BIBLIOGRAPHY

KIAS, NILDA B. APRIL 2012. Chemical and Biological Evaluation of *Tithonia diversifolia* (wild sunflower) Ecosystem Under La Trinidad, Benguet, Province Soil Series. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted from October 2010 to Sept 2011 to describe a wild sunflower ecosystem under La Trinidad soil series; determine some soil chemical properties; determine the microbial growth and population; and relate some soil chemical properties to microbial population.

The *Tithonia diversifolia* (wild sunflower) ecosystem under La Trinidad soil series is characterized to be flat, hilly to steep slopes (1,113-1,430 m elevation). *Tithonia diversifolia* love to grow on vacant lots full of biological wastes, garbage pits near households, road cuts, levees,, and in suburbs. The only weed observed that grow together with *Tithonia diversifolia* is the *Pennisetum pupureum* (napier or Uganda grass).

The pH of the different La Trinidad soil types is characterized as extremely acid to slightly acid condition ranging from 4.3 to 6.6 under a *Tithonia diversifolia* both at rhizosphere and distance away. The OM content of the soils in a wild sunflower between the rhizosphere and lateral distance away are described to be low to adequate range.

Tithonia diversifolia has an acidifying effect on the soil and utilizes and contributes much to the soil OM, thereby, influencing microbial growth in the 15 cm and 30 cm rhizospere depth.

Possible beneficial bacterial growth is a presumptive evidence of antibiotics under a wild sunflower ecosystem on the different La Trinidad soil series.

RESULTS AND DISCUSSION

Description of a Wild Sunflower Ecosystem Under La Trinidad Soil Series

Ambassador silt loam. Soils at a wild sunflower ecosystem were sampled in Shilan at an elevation of 1,378 meters. The wild sunflower plants at the time of sampling were at their late vegetative stage but some were on their state of decomposition due to typhoons. The area is located near an abandoned business establishment and is robustly growing on a piled-up limestone rocks. Above the area is an excavation for an ongoing development. Wild sunflower growing in the vicinity are abundant at road cut edges. The soil color is dark reddish brown (moist consistence) and dull orange (dry consistence).

Bakakeng clay. Soil samples of this type were taken in Beckel, in between houses at the edge of garbage pits and near fences at an elevation of 1,430 meters. Soil color is orange both at moist and dry consistence.

Bineng sandy clay. Soil samples were taken in Bineng 1,295 meters high. Wild sunflower plants were prominently growing at the edge of roads, on rocky and vacant lots. The growth stage of the wild sunflower was at its active vegetative stage. It was further observed that wild sunflower growth was better on dumped soils and edge of roads. . The soil color on site was dark brown (moist consistence) and dull brown (dry consistence).

Buyagan clay loam. The samples were taken at the riverbanks and leeve of the Balili River 1333 m high. The site is usually where weed trims from the oval and other garbage are dumped. Sun flower plants were robustly growing at its late vegetative stage. Further observations show that the plant grows well on soils classified as alluvial soils. These types of soils are usually silt loam or clay loam. Accumulation of plastic bags, and other sort of garbage was a common feature in the site. The soil color observed was pole yellow both under moist and dry consistence.

Halsema clay loam. Soil samples were taken in Shilan on a hilly portion edge of the road 1,364 m high and above the site are terraces being planted with vegetables. Weed stubbles seemed to have been dumped at the edges of the gardens but no weed growth observed. The parent material in the site is limestone. The soil color is dark reddish brown (moist condition) and dull reddish brown (dry condition).

La Trinidad loam. Soil samples were taken at a vacant lot in Pines Park, Lubas surrounded by houses 1,331 m high. The soil in the area is described as entisol with a thin brown colored top soil produced from a limestone parent material. A prominent and evident observation on exposed limestone rocks is the lone growth of wild sunflower. This suggests a nutrient sequestering capability of wild sunflower from the rock. Further, wild sunflower grows vigorously near canals and pits near houses. The brown color is due to the accumulated organic material decomposed from the wild sunflower stubbles.

Puguis gravelly loam. Soil samples were taken in Pico at a vacant lot, at the base of a pine forested mountain 1,350 m high. The sunflower plants were robustly growing on a soil classified as colluvial. The soil color is brown (moist consistence) and dull yellow orange (dry consistence). More over no other crops grow simultaneously with wild sunflower except the napier grass or Uganda grass (*Pennisetum purpureum).*

Rough mountainous land. Soil sample were collected at the mountainous part of Alno, at the edges of the road 1,113 m high. Sunflower growth as further observed is vigorous on colluvial soils. The color is grayish yellow (moist consistence) and dull grayish yellow (dry consistence). It was further observed that the only weed growing together with wild sunflower is the napier grass or Uganda grass (*Pennisetum purpureum)*.

Tacdian clay loam. Samples were collected in Bahong at the edges of a private road cut 1,296 m high. Wild sunflower growth was vigorous at their early vegetative stage and the soils in the area are loose, thus the roots were observed as deep as one meter. The color is brown (moist condition) and dull orange (dry condition).

Some Chemical Properties of Wild Sunflower Ecosystem Under La Trinidad Soil Series

Soil pH

Ambassador silt loam. The soil pH obtained from a wild sunflower rhizosphere (15 cm depth) is 4.0. This value significantly differs from the soil pH obtained from a lateral distance away with a mean of 5.1 (Table 1). This soil is classified to be extremely acidic and moderately acidic respectively (Fitzpatrick, 1999).

The result could be attributed to several factors like plant uptake, root exudates, and decomposition in the rhizosphere by microorganisms (Fitzpatrick, 1987). Further,

Table 1. pH of Ambassador silt loam under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	4.0^{b}
Lateral distance away	5.1^{a}

Means with the same letter/s are not significantly different by 5% DMRT

(PCARRD, 1999) reported that one of the major causes of acidity in the rhizosphere is from microbial activities producing sulfates and weakly dissociated organic acids. The sulfur and ammonium ions released from the decomposition or mineralization of organic materials could be oxidized to dilute HNO_3 (Nitric acid) and H_2SO_4 (Sulfuric acid) that release H^+ in the soil solution. Microbial population as scientists claim is much higher in the rhizosphere than at a distance because of the presence of substrate released by the roots Bakakeng clay. Table 2 presents the soil pH of 4.4 from the rhizosphere and a pH of 4.2 obtained from a lateral distance. Although the pH differences from both are not significant, Bakakeng clay is classified to be extremely acidic. The Cordillera belongs to a humid region with plentiful of rainfall that enhances leaching of base forming cations leaving the sesquioxides. In more humid areas, leaching depletes the upper horizons of Ca and other based-forming cations (Brady and Weil, 1996). Based on observation, the color in the field was orange and orange is nearly like the shade of the color red. Generally, red soils are very acidic due to the oxidized iron (Fe^{3+}). According Miller and Gardiner (2001), in nature, acidic soils remain acidic. Therefore plants that live on acidic

Table 2. pH of Bakakeng clay under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	4.4[a]
Lateral distance away	4.2[a]

Means with the same letter/s are not significantly different by 5% DMRT

soils must tolerate the acidity that is present in the soil. They also mentioned that acidic soils are leached soils, the more leached they are, usually the more strongly acidic they are.

Bineng sandy clay. The soil pH of Bineng sandy clay at the rhizosphere is greater with a mean of 5.2 compared to a lateral distance with a lower soil pH of 4.7. The difference between the two is found to be significant due to the fact that at a distance are pine trees. Soils under pine are acidic.

La Trinidad, Benguet is subject to heavy rainfall during the months of June to November. This could be the cause of the soil to become acidic. Johnson (1914) stated that rainfall is most effective in causing the soil to become acidic if a lot of water moves through the soil rapidly. Bineng sandy clay has sand content that contribute to the presence of macropores which acts as avenues for percolating water. According to the above author sandy soils are often the first to become acidic because water percolates rapidly, and contain only a small reservoir of bases (buffer capacity) due to low clay and organic matter contents. However, the above result implies an advantageous effect of the root in protecting the bases from being leached so that the pH in the rhizosphere is higher than at a lateral distance.

Table 3. pH of Bineng sandy clay under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	5.2[a]
Lateral distance away	4.7[b]

Means with the same letter/s are not significantly different by 5% DMRT

Table 4. pH of Buyagan clay loam under wild sunflower ecosystem

VARIABLE	MEAN

Rhizosphere	5.2[a]
Lateral distance away	5.8[a]

Means with the same letter/s are not significantly different by 5% DMRT

Buyagan clay loam. The difference between the rhizosphere soil pH of 5.2 and soil pH 5.8 at a lateral distance is not significant as shown in Table 4. However, the soil pH at a lateral distance is slightly higher than the soil pH of the rhizosphere. Considering the soil type, it is most likely that it has a contribution to the soil pH. Fine soils like Buyagan clay loam have higher CEC and higher buffering capacity so that any change in the environment would have lesser influence on the soil.

Halsema clay loam. A highly significant soil pH difference was obtained from the rhizosphere compared to a lateral distance. The rhizosphere reveals a more acidic pH (4.3) than the lateral distance with a pH 5.4

Table 5. pH of Halsema clay loam under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	4.3[b]
Lateral distance away	5.4[a]

Means with the same letter/s are not significantly different by 5% DMRT

Being a fine textured soil as Buyagan clay loam, the contributory factor could be attributed to leaching from the upper terraced garden and the rooting system of the wild sunflower. The roots of this plant extends deep so that the percolating water due to high rainfall follows the path of the extending roots.

La Trinidad loam. The pH of the La Trinidad loam taken in Pines Park, Lubas registered a slightly acidic pH of 5.6 under a wild sunflower rhizosphere. This value is significantly higher than the pH 5.4 taken from a lateral distance or no wild sunflower. The pH of La Trinidad loam is classified to be moderately acidic due to the fact that accumulation of wild sunflower debris was observed at the base of the sampled area.

