and chitinase (degrading chitin). Because of its cellulose, *Trichoderma* KA can grow directly on wood, which is primarily composed of chitin, a polymer of n-acetyl- glusamine. In nature one can often find *Trichoderma* KA parasitizing the fruiting bodies and mycelia of other fungi such as the fruiting body of *Hydnochaete* for example *Hydnochaeteduportii*, *Hydnochaetetuberculosa* (Harman, 2004 as cited by Bulcio, 2008).

Cook and Baker (1983) mentioned that any root colonizing microorganism given the advantages of being the first to colonize the root, as may occur with the seed treatment has the potential to preempt the nutrient supply of pathogens.

Taxonomy and Life Cycle

Cook and Baker (1983) classified *Trichoderma* spp.under Phylum, *Deuteromycota*, class *Hyphomycetes* and family *Moniliaceae* and *Gloiosporae.* The organism grows and divides into branches or similar parts as typical fungal hyphae 5 to10*u*m in diameter.

Asexual sporulation occurs as single celled usually green, conidia, that are released in large numbers. Intercalary resting chlamydospores may fuse together (Kubicek, 1998).

Mycoparasitism

Trichoderma spp. parasitizes a range of other fungi. The events leading to mycoparasitism are complex, and take place as follows: first *Trichoderma* KA strains

detect other fungi and grow tropically towards them; remote sensing is at least partially due to the sequential expression of cell wall degrading enzymes. Different strain follows different patterns of induction, but the fungi apparently always produce low levels of an extracellular exochitinase. Diffusion of this enzyme catalyze the release of cell wall oligomers from target fungi, and this in turn induces the expression of fungi toxic endochitinase which also diffuse and begin the attack on the target fungus before contact is actually made. Once the fungi come in contact, *Trichoderma* spp. attach to the host and can coil around it and form appersoria on the surface. Attachment is mediated by the binding of carbohydrates in the *Trichoderma* KA cell wall to Lectins on the target fungus. Once in contact, the *Trichoderma* KA produce several fungitoxic cell-wall degrading enzymes and probably also peptaibol antibiotics. The combined activities of these compounds result in parasitism of the target fungus and dissolution of the cell walls. At the sites of the appresoria, holes can be produced in the target fungus; and directly entry of *Trichoderma* hyphae into the lumen of the target fungus occurs. There are at least 20-30 known genes, proteins and other metabolites that are directly involved in this interaction, which is typical of the complex systems that are used by these fungi in their interactions with other organisms (Harman, 2004 as cited by Ngitew, A 2003).

Effect of *Trichoderma* spp. Against *Fusarium* Diseases

Sivan and Chet (1986) stated that the counts of *Fusarium* spp. decreased mainly on root tips on which the highest counts of the antagonist were recorded. The effectiveness of *T. hanzianum* in the reduction of *F.oxysporum* root population indicates that the antagonist is adapted to serve as an effective competitor on the rhizoplane. The

rhizoplane competence of *Trichoderma* KA was directly correlated with its competitive saprophytic ability (Ahmad and Baker, 1987).

Loresco (2004) revealed that in terms of disease in garden pea, different species of T*richoderma* KA which included *Trichoderma* KA consistently provided low percent infection and was comparable to the fungicide captan. Moreover, plants applied with *Trichoderma* KA isolates provided an acceptable yield.

Severity rating of *Cercospora* leaf spot, plants inoculated with 20ml and 10ml (1x107) *Trichoderma* KA incurred a lower leaf spot severity infection that is significantly different with the leaf spot severity that occurred on the leaves of plants applied with 100g Garden Compost and vermi compost. It also gave the lowest number of leaves with *Cercospora* leaf spot infection than plants amended with Garden Compost and vermi compost (Allatiw, 2009).

MATERIALS AND METHODS

Field Activities

An area of 240 m^2 was prepared and was subdivided into four blocks. Each block was further subdivided accordingly based on the number of treatments. Each plot measured 1 x 10 m^2; the experiment was laid out following the Randomize Complete Block Design (RCBD) and was replicated four times.

Treatment Application

A *Trichoderma* spp. strain referred to as *Trichoderma* KA was used in the study. A spore suspension of 1 x 10^6 spores per ml. was drenched per hill before planting the strawberry runners free from *Fusarium* crown and root rot disease. For vermi compost and chicken manure, 10 kg per 1 x 10 m^2 plot was applied before transplanting. Similarly, 10 kg of chicken manure was applied in Farmer's practice plus 1.2 kg triple 14. The different treatments are shown below:

T_1- Control (without treatment)

T_2- Farmers Practice (10 kg Chicken manure + 1.2 kg triple 14)

T_3- *Trichoderma* KA (1.8 kg/ 1 x 10 m^2 plot)

T_4- *Trichoderma* KA (2.4 kg/ 1 x 10 m^2 plot)

T_5- Vermi compost (10 kg/ m^2 plot)

T_6- Chicken manure (10 kg/ m^2 plot)

Data Gathered:

1. Severity of *Cercospora* leaf spot as affected by application of *Trichoderma* KA and other soil amendments. Weekly rating was assessed following the arbitrary rating scale by (Lumiqued, 2000).

Scale	Description
1	No infection
3	Mild infection, 1-10 necrotic spots
5	Moderate infection,11-25 necrotic spots
7	Severe infection, 26-50 necrotic spots

2. Percent infection- number of plants showing crown and root rot infection at the end of the experiment.

3. Number of flowers- number of flowers gathered weekly.

4. Number of ripe berries- total number of ripe berries.

5. Yield (tons/ ha)

6. Return on cash expenses (ROCE). This was computed using data as net income divided by the cost op production x 100%.

Figure 1 shows the overview of the experiment at the Balili Experimental, La Trinidad Benguet from November 2010 - March 2011.

Figure 1. Overview of the partial experimental area after transplanting at Balili La Trinidad Benguet.

RESULTS AND DISCUSSION

Weekly Severity Rating of *Cercospora* Leaf Spot

Table 1 summarizes the weekly rating of *Cercospora* leaf spot for seven weeks. In the first and second ratings, leaf spot severities were all the same in all the treatments. Differences in leaf spot severity as affected by the application of *Trichoderma* KA, vermi compost and chicken manure were only seen in the third rating which continued until the seventh.

On the third rating, strawberry plants applied with 1.8 and 2.4 kg *Trichoderma* KA 1 x 10 m^2 plot and water concentration of 1 x 10^6/ml and plants applied with 10 kg / plot vermi compost showed the lowest leaf spot infection while those plants applied with chicken manure at 10 kg / plot and those applied with chicken manure added with 1.2 kg triple 14 (farmers practice) including the control had higher leaf spot infection. Low *Cercospora* leaf spot infection continued to occur on strawberries applied with *Trichoderma* KA with the exception of those applied with vermi compost from the fourth until the seventh rating. Those plants applied with 2.4 kg *Trichoderma* KA incurred the lowest leaf spot severity during the seventh or last rating. Statistical analysis showed significant differences in leaf spot severity in the different treatments as affected by the application of *Trichoderma* KA and other soil amendments. Despite the favorable weather for the development of the leaf disease from November 2010 to March 2011, the infection in plant applied with *Trichoderma* KA remained low while infection in the rest of the treatments increased.

According to (Zelinger and Omann, 2007 as cited by Allatiw, 2009) *Trichoderma* KA used as biocontrol agent against fungal diseases. *Trichoderma* KA is a biocontrol

agent of several plant pathogenic fungi like *Rhizoctonia* spp., *Pythuim* spp., *Botrytis* spp., and other fungi which causes both soil borne and leaf or flower-borne diseases of agricultural plants. It also induces the resistance system in plants and suppresses the growth of airborne and soil-borne pathogens (Harman, *et.al*., 2004).

Table 1 shows the weekly mean of lesion size. Plants applied with 1.8 kg ($1x10^6$ spores) *Trichoderma* KA incurred the smallest mean of 1.34mm lesion size after 5 weeks, followed by plants treated with 2.4 kg *Trichoderma* KA with a mean lesion size of 1.43mm . The largest lesion size was obtained from plants applied with 10 kg chicken manure with a mean lesion size of 1.51mm after five weeks, followed by 1.47mm lesion size from the untreated plant (Control) and plants applied with chicken manure added with 1.2 kg triple 14.

Table 1. Weekly mean severity rating of leaf spot by *Cercospora fragariae* from February 2010 to March 2011.

TREATMENT	RATE OF APPLICATION	DAYS AFTER PLANTING (DAP)							
		80	87	94	101	108	115	122	FINAL
Control	No amendment	2.64	2.52	2.96[a]	2.98[a]	3.09[a]	3.14[a]	3.11[a]	1.47[ab]
Farmer's Practice	10 kg chicken manure + 1.2kg triple 14/plot	3.21	2.61	2.70[ab]	2.86[a]	3.46[a]	3.36[a]	2.48[a]	1.47[ab]
Trichoderma	1.8 kg/plot	2.53	2.64	2.45[b]	2.39[b]	2.53[b]	2.21[b]	2.55[b]	1.34[c]
Trichoderma	2.4 kg/plot	2.70	2.53	2.48[b]	2.37[b]	2.30[b]	2.23[b]	2.18[c]	1.43[abc]
Vermi Compost	10kg	2.61	2.30	2.48[b]	2.68[ab]	3.27[a]	3.02[a]	3.41[a]	1.45[abc]
Chicken manure	10 kg	3.03	2.91	3.03[a]	3.11[a]	3.21[a]	3.16[a]	3.34[a]	1.51[a]
CV		18.55	12.13	9.85	9.68	8.73	11.09	7.70	4.39

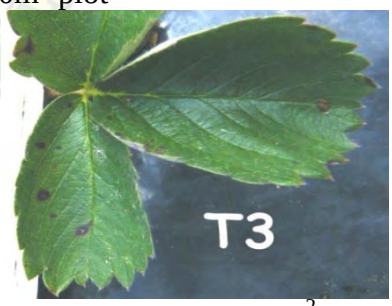
Significant at 5% level DMRT

Figure 2 shows the strawberry leaves sample with cercospora leaf spot. Final size of lesion of *Cercospora* leaf spot as affected by the application the soil amendments. Smaller size of leaf spot were noted on leaves of strawberry applied with 1.8 and 2.4 kg *Trichoderma* KA and those applied with vermi compost compared to lesion size on plants applied with 10 kg chicken manure plus 1.2 kg triple 14 and the control. Significant differences on the sizes of lesion were noted on the different treatments. The smallest size of leaf spot was 1.34mm however was recorded in strawberries applied with 1.8 kg *Trichoderma* KA.

T_0- Without any amendment

T_1- 10kg chicken manure+1.2kg triple 14/ 1x10m^2 plot

T_2- 1.8kg *Trichoderma*/1x10m^2 plot



T_3- 2.4kg *Trichoderma*/1x10m^2 plot

T_4- 10kg Vermi compost/1x10m^2 plot

T_5- 10kg Chicken manure/1x10m^2 plot

Figure 2. Representative of strawberry leaves with *Cercospora* leaf spot from the different treatments.

Number of Flowers as Affected
by The Different Soil Amendments

The numbers of flowers produced in different treatments are presented in Table 3. Results showed that the highest number of flowers produced was obtained from plants applied with Chicken Manure with a mean of 246, 56 days after transplanting and decreased after 66 days. On the other hand, the total number of flowers produced in strawberry applied with 1.8 kg and 2.4 kg *Trichoderma* KA were 209 and 230 in plants after 58 days but decreased after 78 days. Further observation showed that during the experiment, plants applied with 2.4kg *Trichoderma* KA were the first to bear flowers after 38 days, followed by plants applied with 10kg chicken manure and plant applied with 10kg chicken manure + 1.2kg triple 14 bear flowers after 40 days and strawberry plants applied with 10kg vermi compost and those without amendment produced flowers after 43days .

Table 2. Total number of flowers

TREATMENT	RATE OF APPLICATION	MEAN NUMBER OF FLOWERS
Control	No amendment	172.75
Farmers Practice	10 kg chicken manure + 1.2kg triple 14/plot	200.25
Trichoderma	1.8 kg/plot	209.75
Trichoderma	2.4 kg/plot	230.00
Vermi Compost	10kg	212.50
Chicken Manure	10 kg	246.00

Mc Beath (2003) as cited by Allatiw (2009) stated that plants treated with *Trichoderma* spp. demonstrated marked responses in growth. Plants were bigger, healthier, and flowered earlier. *Trichoderma* spp. seems to form a symbiotic relationship with plants.

Number of ripe Berries as Affected by the Different Amendments

Figure 3 showed the strawberry fruit from the different treatments. Total number of ripe berries is shown in Table 3. Results show that plants applied with 10 kg /ha Chicken Manure and plants applied with 1.8 and 2.4kg *Trichoderma* KA with $1x10^6$ spore concentration produced the highest total number of ripe berries. Lower number of ripe berries was noted from plants in the control and from those applied with 10kg chicken manure+ triple-14(Farmers practice) and with 10kg vermi compost. Further observation shows that not all flowers formed developed into fruits due to falling of flowers also known as dehiscence.

Table 3 showed that there were no fruits harvested after 66 days in plants applied with vermi compost on the first 3 blocks. It was also noted that the number of fruits produced was stable after 68 until 72 days. The highest number of fruits was produced after 74 and 92 days in plants applied with Chicken Manure followed by the plants applied with 40g *Trichoderma* KA.