Wild sunflower plant is known to absorb more calcium (Pandosen, 1986) and other non-acid cations thus when decomposed releases these ions into the soil solution. Moreover, the parent material in the site is limestone and is moderately weathered thereby more non-acid cations present. As plants absorbnon-acid cations, they exude protons (H^+) which contribute to soil acidity.

Table 6. pH of La Trinidad loam under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	5.6[a]
Lateral distance away	5.4[b]

Means with the same letter/s are not significantly different by 5% DMRT

Table 7. pH of Puguis gravelly loam under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	5.2[b]
Lateral distance away	4.6[a]

Means with the same letter/s are not significantly different by 5% DMRT

Puguis gravelly loam. This soil type registered a higher soil pH of 5.2 in the rhizosphere compared to a lower mean pH of 4.6 registered by the sample taken from a lateral distance (no wild sunflower). The mean difference is highly significant indicating the influence of the type of soil and wild sunflower itself. The area where wild sunflower was abundant was a colluvial soil eroded from the adjacent mountain. Usually, colluvial soils show gravelly soils because the topsoil is the first to be detached, hence the first to land upon deposition at the lower slope. Current crops observed at a lateral distance where no sunflower growth observed were galinsoga **(***Galinsoga parviflora***)** and cogon (*Imperata cylindrical)*. In fact, cogon is one among the indicator plants used by farmers for soil acidity. Due to acidity, wild sunflower is seldom observed on intensively cropped area.

Rough mountainous land. Rough mountainous land where wild sunflower thrive was sampled in Alno, La Trinidad, Benguet. The soil pH under wild sunflower rhizosphere registered a pH of 5.1 (strongly acid) while soil pH at a lateral distance was 5.8 (moderately acid). The difference between the two is found to be highly significant. The steep slopes and road cuts on the mountains were where wild sunflower growth is abundant. Usually, these kinds of spots are rocky thus still contain most of their

Table 8. pH of Rough mountainous land wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	5.1^{b}
Lateral distance away	5.8^{a}

Means with the same letter/s are not significantly different by 5% DMRT

elemental constituents. Wild sunflower has somewhat like a scavenging ability of extracting directly its nutrients from the rocks. Brady and Weil (1996) mentioned that as the soluble Ca and Mg are removed from the soil by the growing plant or by leaching, the percentage base saturation and pH are gradually reduced. Usually, limestone being the major parent material of soils in the Cordillera is inhabited by wild sunflower in the presence of water or rainfall. Everytime the roots of plants absorb, they exude protons (H^+). Soil pH under rhizosphere may decrease because of microbiological activities. Gray and Williams (1971) published that enzymes released by microorganisms can also be absorbed on the particles and hence be subjected to a lower pH than that in the ambient solution.

Tacdian clay loam. The Tacdian clay loam has a pH of 4.6 in the wild sunflower rhizosphere which is much lower compared to the pH at a lateral distance (no wild sunflower) with a mean of 6.6 (Table 9). The difference between the two means is highly significant.

The root surface can differ from bulk soil in pH and in concentration of anions and cations (Anderson and Ingram, 1993). Ions which are rapidly absorbed by the root,

Table 9. pH of Tacdian clay loam under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	4.6^b
Lateral distance away	6.6^a

Means with the same letter/s are not significantly different by 5% DMRT

may be at very low concentration at the surface. As cations are absorbed they can be replaced by H^+, and in this way there can be a reduction of rhizosphere pH of 5 to 4 with the absorption of NH_4^+ from ammonium sulfate. Conversely, rhizosphere pH can rise following absorption of anions such as nitrate. These pH changes and associated effects on solubility of other ions can have very marked selection effects on the rhizosphere micro flora.

General Observation

It is observed in Figure 2 that the pH under La Trinidad soil series in a wild sunflower rhizosphere is lower compared to the soil pH at a lateral distance away. The contributory factors to such are the deep rooting system of wild sunflower which allow leaching of non-acid cations due to high rainfall in the sites; root exudates like protons (H^+) released as plants absorb non-acid cationic nutrient elements; OM decomposition and microbial population.

Wild sunflower plants acidify the soil due to its sequestering ability. However, when used as an organic fertilizer, it increases the soil pH (Pandosen, 1986).

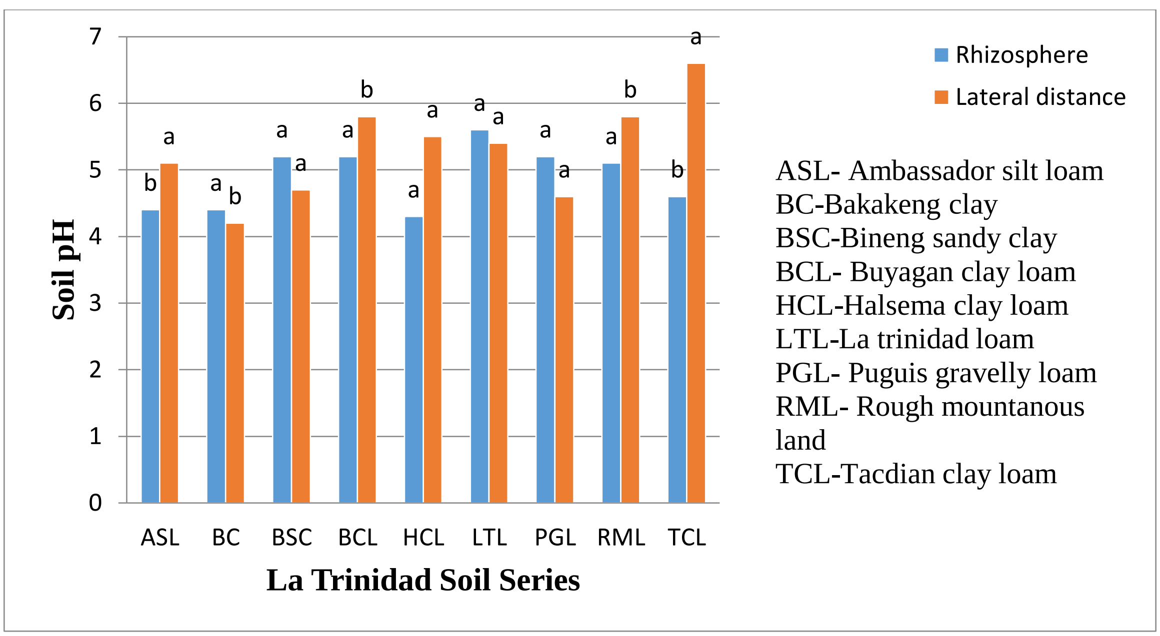


Figure 2. Soil pH of the different La Trinidad soil series under wild sunflower ecosystem between rhizosphere and lateral distance away

Means with the same letter/s are not significantly different by 5% DMRT

Organic Matter Content of the
Different La Trinidad Soil Series.

Ambassador silt loam. Table 10 shows a highly significant difference between the organic matter content of the soil obtained from the rhizosphere compared to a lateral distance in a wild sunflower ecosystem with means of 0.51% and 2.21% respectively. This result could be attributed to plant uptake. The wild sunflower roots can easily extend to the underground soils and as it grows, it utilizes nutrients.

Further, microorganisms usually proliferate and are greater in population where plant residues are. These are their source of energy as they decompose the plant residues like leaves and twigs that fall from the wild sunflower itself. The nutrients from the soils are being used quickly by the wild sunflower plant especially within the rhizosphere (Alexander, 1961).

Table 10. OM content of Ambassador silt loam under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	0.51[b]
Lateral distance away	2.21[a]

Means with the same letter/s are not significantly different by 5% DMRT

Bakakeng clay. The organic matter content of the wild sunflower rhizosphere is higher with a mean of 2.49% compared to the OM content of the soil at a lateral distance with a mean of 0.66% as shown in Table 11. The difference between the two is highly significant implying the vital role of wild sunflower as source of OM.

According to Singer and Munns (2006), clay soils absorb water on their surface or lose water from their charges, thus more of the organic materials are bound in clay-humus complexes or sequestered inside soil aggregates. Further (Brady and Weil, 2008) mentioned that rhizosphere is greatly enriched in organic compounds excreted by the roots.

Table 11. OM content of Bakakeng clay under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	2.49[a]
Lateral distance away	0.66[b]

Means with the same letter/s are not significantly different by 5% DMRT

Bineng sandy clay. The higher organic matter content (3.92%) of the wild sunflower rhizosphere is highly significant over the organic matter content (1.67%) at a lateral distance as shown in Figure 3. One of the several reasons why organic matter in rhizosphere is higher than distance away is that microbial activity is higher in the rhizosphere and root zone. Brady and Weil (2002) claim that the zones are greatly enriched in organic compounds excreted by the roots. In addition, droppings from the wild sunflower together with the garbage from households were observed to have been decomposed at the plant base. The lower soil OM at a lateral distance away may be attributed to decomposed pine needles.

Parnes (1986) says that dead leaves and drops from a tree will be available upon decomposition by micro organism from the rhizosphere or root zone. Similarly (Fitzpatrick, 1987) mentioned that greatest amount of organic matter is derived from plants both from the above ground parts as well as from roots. Generally, leaves and needles constitute up to 80% of the litter, while roots make up of the 20%.

Buyagan clay loam. Table 13 shows that 1.91% organic matter content of the soil in wild sunflower rhizosphere is lower than the lateral distance with a mean of 2.60%.