T_0- Without any amendment

T_1- 10kg chicken manure+1.2kg triple 14/ 1x10m^2 plot

T_2- 1.8kg *Trichoderma*/1x10m^2 plot

T_3- 2.4kg *Trichoderma*/1x10m^2 plot

T_4- 10kg Vermi compost/1x10m^2 plot

T_5- 10kg Chicken manure/1x10m^2 plot

Figure 3. Representatives of strawberry fruits from the different treatments

Table 3. Total number of ripe berries

TREATMENT	RATE OF APPLICATION	TOTALNUMBER OF BERRIES
Control	No amendment	78.50[b]
Farmers Practice	10 kg chicken manure + 1.2kg triple 14/plot	87.250[b]
Trichoderma	1.8 kg/plot	104.75[ab]
Trichoderma	2.4 kg/plot	105.750ab
Vermi Compost	10kg	90.50b
Chicken Manure	10 kg	126.250a
Significant at 5% DMRT		CV 18.26%

Percent number of plant with crown rot

Table 4 shows that plants applied with 1.8 and 2.4kg *Trichoderma* KA gave the lowest percent crown infection by *Fusarium* oxyporum of 18. 1 % the against 43.1 % infection in strawberry plants applied with 10kg Chicken manure+1.2kg triple- 14. This result corroborates the statement of Harman, *et al*., (2004) wherein *Trichoderma* spp. can attack or inhibit plant pathogens. It can also induce systemic and localized resistance to a variety of pathogens. Significant differences were noted in terms of crown infection in the different treatments. As mentioned by Brewer *et al*.,1982 *Trichoderma* KA is the most studied and good biological control agent. It is a well-known antagonist of both soil-borne and airborne plant pathogens.

Table 4. Percent crown rot infection by *Fusarium oxysporum f.*sp. *fragariae*

TREATMENT	RATE OF APPLICATION	TOTALNUMBER OF BERRIES
Control	No amendment	41.4[ab]
Farmers Practice	10 kg chicken manure + 1.2kg triple 14/plot	43.1[a]
Trichoderma	1.8 kg/plot	18.15[d]
Trichoderma	2.4 kg/plot	18.15[d]
Vermi Compost	10kg	34.7[ab]
Chicken Manure	10 kg	30.15[c]

*Significant at 5% level DMRT. CV36.839

The mechanism by which *Trichoderma* KA exerts its antagonistic activity is not yet clear, but it has been proven that *Trichoderma* KA produces and secretes toxic metabolites (antibiotic, toxins) during its growth and during its antagonistic action (Brewer *et al*., 1982).

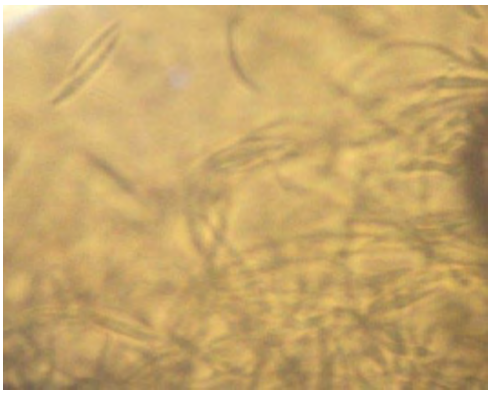
Figure 3 showed that plants treated with *Trichoderma* KA gave the lowest number of crown rot infection in the four blocks, while the highest crown infection were recorded mostly in the plants applied with 10kg chicken manure+1.2kg triple 14, followed by plant applied with vermi compost. Harman *et al*., 2004 cited that *Trichoderma* spp. has been known for many years to produce a wide range of antibiotics substances that can parasitize other fungi. Furthermore, they inhibit or degrade pectinase and other enzymes

that are essential for plant pathogenic fungi such as *Botrytis cinerea* to penetrate leaf surfaces.

Yield (tons/ha)

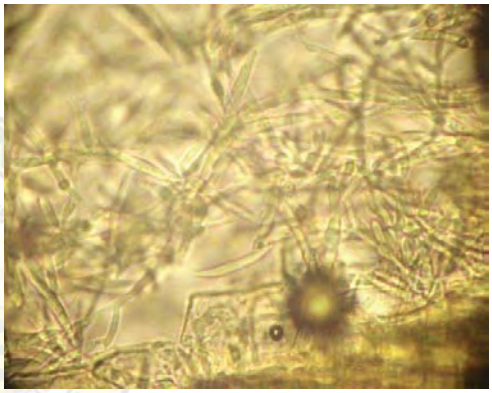
The effect of different amendments on the yield of strawberry is shown in Table 5. Apparently, the highest yield of 16.34 tons per hectare was obtained from plants applied with 10kg chicken manure followed by 14.61 and 13.72 tons per hectare from plants applied with 1.8 and 2.4kg *Trichoderma* KA and significantly differed from those applied with 10kg chicken manure + 1.2 kg triple14 (11.06 tons/ha) and 10kg vermi compost with a mean yield of 11.06 and 11.75 tons/ha. The lowest was recorded for the control (9.54 tons/ha). As stated by Wolf (1999) manure is a good source of micro – macronutrients, though the content of phosphorus and potassium is low compared to the nitrogen content. In addition, the slow release of nutrients from the manure particularly nitrogen can be beneficial for the soil as it aides in dissolving out the humus and soluble salt and deposit them in the underlying layers of the soil.

Table 6 shows that the highest income was obtained from plants amended with 1.8 and 2.4kg of *Trichoderma* KA which gave 3.0 and 3.1, this means that for every peso invested, there is net return of 3 pesos and ten centavos. Net return of 1.3 was obtained from plants applied with 10 kg vermi compost.



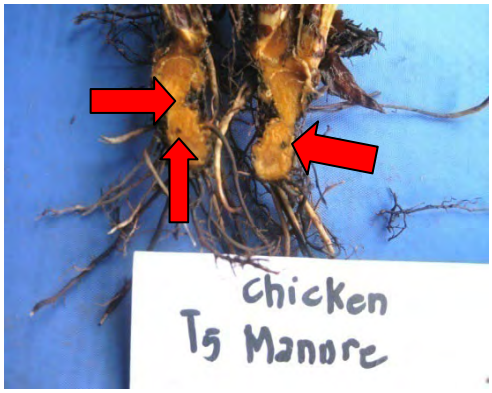
T_0- Without any amendment

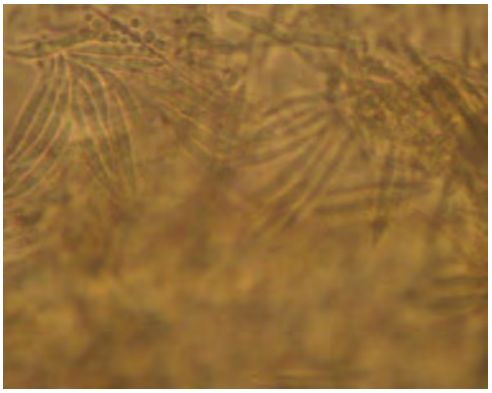
Macro Conidia of *F. Oxysporum f.* sp. *fragariae*



T_1- 10kg chicken manure+1.2kg triple 14/ 1x10m^2 plot

Macro Conidia of *F. Oxysporum f.* sp. *fragariae*





T_5- 10kg Chicken manure/1x10m^2 plot

Macro Conidia of *F. Oxysporum* f. sp. *fragariae*

Figure 4. Roots showing crown rot infection by *Fusarium oxysporum* f sp. *fragariae*

Table 5. Yield (tons/ha)

TREATMENT	RATE OF APPLICATION	WEIGHT
Control	No amendment	9.54[c]
Farmer's Practice	10 kg chicken manure + 1.2kg triple 14/plot	11.067[bc]
Trichoderma	1.8 kg/plot	13.72[ab]
Trichoderma	2.4 kg/plot	14.61[ab]
Vermi Compost	10kg	11.75[bc]
Chicken Manure	10 kg	16.34[a]

*Significant at 5% level DMRT. CV=19.34%

Table 6. Return on cash expenses (ROCE)

TREATMENT	RATE OF APPLICATION	ROCE
Control	No amendment	1.8 bc
Farmers Practice	10 kg chicken manure + 1.2kg triple 14/plot	2.4 c
Trichoderma	1.8 kg/plot	3.0 a
Trichoderma	2.4 kg/plot	3.1 a
Vermi Compost	10kg	1.3 c
Chicken Manure	10 kg	1.6 bc

Highly significant at 1% level CV: 50.46%

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

Effect of soil amendments that include *Trichoderma* KA, vermi compost and chicken manure against *Cercospora* leaf spot and crown rot of strawberry was evaluated from November 2010 until March 2011 to determine any effects on the leaf and root diseases of strawberry; and determine any effect of the amendments on the yield.