Table 12. OM content of Bineng sandy clay under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	3.92[a]
Lateral distance away	1.67[b]

Means with the same letter/s are not significantly different by 5% DMRT

Table 13. OM content of Buyagan clay loam under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	1.91[a]
Lateral distance away	2.60[a]

Means with the same letter/s are not significantly different by 5% DMRT

The difference between the two, however, is not significant. The result could be attributed to plant uptake due to the rooting system of wild sunflower and leaching due to the weather. La Trinidad was struck by typhoon three days before sampling. Run off of nutrients through heavy rains occur when the water moves down the slopes to streams and rivers (PCARRD, 1999).

Halsema clay loam. The soil organic matter content of the rhizosphere is higher with 2.05% than at a lateral distance which is 1.73%. The difference between the two is, however, not significant. The result could be due to the young vegetative stage of wild sunflower at the sampling date and the plant stubbles dumped at the base of the plant. Laegreid et al (1999) mentioned that organic matter content of a soil tends towards an equilibrium level that depends on the rates of microbial breakdown of recently added organic matter and soil humus compounds, soil type, climate and others.

Nutrient availability depends on the population of soil microorganism that is involved in decomposing the organic residue in the soil making it available to plants.

Table 14. OM content of Halsema clay laom under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	2.05[a]
Lateral distance away	1.73[b]

Means with the same letter/s are not significantly different by 5% DMRT

La Trinidad loam. Table 15 shows that soil organic matter in a wild sunflower rhizosphere is 8.23% which is higher at a lateral distance away with 7.58%. This can be confirmed by the brown color. The vacant lot where wild sunflower was growing had some decomposed plant litter at the base. Likewise, plant stubbles from weeds were observed to have accumulated at the wild sunflower base. The lower SOM at a distance away is due to the growth of weeds. Weeds are plants too that compete with soil constituents.

Soil organisms are beneficial to plants through their activities like organic matter decomposition, nitrogen fixation and others. These soil microorganisms are more likely present in the rhizosphere and root zone, thus microbial activity is higher in wild sunflower rhizosphere making the organic matter content higher than in the distance away or no wild sunflower has grown.

Table 15. OM content of La Trinidad loam under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	8.23[a]
Lateral distance away	7.58[a]

Means with the same letter/s are not significantly different by 5% DMRT

<u>Puguis gravelly loam</u>. The soil organic matter obtained is lower in rhizosphere than at a lateral distance, however, there is no significance between the mean differences. It is reasonably clear that the nutrients in the decaying organic residue were utilized by wild sunflower. Parnes (1986) stated that nutrient from the organic matter are being used quickly by plants which could affect the availability of nutrients in the soil.

<u>Rough mountainous land</u>. The 3.20% organic matter content as shown in Table 17 obtained from rhizosphere is higher as compared to a lateral distance (no wild sunflower) with a mean of 2.47%. The difference of the two is highly significant.

The sampling site in Alno La Trinidad is a mountainous area, where wild sunflowers are abundantly growing. The leaves and twigs of wild sunflower decompose

Table 16. OM content of Puguis gravelly loam under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	3.14[a]
Lateral distance away	3.21[a]

Means with the same letter/s are not significantly different by 5% DMRT

Table 17. OM content of Rough mountainous land under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	3.20[a]
Lateral distance away	2.47[b]

Means with the same letter/s are not significantly different by 5% DMRT

in the rhizosphere by microbial activity, thus making the organic matter content of the soil higher compared to a lateral distance.

<u>Tacdian clay loam</u>. (Parnes, 1986) mentioned that many of the active organic substances are water soluble and can be leached easily, hastening the depletion of soils, especially in humid climates. Singer and Munns (2006) mentioned that soil microorganisms eventually utilize all the elements in humus unless it is protected. This could be the attributary factor to the lower OM content obtained from the rhizosphere (3.19%) compared to the higher OM at a lateral distance of 4.04%. the mean difference is significant.

(PCARRD, 1999) added that leaching is the loss of soil nutrients from the root zone of the plants through the action of water. It occurs especially under frequently flooded soil condition or whenever soil water moves by diffusion out of the root zone. The wild sunflower root growth is deep downward and as the root expands and grows, it needs nutrients for growth. Further the organic matter and other nutrients are being lost through the movement of water downward following the roots movement. The vigorous growth of wild sunflower manifests the utilization of OM in the rhizosphere compared to the lateral distance or no wild sunflower.

Table 18. OM content of Tacdian clay loam under wild sunflower ecosystem

VARIABLE	MEAN
Rhizosphere	4.11[a]
Lateral distance away	3.79[a]

Means with the same letter/s are not significantly different by 5% DMRT

General Observation

The OM content of the different La Trinidad soils series under a wild sunflower ecosystem between the rhizosphere and at a lateral distance is shown in Figure 3. There are no definite and distinct differences on the OM content of the soils due maybe to the types of soil and the growth stage of wild sunflower. Within the sampling sites where young plants are growing, lower OM was observed meaning the plants are utilizing it. Whereas in some areas, old plant droppings are decomposing while young ones are emerging. Further, as mentioned in the previous discussion OM too is easily subject to leaching process rendering the loss of these materials.

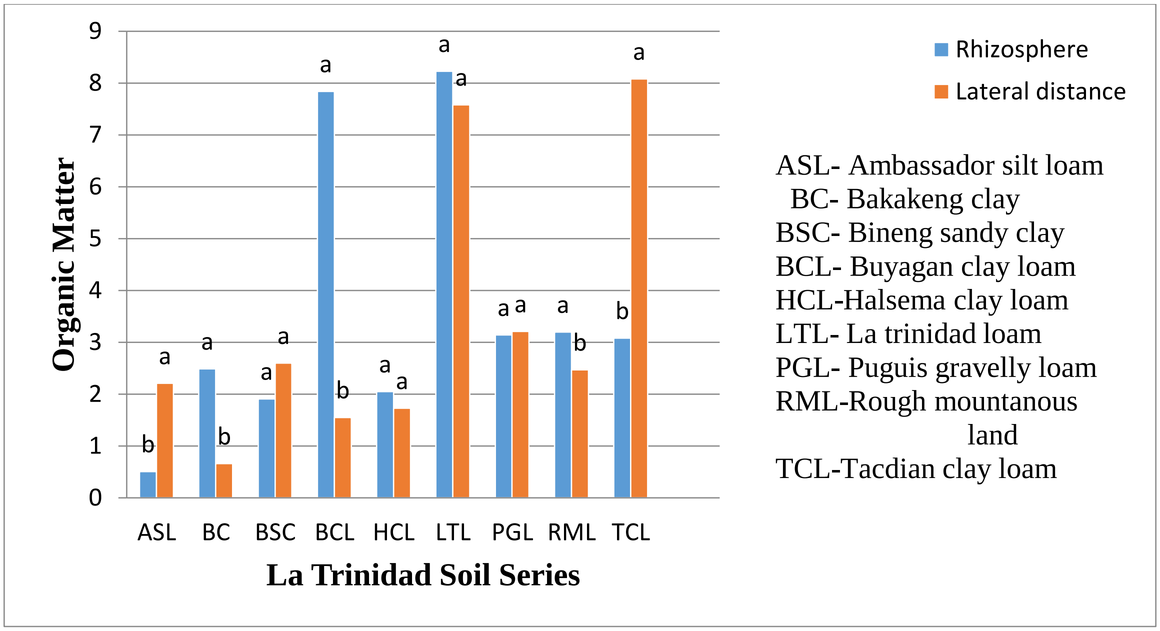


Figure 3. OM content of the different La Trinidad soil series under wild sunflower ecosystem between rhizosphere and lateral distance away

Means with the same letter/s are not significantly different by 5% DMRT

Some Biological Properties of Wild Sunflower Ecosystem Under La Trinidad Soil Series

Bacterial Population

Ambassador silt loam. Table 19 shows the bacterial population at 15 cm and 30cm rhizosphere depth. It shows in the Table that a mean population of 226,725 from the subsoil is highly significant over the surface (15cm) depth with a mean of 13,603. The result could be attributed to the rooting system of the wild sunflower which penetrates deep.

Table 19. Bacterial population of Ambassador silt loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	13,603[b]
30 cm (subsoil)	226,725[a]

Means with the same letter/s are not significantly different by 5% DMRT

Walker (1975) mentioned that as roots move through soil, root cap cells provide nutrients near the tip and elongating zone, but as plants age, root hairs and cortical cells die and all this tissue becomes available to feed many microbes. Considering that the wildsunflower roots reaches 30 cm to one meter depth.

Bakakeng clay. Table 20 presents the number of bacterial population of 2,240 from the 15 cm depth and 1,873 obtained from a 30 cm depth. Although the bacterial population difference is not significant, it was still observed that a higher number of bacteria were obtained from a 15 cm depth. One reason which Alexander (1977) mentioned is the availability of residues of roots or above ground tissue which is more on the surface ground (15cm) than subsurface ground (30cm).

Table 20. Bacterial population of Bakakeng clay under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	2,240[a]
30 cm (subsoil)	1,873 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Table 21. Bacterial population of Bineng sandy clay under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	105,845 [a]
30 cm (subsoil)	130,856 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Bineng sandy clay. The bacterial population for Bineng sandy clay is higher at 30 cm depth with a mean of 130,856 compared to a 15 cm depth with a mean of 105,845. However, there was no observed statistical difference between the microbial counts. Soil sample from Bineng sandy clay was taken at the road sides. The number of bacteria at soil surface may have been affected by vehicle exhaust.

Buyagan clay loam. The 115,711 number of bacteria from 30cm depth is higher compared to a 15 cm depth with a mean of 13,806. The difference between the two is highly significant based on statistics.

Gray and William, (1971) explains that those microorganisms growing on or near surface maybe subjected to considerable changes in temperature during the course of the day, while microbes living in the lower parts of the soil may experience only small scale changes in temperature throughout the year. That is why some microbes choose to live in the lower parts of the soil.