Based from the results, Plant applied with 1.8 and 2.4 kg *Trichoderma* KA with spore concentration of $1x10^6$ gave the lowest *Cercospora* infection on the leaves. Plant applied with 1.8 and 2.4 kg *Trichoderma* KA including plants applied with 10 kg vermi compost produced the smallest size of lesion.

Similarly, *Trichoderma* KA treated plants with 1.8 and 2.4 kg gave a yield of 14.61 and 13.72 tons/ha which is comparable to the highest yield of 16.34 from plants applied with 10 kg chicken manure. Those also applied with *Trichoderma* KA gave the highest return on cash expenses (ROCE) which is 3.1 and 3.0. The lowest return on cash expenses of 1.3 was noted from plants applied with 10 kg vermi compost and from plants applied with 10 kg chicken manure.

Conclusion

Trichoderma KA at 1.8 and 2.4 kg applied before transplanting prevented *Cercospora* leaf spot from becoming severe by limiting the increase of lesion size. It also gave the lowest number of plants with crown and root infection and acceptable yield. vermi compost at 10 kg/ plot can also limit the increase of *Cercospora* lesion size.

Recommendation

Trichoderma KA at 1.8 and 2.4 kg / 1 x $10m^2$ can be used to manage leaf spot caused by *Cercospora* and root and crown rot caused by *Fusarium oxysporum* of strawberry.

LITERATURE CITED

AGRIOS, G.N. 1988. Plant Pathology. 3rd ed. San Diego, USA: APS Press. P. 456.

AHMAD, J. S. and R. BAKER. 1987. Competitive saprophyte ability and cellulolyties activity rhizosphere. Compotent mutants *Trichoderma harzianum*. Phytopathology. Pp. 77, 358.

ALLATIW, T. A. 2009. Management of *Cercospora* Leaf Spot of Strawberry Using Soil Amendments and *Trichoderma* KA. Unpublished Thesis Benguet State University, La Trinidad, Benguet.

BEWER, D., G. E. HARMAN, I. Chet and R. BAKER. 1982. Production of experimental quantities of isocynicle metabolites of *Trichoderma harzanum* Microbiology. 28:1252.

BULCIO J. 2008. Management of Club root (*Plasmodiophora brassicae* Woronin) on Cabbage using *Trichoderma* KA and lime in Natubleng, Buguias, Benguet. Unpublished Thesis Benguet State University, La Trinidad, Benguet.

COOK, R. J and K. F BAKER. 1983. The nature of Practice of biological control of Plant pathogens. American Pythopathological Society, St. Paul. MN. P. 539.

ELAD, Y. Y. and I. Chet. 1981. Biological Control of *Rhizoctonia solani* by *Trichoderma harzanium* in carnation. Plant disease. P. 675.

GALIAN, J. L. 2005. Effect of different levels of *Trichoderma* Compost as Plant Growth Promoter in Garden Pea (*Pisum sativum*). Unpublished Thesis Benguet State University, La Trinidad, Benguet.

HARMAN. G. E. and Nederhoff E. F. 2004. *Trichoderm*a – opportunistic, avirulent plant symbionts. Retrieved July 10, 2010 from http//:www.Nature.Com/reviews/micro

HERMANO, F. G. 1999. Strawberry Production Management and Technology. ISBN. Pp. 1-2.

KUBICEK, C. P. 1998.*Trichoderma* and *Gliocladim*. Vol. 2 Taylor and Francis, London, Retived at Http://www.nature.com/reviews/micro

LORESCO, T. M. 2004. Management of *Fusarium*wilt disease (*Fusarium oxysporum* Schlecht. *f. sp. pisi*) of garden pea (*Pisum sativum L.*) using *Trichoderma* species. Unpublished Thesis Benguet State Univesrsity, La Trinidad, Benguet

LOUWS, F. AND R. T. WUKASCH . 2003. Root problems of strawberries. University of Guelph. Retrieved July 13, 2010 from http://www.uoguelph.ca/labserv/units/pdc/files/039strawberriesroot_strawberriesrootdiseases.pdf

LUMIQUED A. G. 2000. Plant Pathology. Benguet State Univesrsity, La Trinidad, Benguet. P. 20.

NAGPALA, A. L. 1999. Etiology and Management of the Root and Wilt of Garden Pea (*Pisum sativum*) in Benguet and Mountain Provence. Unpublish Ph.D Dissertation. University of the Philippines, Los Baños, Laguna.

NEDERHOFF, E. 2001. Biological control of root disase. Crophouse ltd New Zealand. Retrived July 13 2010 from Http://www.crophouse.co.nz/files/GrW15biological.control

NGITEW, A. 2003. Survey and Identification of Fungal Diseases of Strawberry. Unpublished Thesis. Benguet State University, La Trinidad, Benguet. Pp. 3, 4, 7, 20, &31.

NUŇEZ, N. M. 2005. Evaluation of *Trichoderma* KA compost as Biological Control agent against Fusarium wilt (*Fusarium oxysporium*) f. sp Chrysanthiae of Chrysanthemum.Unpublished Thesis Benguet State University, La Trinidad, Benguet.

PANINGBATAN, R. A. M. G. MAKAMARA and A. C. VILAR. 1992. Seed coating with *Trichoderma viride* on the biological control of Sclerotium wilt in mungbean. Philippine Phytological society. PP. 54.

SHAMAG. 2010. The law on Organic Agriculture is now in place. Benguet State University. Volume XIV number 6. June 2010. Pp. 3, 7, 8

SIVAN, A. and I. CHET. 1986. Biological Control of *Fusarium* sp. In cotton, wheat and muskmelon by *T. harzianum*.Phytophatology. Pp. 8, 116-139, 297.

WOLF, B. 1999, The Effect of Fertilizer Triangle, Interrelationship of Air, Water and Nutrients in Maximizing soil Productivity. p.126.