Table 22. Bacterial population of Buyagan clay loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	13,806 [b]
30 cm (subsoil)	115,711 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Halsema clay loam. Table 23 shows no significant difference between the count 15 cm depth (131,764) and 30 cm depth (118,022). However abundance of bacteria was observed to be higher at 15 cm depth than at 30 cm depth. This could be due to plant stubbles that are dumped and has undergone decomposition at the plant base. As plant stubbles decompose, OM content of the soil increases which favors the proliferation of microorganisms.

La Trinidad loam. Abundance of bacteria at 30 cm depth is much greater than at 15cm depth rhizosphere as observed on this soil series. Alexander (1961) mentioned that the number of bacteria becomes greater with depth so that they make up a larger segment of the subsurface community and this could be attributed to the downward

Table 23. Bacterial population of Halsema clay loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	131,764 [a]
30 cm (subsoil)	118,022 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Table 24. Bacterial population of La Trinidad loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	1,368 [b]
30 cm (subsoil)	164,270 [a]

Means with the same letter/s are not significantly different by 5% DMRT

movement of conidia with water or a differential effect of oxygen or carbon dioxide on the bacteria.

Puguis gravelly loam. At this soil type, it is still observed that the greater number of bacteria at 30cm depth is significantly greater than the number of bacteria at 15 cm depth. This could still be due to the root density of the wild sunflower which excretes an organic compound down reaching 30 cm depth rhizosphere which in response microorganisms get their energy and multiply in number.

Rough mountainous land. The number of bacteria was still observed to be high at 30 cm depth than at 15 cm depth as shown in Table 26. However, the difference between the two is not significant. One reason is that other organic compounds may have been

Table 25. Bacterial population of Puguis gravelly loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	184,102 [b]
30 cm (subsoil)	397,724 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Table 26. Bacterial population of Rough mountainous land under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	17,364 [b]
30 cm (subsoil)	30,635 [a]

Means with the same letter/s are not significantly different by 5% DMRT

carried by percolating water which moved downward due to heavy rainfull before the date of sampling.

Tacdian clay loam. The mean of 147,629 bacterial population obtained from the 30 cm depth was highly significant over the mean of 24,410 obtained from the 15cm depth rhizosphere. The wild sunflower plants growing in this series at the time of sampling were on their late vegetative growth stage hence, some of the roots may have rotten. Leaching could also be a factor here.

Table 27. Bacterial population of Tacdian clay loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	24,410 [a]
30 cm (subsoil)	147,629 [b]

Means with the same letter/s are not significantly different by 5% DMRT

General Observation

Figure 4 shows that bacterial population is greater at the subsoil (30 cm deep) than at the surface (15 cm deep). Alexander (1977) reported that the microbial numbers are larger in the inner zone where the biochemical interactions between microorganisms and roots are most pronounced.

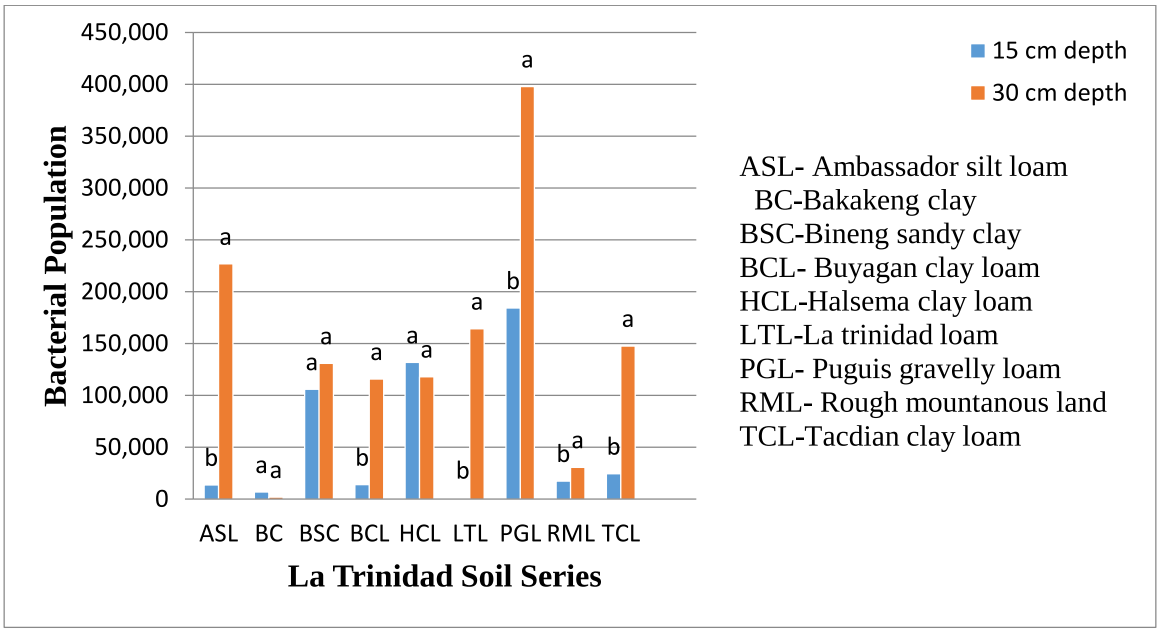


Figure 4. Bacterial population of the different La Trinided soil series under wild sunflower ecosystem between 15cm and 30 cm rhizosphere depth

Means with the same letter/s are not significantly different by 5% DMRT

Streptomyces Population

Ambassador silt loam. Table 28 shows the number of streptomyces which is higher at 15cm depth with a mean of 1,046, which is higher compared to a 30cm depth with a mean of 723. It can be deduced that soil type influences streptomyces population and proliferation. Alexander (1977) wrote that the size of the community depends on the soil type, particularly on certain physical characteristics, organic matter contents, and pH of the environment. Wild sunflower plants at the time of sampling were at their late

Table 28. Streptomyces population of Ambassador silt loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	1,046[a]
30 cm (subsoil)	723[b]

Means with the same letter/s are not significantly different by 5% DMRT

vegetative stage and some were on their state of decomposition. This can contribute to the abundance of streptomyces at the first 15cm soil rhizosphere.

Bakakeng clay. There were no observed significant difference between the number of streptomyces population at 15cm and 30cm depth rhizosphere. Streptomyce population, however, is higher in the soil than at the surface.

Schaetzl and Anderson (2005) mentioned that about 90 % of the actinomycetes in soils are streptomycetes. They live in soils and plant litter, and can degrade complex substances such as lignin, chitin, humin, aromatic compounds, keratin and cellulose. Dr. Cann (2007) concludes that streptomyces are metabolically diverse and can utilize almost anything, including, sugars, alcohols, amino acids, and aromatic compounds. This is achieved by producing extracellular hydrolytic enzymes. On the other hand Volk and Wheeler (1988) mentioned that actinomycetes produce plant disease, such as potato scab (streptomyces scabies). Member of the genus streptomyces are only rarely pathogenic but they have achieved prominence as a result of their ability to produce antibiotics. In fact these natural antibiotics sometimes protect plant roots from attack by disease organisms.

Table 29. Streptomyces population of Bakakeng clay under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	948 [a]
30 cm (subsoil)	1,043 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Bineng sandy clay. This soil series shows a highly significant difference between streptomyces count a 15cm depth with a lower mean of 487 compared to a 30 cm with a higher mean of 1,037. Since wild sunflower at the time of sampling was at their active vegetative stage and that the site is very steep, it is possible that microbes have been carried downward by pecolating water. Moreover, the sites where wild sunflower is abundant were observed to have been dumped with partially decomposed plant stubbles and garbage. Streptomyces consequently play an important role in the degredation of organic matter, most commonly noted in compost pile (Microwiki, 2010).

Table 30. Streptomyces population of Bineng sandy clay under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	487 [b]
30 cm (subsoil)	1,037 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Table 31. Streptomyces population of Buyagan clay loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	457 [b]
30 cm (subsoil)	1,039 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Buyagan clay loam. Streptomyces count is substabtially greater at the subsoil than at the surface. Wild sunflower is abundant at the level of the Balili River where the composite sample was obtained. It is also on this site where wastes are decomposed frim the oval of BSU and the soil here is classified as alluvium. Moreover, Alexander (1977) mentioned that actinomycetes are affected directly by the presence of available carbon, and their number is especially great in land rich in OM. Actinomycetes are numerous and widely distributed in soil and are next to bacteria in abundance. The common genera of actinomycetes are streptomyces nearly 70% than other genera of actinomycetes like nicordia and micromonospora, mentioned by (Agriculture Info. Bank, 2011).

Halsema clay loam. Streptomyces population is still greater at the subsoil compared to the surface. On one hand, there was no observed statistical significant difference. The low streptomyces population could be attributed to the acidity within the wild sunflower ecosystem. Most strains of streptomyces and other related forms fail to proliferate or have negligible activity below pH 5.0 (Gray and Williams, 1971).

Table 32. Streptomyces population of Halsema clay loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	373 [a]
30 cm (subsoil)	416 [a]

Means with the same letter/s are not significantly different by 5% DMRT

La Trinidad loam. Streptomyces count is still observed to be high at 30cm depth rhizosphere in this soil type compared to the 15cm depth rhizosphere. Difference of the two is highly significant. This could still be due to the root density of wild sunflower and its root excretion of sugars and other organic compounds which serves as food for the streptomyces (Schaetzl and Anderson, 2005).

Puguis gravelly loam. At this soil type, numbers of streptomyces are known to be high at 15cm depth than at 30cm depth and the difference between the two is highly significant. The result could be attributed to the higher pH attained form this soil type at the surface soil. As was mentioned previously, streptomyces is sensitive to acidity.