APPENDICES

Appendix Table 1. First severity rating of leaf spot (*Cercospora fragariae*)

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	32	31	53	32	148	37.00
Farmers Practice	36	40	42	32	180	45.00
Trichoderma 30g	30	36	36	40	142	35.50
Trichoderma 40g	40	38	34	40	152	38.00
Vermi Compost	26	40	42	38	146	36.50
Chicken Manure	40	40	52	38	170	42.50
TOTAL	204	225	259	220	938	234.50

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	310.167	103.389	1.9660		
Factor A	5	286.833	57.367	1.0909 ^{ns}	2.90	4.56
Error	15	788.833	52.589			
Total	23	1385.833				

CV: 18.55%

* Significant
** Highly significant
^{ns} Not significant

Appendix Table 2. Second severity rating of leaf spot (*Cercospora fragariae*)

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	36	30	47	28	141	35.25
Farmers Practice	34	34	38	40	146	36.50
Trichoderma 30g	32	36	40	40	148	37.00
Trichoderma 40g	34	36	36	46	142	35.50
Vermi Compost	30	26	36	37	129	32.25
Chicken Manure	39	38	38	48	163	40.75
TOTAL	205	200	235	239	869	217.25

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	150.125	50.042	2.5521		
Factor A	5	153.708	30.742	1.5678^{ns}	2.90	4.56
Error	15	294.125	19.608			
TOTAL	23	597.958				

CV: 12.23%

* Significant
** Highly significant
^{ns} Not significant

Appendix Table 3. Third severity rating of leaf spot (*Cercospora fragariae*)

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	36	40	52	38	166	41.50
Farmer's Practice	34	36	40	41	151	37.75
Trichoderma 30g	32	30	37	38	137	34.25
Trichoderma 40g	33	36	36	34	139	34.75
Vermi Compost	27	36	36	40	139	34.75
Chicken Manure	40	42	40	48	170	42.50
TOTAL	202	220	241	239	902	225.5

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	167.500	55.833	4.0754		
Factor A	5	266.833	53.367	3.8954*	2.90	4.56
Error	15	205.500	13.700			
TOTAL	23	639.833				

CV: 9.85%

* Significant
** Highly significant
ns Not significant

Appendix Table 4. Fourth severity rating of leaf spot (*Cercospora fragariae*)

	BLOCK					
TREATMENT	I	II	III	IV	TOTAL	MEAN
Control	38	38	53	38	167	41.75
Farmer's Practice	36	40	42	42	160	40.00
Trichoderma 30g	32	30	36	36	134	33.50
Trichoderma 40g	32	34	33	34	133	33.25
Vermi Compost	33	38	37	42	150	37.50
Chicken Manure	42	40	42	50	174	43.50
TOTAL	213	220	243	242	918	229.5

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	116.833	38.944	2.8404		
Factor A	5	364.000	72.500	5.3096**	2.90	4.56
Error	15	205.667	13.711			
TOTAL	23	686.500				

CV: 9.68%

* Significant
** Highly significant
ns Not significant

Appendix Table 5. Fifth severity rating of leaf spot (*Cercospora fragariae*)

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	33	40	50	50	173	43.50
Farmer's Practice	42	48	44	60	194	48.50
Trichoderma 30g	28	38	36	40	142	35.50
Trichoderma 40g	30	33	30	36	129	32.25
Vermi Compost	41	44	46	53	183	45.75
Chicken Manure	44	43	45	48	180	45.00
TOTAL	218	246	251	287	1001	250.50

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	389.458	129.819	9.7956		
Factor A	5	814.708	162.942	12.2949**	2.90	4.56
Error	15	198.792	13.253			
TOTAL	23	1402.958				

CV: 8.73%

* Significant
** Highly significant
ns Not significant

Appendix Table 6. Sixth severity rating of leaf spot (*Cercospora fragariae*)

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	30	42	52	52	176	44.00
Farmer's Practice	45	40	49	54	188	47.00
Trichoderma 30g	27	32	28	37	124	31.00
Trichoderma 40g	29	30	33	33	125	31.25
Vermi Compost	35	38	41	55	169	42.25
Chicken Manure	42	39	43	53	177	44.25
TOTAL	208	221	256	284	959	239.75

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	559.458	186.486	9.4890		
Factor A	5	982.708	196.542	10.0007**	2.90	4.56
Error	15	294.792	19.653			
TOTAL	23	1836.958				

CV: 11.09%

* Significant
** Highly significant
ns Not significant

Appendix Table 7. Seventh severity rating of leaf spot (*Cercospora fragariae*)

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	35	38	49	52	174	43.50
Farmer's Practice	43	48	46	58	195	48.75
Trichoderma 30g	30	36	36	40	142	35.50
Trichoderma 40g	30	30	28	34	122	30.50
Vermi Compost	45	46	46	54	191	47.75
Chicken Manure	46	45	47	49	187	46.25
TOTAL	229	243	252	287	1011	252.25

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	305.458	101.819	9.6792		
Factor A	5	1111.375	222.275	21.1299 **	2.90	4.56
Error	15	157.792	10.519			
TOTAL	23	1574.625				

CV= 7.70%

* Significant
** Highly significant
ns Not significant

Appendix Table 8. First number of flowers

TREATMENT	BLOCK				TOTAL	MEAN
	I	II	III	IV		
Control	8	5	5	13	31	7.75
Farmers Practice	6	6	7	5	24	6.00
Trichoderma 30g	5	8	9	11	33	8.25
Trichoderma 40g	5	6	10	10	31	7.75
Vermi Compost	2	3	9	12	26	6.50
Chicken Manure	5	9	12	16	42	10.50
TOTAL	31	37	52	67	187	46.75

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	Comp. F 0.1
Replication	3	130.125	43.375	7.3830		
Factor A	5	49.708	9.942	1.6922^{ns}	2.90	4.56
Error	15	88.125	5.875			
TOTAL	23	267.958				

CV: 31.11%

* Significant
** Highly significant
^{ns} Not significant

Appendix Table 9. Second number of flowers

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	16	20	9	29	74	18.5
Farmers Practice	16	11	22	12	61	15.25
Trichoderma 30g	20	10	15	27	72	18
Trichoderma 40g	26	8	20	23	77	19.25
Vermi Compost	5	3	31	22	61	15.25
Chicken Manure	18	38	23	35	114	28.5
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	322.458	107.486	1.4296		
Factor A	5	478.375	95.675	1.2725^{ns}	2.90	4.56
Error	15	1127.792	75.186			
TOTAL	23	1928.625				

CV: 45.34%

* Significant
** Highly significant
^{ns} Not significant

Appendix Table 10. Third number of flowers

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
T_1=Control	26	27	83	46	182	45.5
T2=Farmers Practice	30	35	39	90	194	48.5
T3=Trichoderma 30g	22	25	61	66	174	43.5
T4=Trichoderma 40g	25	41	70	71	207	51.75
T5=Vermi Compost	50	58	47	105	260	65.00
T6=Chicken Manure	62	42	100	86	290	72.5
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	7740.458	2580.153	9.5460		
Factor A	5	2719.208	543.842	2.0121^{ns}	2.90	4.56
Error	15	4054.292	270.286			
TOTAL	23	14513.958				

CV: 30.19%

* Significant
**Highly significant
^{ns} Not significant

Appendix Table 11. Fourth number of flowers

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	7	10	25	18	60	15.00
Farmers Practice	17	20	29	18	84	21.00
Trichoderma 30g	21	23	10	21	75	18.75
Trichoderma 40g	20	27	12	13	72	18.00
Vermi Compost	8	23	12	17	60	15.00
Chicken Manure	21	12	17	10	60	15.00
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	44.125	14.708	0.3176		
Factor A	5	127.875	25.575	0.5523^{ns}	2.90	4.56
Error	15	694.625	46.308			
TOTAL	23	866.625				

CV: 39.74%

* Significant
**Highly significant
^{ns} Not significant

Appendix Table 12. Fifth number of flowers

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	35	26	18	25	104	26.00
Farmers Practice	30	14	35	22	101	25.25
Trichoderma 30g	21	30	35	38	124	31.00
Trichoderma 40g	34	19	38	36	137	31.75
Vermi Compost	16	14	43	52	125	31.25
Chicken Manure	36	47	34	57	174	43.50
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	614.458	204.819	1.9002		
Factor A	5	854.708	170.942	1.5869^{ns}	2.90	4.56
Error	15	1616.792	107.786			
TOTAL	23	3085.958				

CV: 33.00%

* Significant
**Highly significant
^{ns} Not significant

Appendix Table 13. Sixth number of flowers

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	7	20	19	18	64	16.00
Farmers Practice	16	20	25	18	79	19.75
Trichoderma 30g	21	23	10	21	75	18.75
Trichoderma 40g	20	24	12	23	79	19.75
Vermi Compost	8	22	12	12	54	13.50
Chicken Manure	21	12	17	10	60	15.00
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	81.458	27.153	0.9096		
Factor A	5	141.375	28.275	0.8471^{ns}	2.90	4.56
Error	15	447.792	29.853			
TOTAL	23	670.625				

CV: 31.91%

* Significant
**Highly significant
^{ns} Not significant

Appendix Table 14. Seventh number of flowers

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	9	23	21	21	74	18.50
Farmers Practice	17	21	28	20	86	21.50
Trichoderma 30g	24	25	13	24	86	21.50
Trichoderma 40g	22	27	14	25	88	22.00
Vermi Compost	11	24	15	14	64	16.00
Chicken Manure	23	15	19	13	70	17.50
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	82.333	27.444	0.9074		
Factor A	5	126.000	25.200	0.8332 ^{ns}	2.90	4.56
Error	15	453.667	30.422			
TOTAL	23	662.000				

CV: 28.20%

* Significant
** Highly significant
^{ns} Not significant

Appendix Table 14. Eighth number of flowers

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	7	11	22	7	47	11.75
Farmers Practice	14	11	29	40	94	23.50
Trichoderma 30g	8	16	33	44	101	25.25
Trichoderma 40g	41	24	26	68	159	39.75
Vermi Compost	16	10	19	51	96	24.00
Chicken Manure	10	22	24	56	112	28.00
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	3249.458	1083.153	9.8124		
Factor A	5	1618.375	323.675	2.9322*	2.90	4.56
Error	15	1655.792	110.386			
TOTAL	23	6523.625				

CV: 41.40%

* Significant
** Highly significant
ns Not significant

Appendix Table 15. Ninth number of flowers

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	4	16	14	21	55	13.75
Farmers Practice	10	4	25	20	59	14.75
Trichoderma 30g	19	13	27	38	97	24.25
Trichoderma 40g	4	14	37	25	80	20.00
Vermi Compost	16	29	17	42	104	26.00
Chicken Manure	7	10	22	23	62	15.50
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	1251.458	417.153	8.0657		
Factor A	5	541.708	108.342	2.0948^{ns}	2.90	4.56
Error	15	775.792	51.719			
TOTAL	23	2568.958				

CV: 37.77%

* Significant
** Highly significant
^{ns} Not significant

Appendix Table 16. Total number of flowers

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
T_1=Control	119	158	216	198	691	172.75
T2=Farmers Practice	156	142	239	264	801	200.25
T3=Trichoderma 30g	161	175	213	290	839	209.75
T4=Trichoderma 40g	197	190	239	294	920	230.00
T5=Vermi Compost	132	186	205	205	850	212.50
T6=Chicken Manure	203	207	268	306	984	246.00
TOTAL						

Appendix table 17. First size of lesion measured per mm.

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	1.62	1.56	1.36	1.43	5.97	1.49
Farmer's Practice	1.56	1.42	1.36	1.35	5.69	1.42
Trichoderma 30g	1.36	1.23	1.51	1.35	5.45	1.36
Trichoderma 40g	1.43	1.36	1.54	1.28	5.61	1.40
Vermi Compost	1.50	1.22	1.42	1.53	5.67	1.42
Chicken Manure	1.81	1.71	1.68	1.71	6.91	1.73
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	0.058	0.019	1.8340		
Factor A	5	0.352	0.070	6.7253**	2.90	4.56
Error	15	0.157	0.010			
TOTAL	23	0.566				

CV: 60.77%

* Significant
** Highly significant
ns Not significant

Appendix table 18. Second size of lesion measured per mm.

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	1.52	1.46	1.76	1.50	6.24	1.56
Farmer's Practice	1.45	1.62	1.54	1.34	5.95	1.49
Trichoderma 30g	1.36	1.42	1.35	1.38	5.51	1.38
Trichoderma 40g	1.36	1.30	1.38	1.36	5.4	1.35
Vermi Compost	1.25	1.50	1.42	1.42	5.59	1.40
Chicken Manure	1.50	1.56	1.68	1.40	6.14	1.53
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	0.061	0.020	2.5933		
Factor A	5	0.155	0.031	3.93208*	2.90	4.56
Error	15	0.118	0.008			
TOTAL	23	0.334				

CV: 6.12%

* Significant
** Highly significant
ns Not significant

Appendix table 19. Third size of lesion measured per mm.

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	1.57	1.42	1.36	1.29	5.64	1.41
Farmer's Practice	1.72	1.53	1.50	1.40	6.15	1.54
Trichoderma 30g	1.29	1.31	1.26	1.28	5.14	1.28
Trichoderma 40g	1.32	1.41	1.29	1.25	5.27	1.31
Vermi Compost	1.62	1.58	1.49	1.36	6.05	1.57
Chicken Manure	1.41	1.38	1.28	1.33	5.4	1.35
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	0.104	0.035	9.0078		
Factor A	5	0.217	0.043	11.3021**	2.90	4.56
Error	15	0.058	0.004			
Total	23	0.378				

CV: 4.42%

* Significant
** Highly significant
ns Not significant

Appendix table 20. Fourth size of lesion measured per mm.

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	1.53	1.42	1.37	1.42	5.47	1.43
Farmer's Practice	1.48	1.36	1.51	1.36	5.71	1.43
Trichoderma 30g	1.42	1.26	1.46	1.26	5.4	1.35
Trichoderma 40g	1.37	1.42	1.33	1.27	5.39	1.35
Vermi Compost	1.54	1.42	1.34	1.56	5.86	1.46
Chicken Manure	1.41	1.36	1.52	1.71	6	1.5
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	0.022	0.007	0.7041		
Factor A	5	0.075	0.015	1.4173^{ns}	2.90	4.56
Error	15	0.160	0.011			
TOTAL	23	0.258				

CV: 7.26%

* Significant
**Highly significant
^{ns} Not significant

Appendix table 21. Fifth size of lesion measured per mm.