Table 33. Streptomyces population of La Trinidad loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	157 [b]
30 cm (subsoil)	697 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Table 34. Streptomyces population of Puguis gravelly loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	549 [a]
30 cm (subsoil)	100 [b]

Means with the same letter/s are not significantly different by 5% DMRT

Walker(1975) mentioned that the filamentous microorganisms are present in A horizon as well as at considerable depth below the surface, but the cell density estimated by plating techniques progressively declines with depth in the soil profile.

Rough mountainous land. There is no observed statistical significance on the number of streptomyces counted on this soil type but the surface soil registered a higher count than the subsoil. Actinomycetes such as streptomyces produce thin walled conidia which have hydrophobic properties not unlike those of some fungal conidia. They are generally supposed to be resistant to disecation and can survive for long periods in dried soils. They are more resistant to heat than vegetative mycelium and could survive partial heat sterilization of soil (Gray and Williams, 1971).

Table 35. Streptomyces population of Rough mountainous land under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	534 [a]
30 cm (subsoil)	387 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Tacdian clay loam. There is no significant difference between streptomyces count for a 15cm depth with a mean of 127 and at 30cm depth with a mean of 202. Althouhg a very low number in both depths were obtained, the subsoil has a higher count compared to the surface soil count. This could be due to sudden changes of temperature, availability of nutrients and accumulation of some nutrients needed, which have been carried away by heavy rainfall.

Table 36. Streptomyces population of Tacdian clay loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	127 [a]
30 cm (subsoil)	202 [a]

Means with the same letter/s are not significantly different by 5% DMRT

General Observation

Streptomyces population is greater at 30 cm (subsoil) than at 15 cm (surface soil) on the different La Trinidad soil series under wild sunflower ecosystem. The population is observed to be more dependent on soil pH, ecosystem soil type, and weather.

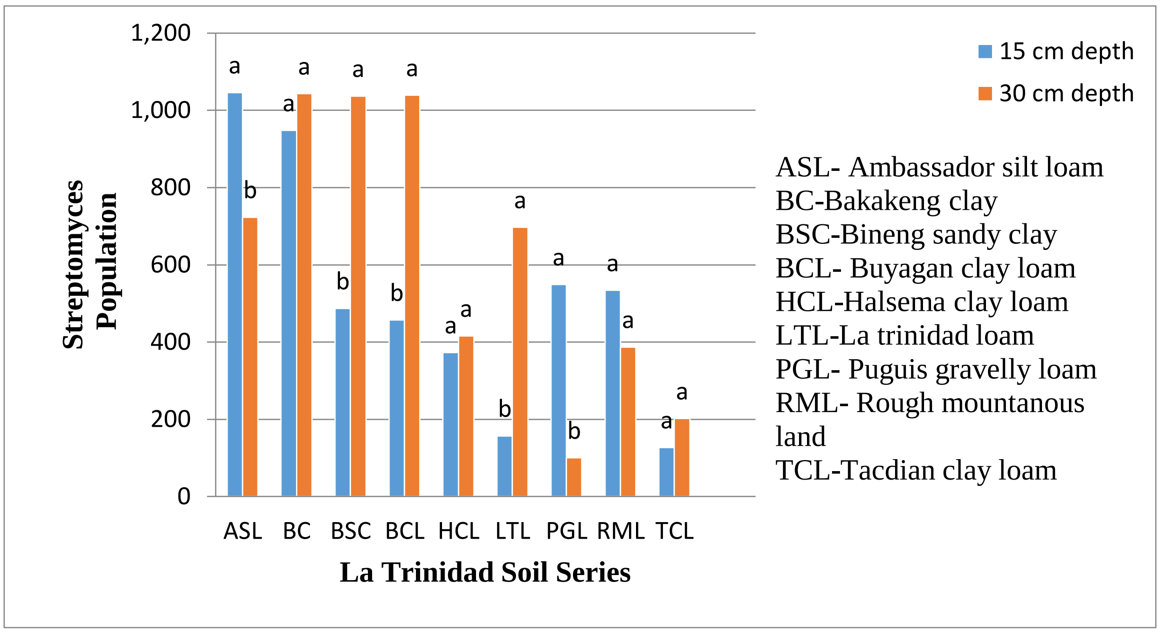


Figure 5. Streptomyces population of the different La Trinidad soil series under wild sunflower ecosystem between 15 cm and 30 cm rhizosphere depth

Means with the same letter/s are not significantly different by 5% DMRT

Possible Beneficial Bacterial Count
Depth Under Wild Sunflower 15cm Rhizosphere

Table 37 summarizes the number of possible beneficial bacteria observed from wild sunflower 15 cm rhizosphere depth. Result shows that regardless of soil type and dilution, possible beneficial bacterial growth was observed under a wild sunflower 15 cm rhizosphere depth. Beneficial bacteria are those that have the ability to inhibit the growth of other microorganisms. The ambassador silt loam has the highest number of possible beneficial bacteria and is statistically different from the counts observed from the other soil types. Generally, inhibition was observed on areas with naturally growing wild sunflower which are undisturbed, particularly limestone as the parent material. The inhibition is observed in Figure 9 which shows the bacterial isolates with clear zone around the bacterial colony observed after 48 hours of incubation. The halo devoid of growth is good presumptive evidence that the colony surrounded by the zone of clearing is producing an antibiotic.

Table 37. Possible beneficial bacterial count under wild sunflower 15cm rhizosphere depth

Soil Type	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}
Ambassador silt loam	12.00[a]	4.00[b]	0.00[b]	0.00[c]	0.00[c]
Bakakeng clay	0.67[a]	1.00[a]	0.00[b]	0.00[b]	0.00[b]
Bineng Sandy clay	2.00[a]	0.33[b]	1.00[b]	0.33[b]	0.00[b]
Buyagan clay loam	0.33[a]	1.67[a]	1.00[a]	0.33[a]	0.00[a]
Halsema clay loam	1.00[a]	0.67[a]	1.00[a]	0.33[a]	0.00[a]
La Trinidad loam	3.00[a]	2.00[a]	1.67[a b]	0.67[bc]	0.00[c]
Puguis gravelly loam	0.00[a]	0.33[a]	0.00[a]	0.00[a]	0.33[a]
Rough mountainous land	3.00[a]	2.67[a]	0.67[b]	0.00[b]	0.00[b]
Tacdian clay loam	0.00[a]	0.00[a]	0.33[a]	0.33[a]	0.00[a]

Means with the same letter/s are not significantly different by 5% DMRT

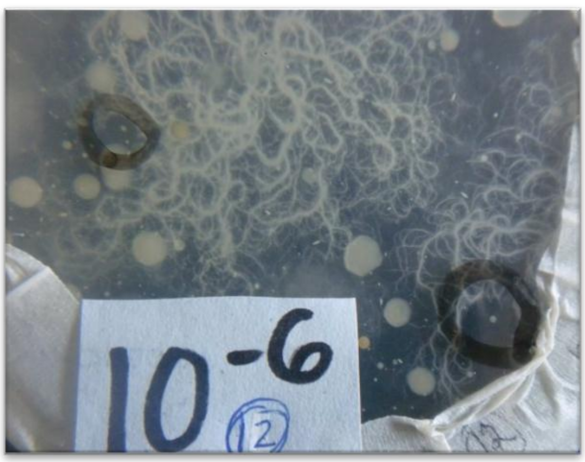
LTL isolates PGL isolates ASL isolates

Figure 6. Isolates with inhibition zone under wild sunflower 15cm rhizosphere depth.

An antibiotic is a substance formed by one organism that, in low concentrations, inhibits the growth of another organism. Many soil inhabitants produce inhibitory substances in laboratory media, and it is not difficult to isolate strains that, when tested in pure culture, suppress numerous microorganisms. A variety of actinomycetes, bacteria and fungi are able to synthesize antibiotics (Alexander, 1977). Actinomycetes are particularly active in this regard, and streptomycin, chloramphenicol, cycloheximide, and chlortetracycline are but the few of the important chemotherapeutic substances synthesized by them. The most frequently encountered bacteria synthesizing antibiotics are species of Bacillus and strains of Pseudomonas that liberate pyocyanin and related compounds.

Possible Beneficial Bacterial Count
Under Wild Sunflower 30 cm
Rhizosphere Depth

Actual count of possible beneficial bacteria from soil samples collected from wild sunflower rhizosphere at 30 cm soil depth is presented in Table 38. The ambassador silt loam has the highest number of possible beneficial bacteria. The result could be explained by the accumulation of the wild sunflower that fall on the base of the plant. As the original material and the initial products undergo further decomposition, they are converted to brown or black organic complexes. These complexes favor the proliferation of organisms that produce antibiotics. Alexander (1977) mentioned that the community of the rhizosphere is composed mainly of nonpathogenic microorganisms.



Isolates from Bineng sandy clay

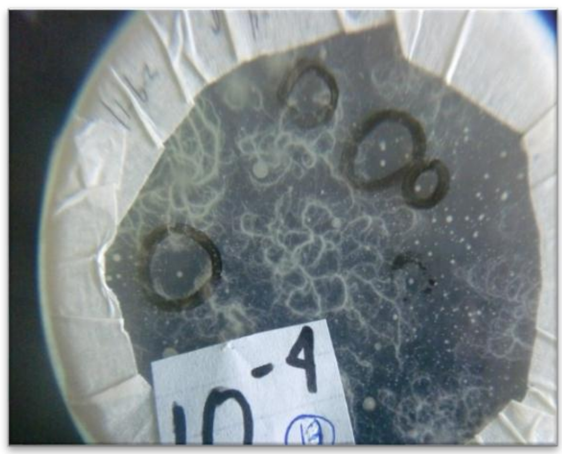

Isolates from Buyagan clay loam

Figure 7. Isolates with inhibition zone under wild sunflower 30 cm rhizosphere depth

The possible beneficial bacterial count was observed to have decreased with depth. The downward movement of water removes from the zone of microbial accessibility substances essential for proliferation (Alexander, 1977). Figure 7 is an example of the isolates suppressing the growth of other microorganisms. These were observed after 48 hours of incubation.