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	1.45	1.38	1.56	1.43	5.82	1.45
Farmer's Practice	1.38	1.42	1.46	1.47	5.73	1.43
Trichoderma 30g	1.32	1.51	1.26	1.22	5.31	1.33
Trichoderma 40g	1.26	1.30	1.32	1.33	5.21	1.30
Vermi Compost	1.42	1.45	1.48	1.42	5.77	1.44
Chicken Manure	1.52	1.42	1.36	1.36	5.66	1.41
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	0.006	0.002	0.3488		
Factor A	5	0.083	0.017	2.8276^{ns}	2.90	4.56
Error	15	0.088	0.006			
TOTAL	23	0.177				

CV: 5.49%

* Significant
** Highly significant
^{ns} Not significant

Appendix table 22. First number of ripe berries

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	0	5	1	7	13	3.25
Farmer's Practice	1	4	2	0	7	1.75
Trichoderma 30g	3	4	4	9	20	5
Trichoderma 40g	4	10	4	8	26	6.5
Vermi Compost	0	0	0	4	4	1
Chicken Manure	2	7	5	16	30	7.5
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	115.333	38.444	5.9965		
Factor A	5	135.833	27.167	4.2347	2.90	4.56
Error	15	96.167	6.411			
TOTAL	23	347.333				

CV: 60.77%

* Significant
** Highly significant
ns Not significant

Appendix table 23. Second number of ripe berries

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	8	7	4	16	35	8.75
Farmer's Practice	9	10	12	2	33	8.25
Trichoderma 30g	4	2	10	16	32	8
Trichoderma 40g	10	4	7	19	40	10
Vermi Compost	1		10	15	26	6.5
Chicken Manure	9	18	15	20	62	15.5
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	245.667	81.889	3.3947		
Factor A	5	198.500	39.700	1.6458^{ns}	2.90	4.56
Error	15	361.833	24.122			
TOTAL	23	806.000				

CV: 51.70%

* Significant
**Highly significant
^{ns} Not significant

Appendix table 23. Second number of ripe berries

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	6	9	3	7	25	6.25
Farmer's Practice	10	5	7	6	28	7
Trichoderma 30g	6	9	9	12	36	9
Trichoderma 40g	7	6	8	10	31	7.75
Vermi Compost	0	3	15	13	31	7.75
Chicken Manure	7	9	18	15	49	12.25
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	91.00	30.333	2.1667		
Factor A	5	90.333	18.067	1.2905^{ns}	2.90	4.56
Error	15	210.000	14.0000			
TOTAL	23	391.333				

CV: 44.90%

* Significant
**Highly significant
^{ns} Not significant

Appendix table 24. Third number of ripe berries

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	9	16	14	18	57	14.25
Farmer's Practice	13	12	22	16	63	15.75
Trichoderma 30g	13	21	20	24	78	19.5
Trichoderma 40g	13	14	21	22	70	12.5
Vermi Compost	7	7	29	32	75	12.75
Chicken Manure	18	19	28	30	95	23.75
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	568.167	189.389	8.4339		
Factor A	5	219.500	43.900	1.9550	2.90	4.56
Error	15	336.833	22.256			

CV: 25.97%

* Significant
** Highly significant
ns Not significant

Appendix table 25. Fourth number of ripe berries

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	3	8	11	11	33	8.25
Farmer's Practice	7	7	15	10	39	9.75
Trichoderma 30g	7	12	11	12	42	10.5
Trichoderma 40g	6	8	13	12	39	9.75
Vermi Compost	7	5	15	19	46	11.5
Chicken Manure	11	10	10	14	45	11.25
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	167.667	55.887	7.66777	2.90	4.56
Factor A	5	28.333	5.667	0.77774^{ns}		
Error	15	109.333	7.289			
TOTAL	23	305.333				

CV: 26.56%

* Significant
**Highly significant
^{ns} Not significant

Appendix table 26. Fifth number of ripe berries

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	3	5	6	8	22	5.5
Farmer's Practice	6	3	11	4	24	6
Trichoderma 30g	7	4	7	12	30	7.5
Trichoderma 40g	6	2	9	14	31	7.75
Vermi Compost	6	1	9	13	29	7.25
Chicken Manure	8	10	8	14	40	10
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	150.333	50.111	6.7616		
Factor A	5	49.833	9.967	1.3448^{ns}	2.90	4.56
Error	15	111.167	7.411			
TOTAL	23	311.333				

CV: 37.12%

* Significant
**Highly significant
^{ns} Not significant

Appendix table 27. Sixth number of ripe berries.

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	3	8	10	12	33	8.25
Farmer's Practice	6	8	15	7	36	9
Trichoderma 30g	5	9	12	20	46	11.5
Trichoderma 40g	14	14	14	11	53	13.25
Vermi Compost	4	11	14	17	46	11.5
Chicken Manure	9	10	17	18	54	13.5
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	212.333	70.778	6.3132		
Factor A	5	92.833	18.567	1.6561^{ns}	2.90	4.56
Error	15	168.167	11.211			
TOTAL	23	473.333				

CV: 29.98%

* Significant
** Highly significant
^{ns} Not significant

Appendix table 28. Seventh number of ripe berries

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	11	13	18	16	58	14.5
Farmer's Practice	19	22	30	24	90	22.5
Trichoderma 30g	20	21	30	22	93	23.25
Trichoderma 40g	18	25	27	30	100	25
Vermi Compost	14	13	14	26	67	16.75
Chicken Manure	23	10	22	22	83	20.25
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	218.458	72.819	4.7951		
Factor A	5	327.708	65.542	4.3159*	2.90	4.56
Error	15	227.792	15.186			
Total	23	773.958				

CV: 19.05%

* Significant
** Highly significant
ns Not significant

Appendix table 29. Eight number of ripe berries

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	7	10	14	5	36	11.5
Farmer's Practice	4	4	11	10	29	7.25
Trichoderma 30g	8	15	16	3	42	10.5
Trichoderma 40g	5	9	14	5	33	8.25
Vermi Compost	12	5	7	14	38	9.5
Chicken Manure	8	9	17	3	37	9.25
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	154.125	51.375	3.0088		
Factor A	5	24.708	4.942	0.2894	2.90	4.56
Error	15	256.125	17.075			
TOTAL	23	434.958				

CV: 46.13%

* Significant
** Highly significant
ns Not significant

Appendix table 30. Total number of ripe berries

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	50	81	83	100	314	78.5
Farmer's Practice	70	75	125	79	419	104.75
Trichoderma 30g	73	97	119	130	419	104.75
Trichoderma 40g	83	92	117	131	423	105.75
Vermi Compost	51	45	113	153	362	90.5
Chicken Manure	95	108	140	162	505	126.25
TOTAL						

Appendix table 31. First weight of ripe berries per grams

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	0	38	11	76	125	31.25
Farmer's Practice	8	16	41	0	65	16.25
Trichoderma 30g	21	38	26	125	210	57.5
Trichoderma 40g	35	128	32	84	279	69.75
Vermi Compost	0	0	0	76	76	19
Chicken Manure	22	123	44	156	325	81.25
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	18793.500	6264.500	6.0091		
Factor A	5	16158.833	3231.767	3.1000*	2.90	4.56
Error	15	15637.500	1042.500			