Table 38. Possible beneficial bacterial count under wild sunflower 30cm rhizosphere depth

Soil Type	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}
Ambassador silt loam	12.67 [a]	6.67 [a]	1.00[b]	0.00 [b]	0.00 [b]
Bakakeng clay	8.00 [a]	4.00 [a]	2.33 [b]	0.33[c]	0.33[c]
Bineng Sandy clay	2.33[a]	2.00 [a]	2.67 [a]	0.67 [a]	0.67 [a]
Buyagan clay loam	0.33 [a]	7.00 [a]	4.67 [a]	0.33 [b]	0.00 [b]
Halsema clay loam	0.00 [a]	1.33 [a]	0.33 [b]	0.00 [b]	0.00 [b]
La Trinidad loam	0.67 [a]	3.00 [a]	1.00 [b]	0.33 [b]	0.00 [b]
Puguis gravelly loam	0.00 [a]	0.33 [a]	0.00 [a]	0.33 [a]	0.00 [a]
Rough mountainous land	0.00 [a]	0.67 [a]	0.33 [a]	0.33 [a]	0.00 [a]
Tacdian clay loam	0.00 [a]	0.67 [a]	0.00 [b]	0.00 [b]	0.00 [b]

Means with the same letter/s are not significantly different by DMRT

Fungal Population of the Different
La Trinidad Soil Types

Ambassador silt loam. Table 39 shows no significant differences between the fungal populations from a 15cm depth compared to a 30cm depth rhiosphere. However, abundance of fungi was still observed to be higher at at this soil type on this soil type as compared to other soil series of La Trinidad.

Table 39. Fungal population of Ambassador silt loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	15,196[a]
30 cm (subsoil)	9,971 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Most of the factors in the environment vary with climate changes through out the year. This is especially true of temperature, moisture content and nutrient supply. In less extreme climate, one of the most regularly fluctuating factors is that of nutrient supply flushes of nutrient occurring after leaf fall (Walker, 1975).

Bakakeng clay. This soil type shows highly significant differences between 15cm depth (51,344) and 30cm depth (22,761). Abundance of fungi at 15cm than in 30cm depth could be due to the fact that the sampling site where wild sunflower is abundant is gargabe pits between households. Alexander (1977) mentioned that the frequency of bacteria, fungi, algae declines with depth, then the influence of depth may result from the availability of organic matter. Moreover, (Coyne and Thompson, 2006) mentioned that

Table 40. Fungal population of Bakakeng clay under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	51,344 [a]
30 cm (subsoil)	22,761 [b]

Means with the same letter/s are not significantly different by 5% DMRT

the biologically active layer shrinks even further to approximately 30cm (12inches), or the approximate plant rooting depth. As the soil depth increases, the number of bacteria significantly decreases, and this is true for most soil.

Soil organisms can be found at great depths in soil but this does not mean that they are active. Their presence could simply reflect their transport through soil channels from the soil surface to deeper depths. Sometimes greater numbers of fungi are observed in 30cm soil depth than in 15cm soil depth. This could be attributed to the wild sunflower root system which expands and grows downward. Because plant roots represent an abundant food source for saprophytes and parasites and the organisms that prey on them, the population of the soil organisms immediately adjacent to the plant roots in the rhizosphere is greater.

Bineng sandy clay. Table 41 shows the number of fungi at 15cm depth (62,465) and at 30cm depth (26,129). The difference of the two is highly significant. Jones (1982) mentioned that soil temperature strongly influences the activity of all soil microorganisms, and it is especially important in the transformation of ammonia to nitrate. In addition (Gray and Williams,1971) mentined that those growing on or near the surface maybe subjected to considerable changes in temperature during the course of the day, while microbes living in the lower parts of the soil may experience only small scale changes in temperature thoughout the year. In this case low temperature may affect microbial activity.

Table 41. Fungal population of Bineng sandy clay under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	62,465 [a]
30 cm (subsoil)	26,129 [b]

Means with the same letter/s are not significantly different by 5% DMRT

Buyagan clay loam. The number of fungi at 15cm depth is lower with a mean of 46,030 compared to a 30cm depth with a higher mean of 57,712. The differences of the two are highly significant. Walker (1975) mentined that the abundance and physiological activity of the fungus flora at different habitats vary considerably, and the community and its biochemical activities undergo appreciable fluctuation with the time at any single site. Soil type Buyagan clay loam was obtained from riverbank of Balili usually where weed trims from oval and other garbage are dumped. This could influence the abundance of fungus at this soil type.

Table 42. Fungal population of Buyagan clay loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	46,030 [b]
30 cm (subsoil)	57,712 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Table 43. Fungal population of Halsema clay loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	25,279 [a]
30 cm (subsoil)	20,923 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Halsema clay loam. There was no observed statistical significance between the number of fungi at 15cm and 30cm depth rhizosphere. At this soil type which was sampled at Shilan in a hilly portion at the edge or the roads, there maybe an influence of the vehicle exhaust on the abundance of fungus.

La Trinidad loam. The La Trinidad loam has a higher number of fungi at 15cm depth with a mean of 52,785 compared to a 30cm depth with a mean of 22,568. The difference between the two is highly significant.

Result could be due to the organic matter content of the soil which is classified to have adequate organic matter in the rhizosphere which served as food for the microorganisms.

Table 44. Fungal population of La Trinidad loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	52,785 [a]
30 cm (subsoil)	22,568 [b]

Means with the same letter/s are not significantly different by 5% DMRT

Table 45. Fungal population of Puguis gravelly loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	79,558 [a]
30 cm (subsoil)	31,143 [b]

Means with the same letter/s are not significantly different by 5% DMRT

Puguis garvelly loam. The Puguis garvelly loam has a higher number of fungi at 15cm depth with a mean of 79,588 compared to a 30cm depth with a mean of 31,143. The difference between the two is highly significant.

Alexander (1977) mentioned that the major external influence imposed on the fungus community include the organic matter status, hydrogen ion concentration, organic and inorganic fertilizers, the moisture regime aeration, temperature, position in the profile, season of year and composition of the vegetation.

Rough mountainous land. Table 46 shows the number of fungi at 15cm depth with a mean of 25,263 and 30cm depth with a mean of 65,268. The difference of the two is highly significant.

Position in the profile which is a colluvial soil from the above mountain, utilizable organic matter at this soil type, temperature and adequate moisture, have something to do with the number of fungi. This was confirmed by Coyne and Thompson (2006) who mentioned that all living things demand adequate moisture, and it is surprising, therefore that soil water has a direct effect upon the abundance and functions of fungi. Their capacity for catalyzing chemical changes in poor or lacking entirely when the water supply is low.

Table 46. Fungal population of Rough mountainous land under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	25,263 [b]
30 cm (subsoil)	65,268 [a]

Means with the same letter/s are not significantly different by 5% DMRT

Tacdian clay loam. Tacdian clay loam shows a higher number of fungi at 30cm depth than at 15cm depth. This could due to rooting system of wild sunflower plants. This could also due to the accumulation of materials, carried down from the upper layer 15 cm depth to the lower parts of the profile that affects the abundance of microorganicmc in 30cm depth.

Table 47. Fungal population of Tacdian clay loam under wild sunflower ecosystem

RHIZOSPHERE DEPTH	MEAN
15 cm (soil surface)	25,263 [b]
30 cm (subsoil)	65,268 [a]

Means with the same letter/s are not significantly different by 5% DMRT

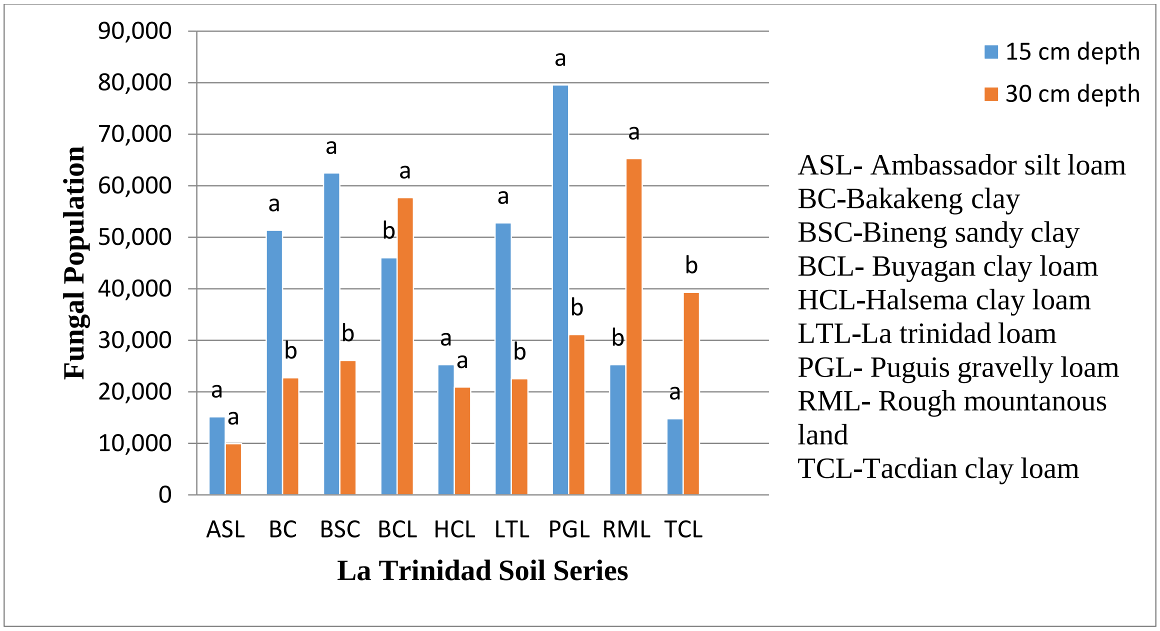
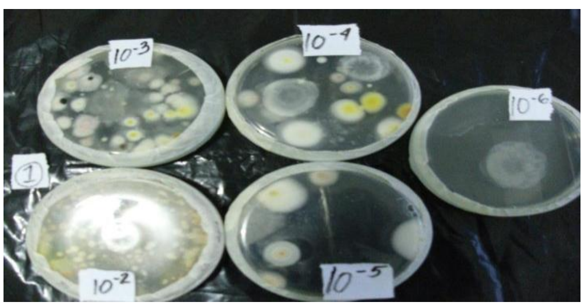
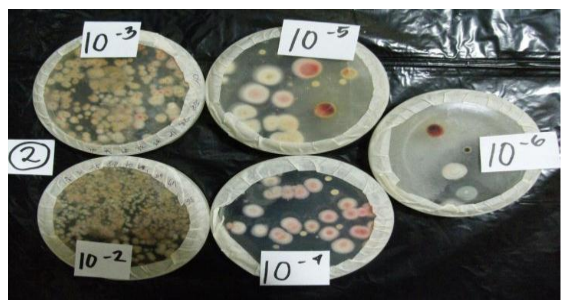


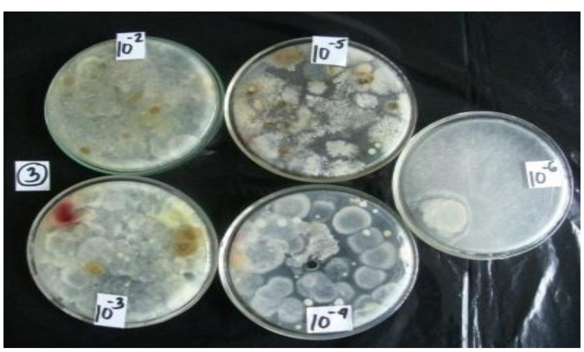
Figure 8. Fungal population of the different soil series under wild sunflower ecosystem 15 cm and 30 cm rhizosphere depth
Means with the same letter/s are not significantly different by 5% DMRT



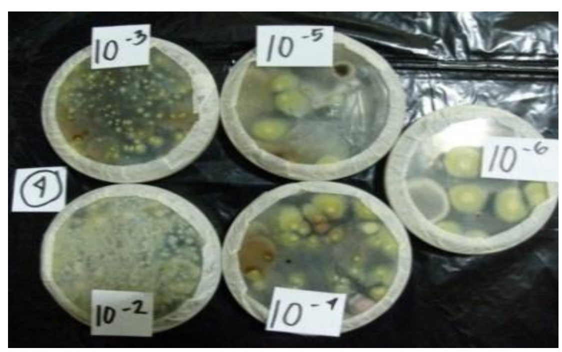
Isolates from Ambassador silt loam



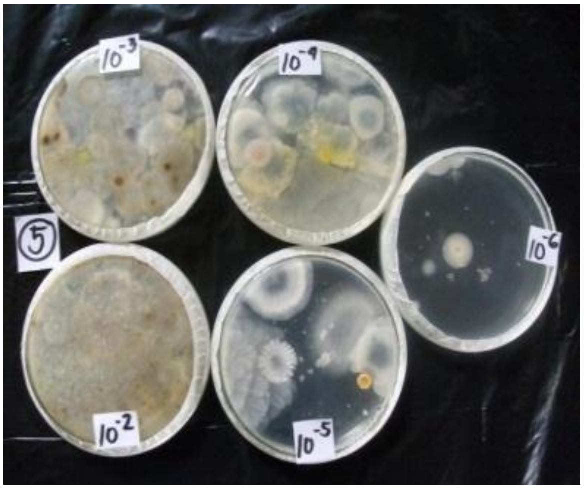
Isolates from Bakakeng clay



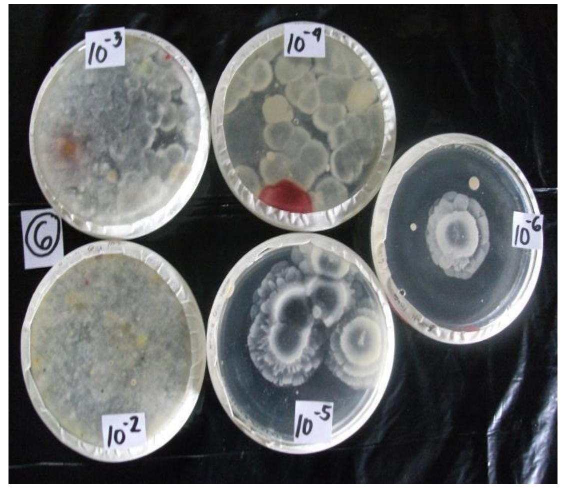
Isolates from Bineng sandy clay



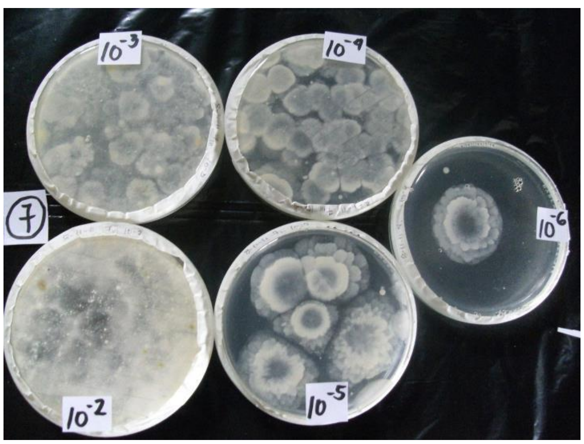
Isolates from Buyagan clay loam



Isolates from Halsema clay loam

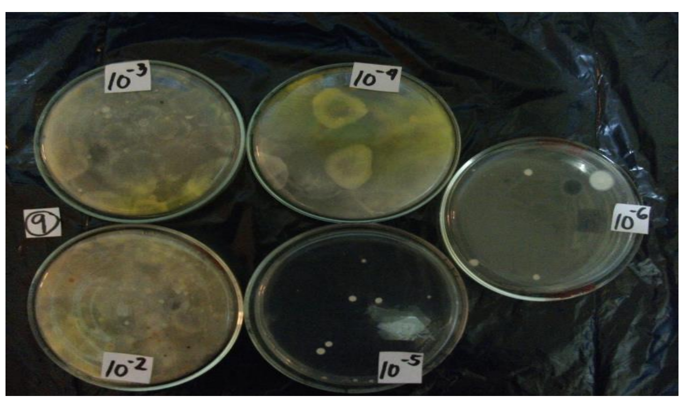


Isolates from La Trinidad loam



Isolates from Puguis gravelly loam

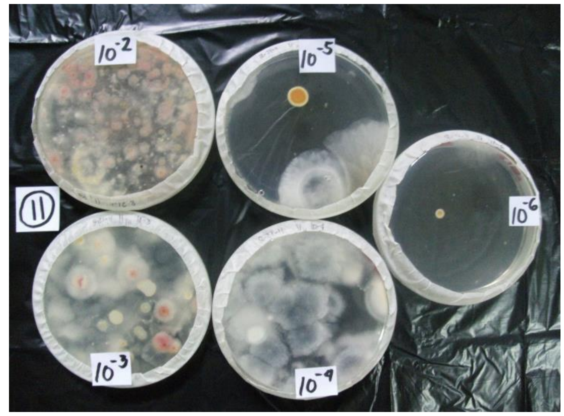
Isolates from Rough mountainous land



Isolates from Tacdian clay loam

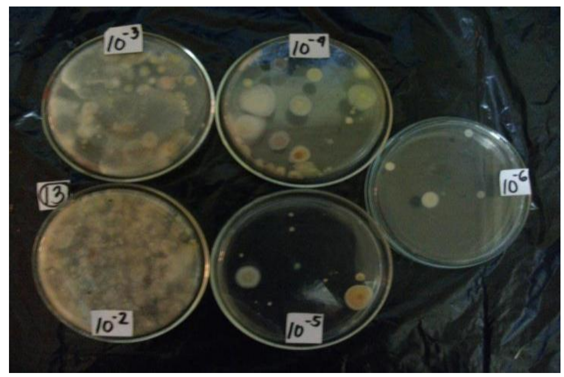
Figure 9. Fungi isolates from the different La Trinidad soil series under wilds sunflower ecosystem 15 cm depth rhizosphere