CV: 70.83%

* Significant
** Highly significant
ns Not significant

Appendix table 32. Second weight of ripe berries per grams

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	47.26	40.92	27.99	92.11	208.28	52.07
Farmer's Practice	46.91	49.55	106.32	22.29	225.07	56.27
Trichoderma 30g	24.28	16.9	17.51	120.73	179.42	44.85
Trichoderma 40g	53.77	29.29	53.7	115.23	251.99	63
Vermi Compost	7.63	0	59.46	89.82	156.91	39.23
Chicken Manure	45.81	95.65	99.96	201.11	442.53	110.63
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	18436.872	6145.624	5.2512		
Factor A	5	13277.492	2655.498	2.2690^{ns}	2.90	4.56
Error	15	17554.759	1170.317			
TOTAL	23	50589.833				

CV: 55.69%

* Significant
**Highly significant
^{ns} Not significant

Appendix table 33. Third weight of ripe berries per grams

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	14.96	53.46	90.56	80.30	239.28	59.82
Farmer's Practice	52.81	43.58	125.14	70.38	291.91	72.98
Trichoderma 30g	35.92	87.98	51.47	104.76	280.13	70.03
Trichoderma 40g	47.15	72.57	94.29	115.78	329.79	82.45
Vermi Compost	39.63	45.58	123.43	189.27	397.91	94.48
Chicken Manure	90.17	75.18	110.34	140.41	416.1	104.02
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	18436.872	6145.624	5.2512		
Factor A	5	13277.492	2655.498	2.2690^{ns}	2.90	4.56
Error	15	17554.759	1170.317			
TOTAL	23	49269.124				

CV: 55.69%

* Significant
**Highly significant
^{ns} Not significant

Appendix table 34. Fourth weight of ripe berries per grams

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	25	65.2	91.8	106.50	288.5	72.13
Farmer's Practice	51	72.6	143.6	68.80	336	84
Trichoderma 30g	46.6	80.12	103.7	154	384.42	96.10
Trichoderma 40g	102.5	101.8	107.6	107	418.9	104.72
Vermi Compost	14.10	96.9	109.3	134.04	354.34	84.58
Chicken Manure	72.6	97.8	153.1	142.03	465.53	116.38
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	18185.570	6061.857	9.9078		
Factor A	5	4910.206	982.041	1.6051^{ns}	2.90	4.56
Error	15	9177.394	611.826			
TOTAL	23	32273.170				

CV: 26.41%

* Significant
**Highly significant
^{ns} Not significant

Appendix table 35. Fifth weight of ripe berries per grams

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	10.25	72.10	87.53	91.32	261.20	65.30
Farmer's Practice	15.37	73.15	127.25	103.43	319.2	79.80
Trichoderma 30g	13.43	75.12	115.37	192.37	396.29	99.07
Trichoderma 40g	145.20	143.20	149.16	80.27	517.83	129.46
Vermi Compost	27.15	106.10	136.12	172.81	442.18	110.54
Chicken Manure	68.50	79.70	170.78	173.16	492.14	123.03
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	30836.021	10278.674	7.1085		
Factor A	5	12455.515	2491.103	1.7228 ^{ns}	2.90	4.56
Error	15	21689.519	1445.968			
TOTAL	23	64981.054				

CV: 37.12%

* Significant
**Highly significant
^{ns} Not significant

Appendix table 36. Sixth weight of ripe berries per grams

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	39	100	162	161	462	115.5
Farmer's Practice	90	175	234	166	665	166.25
Trichoderma 30g	193.05	204	258	219	874.05	218.51
Trichoderma 40g	127	217	318	240	902	225.5
Vermi Compost	115	97	111	221	544	136
Chicken Manure	147	165	164	236	739	184.75
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	33164.979	11054.993	7.1779		
Factor A	5	38291.730	7658.346	4.9725**	2.90	4.56
Error	15	23102.223	1540.148			
TOTAL	23	94558.932				

CV: 22.65%

* Significant
** Highly significant
ns Not significant

Appendix table 37. Seventh weight of ripe berries per grams

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	60	40	70	30	200	50
Farmer's Practice	30	30	80	30	170	42.5
Trichoderma 30g	50	100	120	70	340	85
Trichoderma 40g	40	70	60	110	280	70
Vermi Compost	80	50	140	20	390	97.5
Chicken Manure	60	80	110	40	290	72.5
TOTAL						

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	8333.333	2777.778	3.8168		
Factor A	5	5550.000	1110.000	1.5252^{ns}	2.90	4.56
Error	15	10916.667	727.778			
TOTAL	23	24800.000				

CV: 41.40%

* Significant
** Highly significant
^{ns} Not significant

Appendix table 38. Total weight of ripe berries tons per hectare

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
Control	300	620	670	780	2370	50
Farmer's Practice	480	630	1030	610	2750	42.5
Trichoderma 30g	510	830	870	1200	3410	85
Trichoderma 40g	690	900	990	1050	3630	70
Vermi Compost	330	460	920	1210	2920	97.5
Chicken Manure	700	870	1100	1390	4060	72.5
TOTAL	3010	4310	5580	6240	19140	4785

ANALYSIS OF VARIANCE TABLE

Source	Degrees of Freedom	Sum of Squares	Mean Square	F Value	Comp. F 0.5	0.1
Replication	3	1020883.33	340294			
Factor A	5	484450.00	96890.00	4.07^{ns}	2.90	4.56
Error	15	357116.67	23807.78			
TOTAL	23	1862450.00				

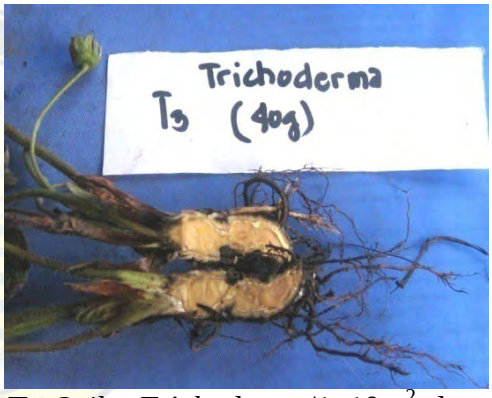
CV: 41.40%

Appendix Figure 5. Representatives of strawberry roots from the different treatments.

T_0- Without any amendment

T_1- 10kg chicken manure+1.2kg triple 14/ 1x10m^2 plot

T_2- 1.8kg *Trichoderma*/1x10m^2 plot



T_3- 2.4kg *Trichoderma*/1x10m^2 plot

T_4- 10kg Vermi compost/1x10m^2 plot

T_5- 10kg Chicken manure/1x10m^2 plot

Appendix Figure 6. Strawberry sample plants with and without crown rot infection (T_0, T_1, and T_5) (T_2, T_3 and T_4)

T_0- Without any amendment

T_1- 10kg chicken manure+1.2kg triple 14/ 1x10m^2 plot

T_2- 1.8kg *Trichoderma*/1x10m^2 plot

T_3- 2.4kg *Trichoderma*/1x10m^2 plot

T_4- 10kg Vermi compost/1x10m^2 plot

T_5- 10kg Chicken manure/1x10m^2 plot