Isolates from Ambassador silt loam

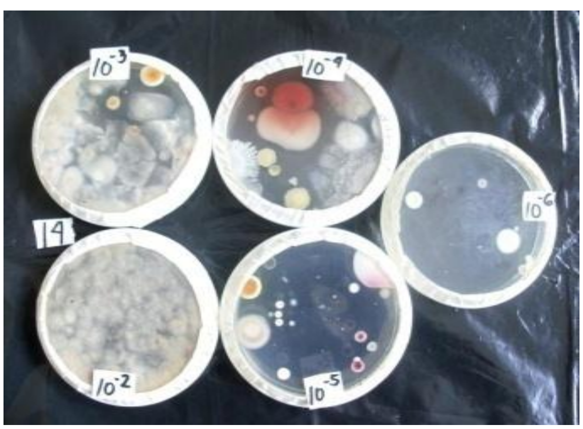


Isolates from Bakakeng clay

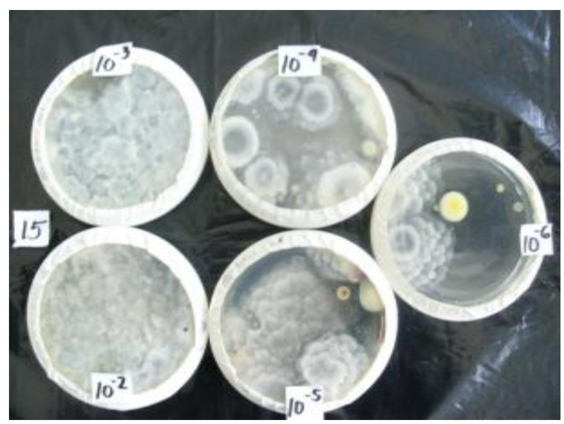
Isolates from Bineng sandy clay



Isolates from Buyagan clay loam

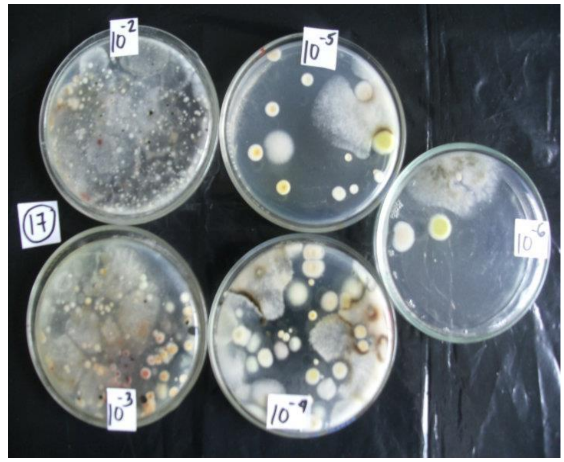


Isolates from Halsema clay loam

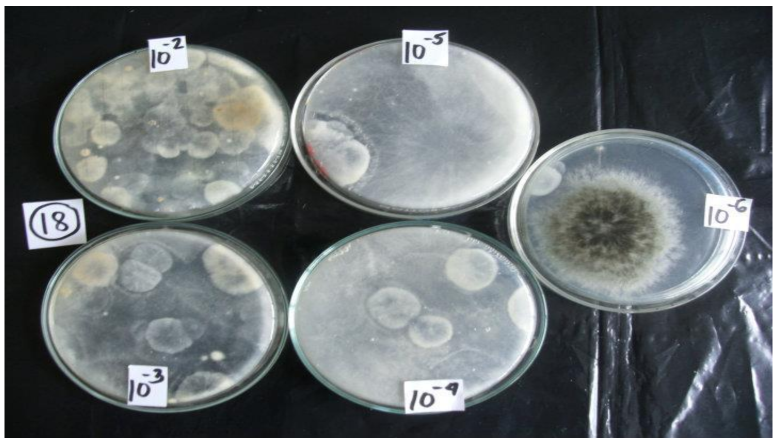


Isolates from La Trinidad loam

Isolates from Puguis gravelly loam



Isolates from rough mountainous land



Isolates from Tacdian clay loam

Figure 10. Fungi isolates from the different La Trinidad soil series under wilds sunflower ecosystem 30 cm depth rhizosphere

Relationship Between Soil pH and
Bacterial population at 15 cm
Rhizosphere Depth

Table 48 shows the relationship between soil pH and bacterial population at 15 cm depth rhizosphere. In all of the La Trinidad soil series, no significant relationship is observed between soil pH and 15 cm rhizosphere bacterial count under a wild sunflower ecosystem. This means that the bacterial population under a wild sunflower ecosystem is not affected by the soil pH but maybe on the kind of bacteria.

Table 48. Relationship between soil pH and bacterial population at 15 cm rhizosphere depth

SOIL TYPE	SOIL PH	BACTERIAL POPULATION 15 CM DEPTH	CORRELATION
Ambassador silt loam	4.4 [b]	13,603 [b]	-0.79 [ns]
Bakakeng clay	4.4 [a]	6,722 [a]	-0.87 [ns]
Bineng Sandy clay	5.2 [a]	105,845 [a]	0.80 [ns]
Buyagan clay loam	5.2 [a]	13,806 [b]	0.95 [ns]
Halsema clay loam	4.3 [b]	131,764 [a]	0.78 [ns]
La Trinidad loam	5.6 [a]	1,368 [b]	-0.34 [ns]
Puguis gravelly loam	5.2 [a]	184,102 [b]	0.49 [ns]
Rough mountainous land	5.1 [b]	17,364 [b]	-0.99 [ns]
Tacdian clay loam	4.6 [b]	24,410 [a]	0.40 [ns]

Means with the same letter/s are not significantly different by 5% DMRT

Relationship Between Soil pH and
Fungal population at 15cm Rhizosphere Depth

Table 49 shows that the soil pH has no relationship with fungal population at 15cm rhizosphere depth regardless of the soil type in a wild sunflower ecosystem.

Table 49. Relationship between soil pH and fungal population at 15 cm rhizosphere depth

SOIL TYPE	SOIL PH	FUNGAL POPULATION 15 CM DEPTH	CORRELATION
Ambassador silt loam	4.4[b]	15,196[a]	-0.36[ns]
Bakakeng clay	4.4[a]	51,344 [a]	0.98[ns]
Bineng Sandy clay	5.2 [a]	62,465 [a]	-0.97 [ns]
Buyagan clay loam	5.2 [a]	46,030 [b]	-0.98[ns]
Halsema clay loam	4.3 [b]	25,279 [a]	0.70 [ns]
La Trinidad loam	5.6 [a]	52,785 [a]	-0.97 [ns]
Puguis gravelly loam	5.2 [a]	79,558 [a]	-0.94 [ns]
Rough mountainous land	5.1 [b]	25,263 [b]	-0.18 [ns]
Tacdian clay loam	4.6 [b]	14,828 [b]	0.20 [ns]

Means with the same letter/s are not significantly different by 5% DMRT

Relationship Between
OM and Bacterial Count
at 15 cm Rhizosphere Depth

The bacterial population is not affected so far by OM on La Trinidad, Benguet soil series under a wild sunflower ecosystem as 15 cm rhizosphere depth. It could be due to the weather, slope of the sampling sites, and growth stage of wild sunflower.

Table 50. Relationship between OM and bacterial population at 15 cm rhizosphere depth

SOIL TYPE	ORGANIC MATTER	BACTERIAL COUNT 15 CM DEPTH	CORRELATION
Ambassador silt loam	0.51[b]	13,603[b]	0.20 [ns]
Bakakeng clay	2.49[a]	6,722 [a]	0.48 [ns]
Bineng Sandy clay	1.91 [a]	105,845 [a]	-0.16 [ns]
Buyagan clay loam	7.48 [a]	13,806 [b]	0.90 [ns]
Halsema clay loam	2.05 [a]	131,764 [a]	0.55 [ns]
La Trinidad loam	8.23 [a]	1,368 [b]	0.99 [ns]
Puguis gravelly loam	3.14 [a]	184,102 [b]	0.54 [ns]
Rough mountainous land	3.20 [a]	17,364 [b]	-0.06 [ns]
Tacdian clay loam	3.08 [b]	24,410 [a]	-0.69 [ns]

Means with the same letter/s are not significantly different by 5% DMRT

Relationship Between
OM and Fungal Count
at 15 cm Rhizosphere Depth

Table 51 shows that fungal count at 15 cm rhizosphere depth is not affected by OM content of the soil under a wild sunflower ecosystem. This is due to all La Trinidad soil series.

Table 51. Relationship between OM and fungal population at 15 cm rhizosphere depth

SOIL TYPE	ORGANIC MATTER	FUNGAL POPULATION 15 cm depth	CORRELATION
Ambassador silt loam	0.51[b]	15,196[a]	-0.32[ns]
Bakakeng clay	2.49[a]	51,344[a]	0.15[ns]
Bineng Sandy clay	1.91[a]	62,465[a]	-0.17[ns]
Buyagan clay loam	7.48[a]	46,030[b]	-0.72[ns]
Halsema clay loam	2.05[a]	25,279[a]	-0.80[ns]
La Trinidad loam	8.23[a]	52,785[a]	0.27[ns]
Puguis gravelly loam	3.14[a]	79,558[a]	-0.94[ns]
Rough mountainous land	3.20[a]	25,263[b]	-0.99[ns]
Tacdian clay loam	3.08[b]	14,828[b]	-0.97[ns]

Means with the same letter/s are not significantly different by 5% DMRT

Relationship Between
Soil pH and Bacterial population
at 30 cm Rhizosphere Depth

Table 52 presents no relationship so far between soil pH and bacterial population under 30 cm rhizosphere depth.

Table 52. Relationship between soil pH and bacterial populationt at 30 cm rhizosphere depth

SOIL TYPE	SOIL PH	BACTERIAL POPULATION 30 CM DEPTH	CORRELATION
Ambassador silt loam	4.4[b]	226,725[a]	0.22 [ns]
Bakakeng clay	4.4[a]	1,873 [a]	-0.48 [ns]
Bineng Sandy clay	5.2 [a]	130,856 [a]	-0.99*
Buyagan clay loam	5.2 [a]	115,711 [a]	-0.94 [ns]
Halsema clay loam	4.3 [b]	118,022 [a]	0.05 [ns]
La Trinidad loam	5.6 [a]	164,270 [a]	0.86 [ns]
Puguis gravelly loam	5.2 [a]	397,724 [a]	1.00**
Rough mountainous land	5.1 [b]	30,635 [a]	0.26 [ns]
Tacdian clay loam	4.6 [b]	147,629 [a]	-0.12 [ns]

Means with the same letter/s are not significantly different by 5% DMRT

Relationship Between
Soil pH and Fungal Population
at 30 cm RhizosphereDepth

The relationship between soil pH and fungal count is shown in Table 53. There is no observed significance of soil type on fungal population in all soil types under a wild sunflower ecosystem at 30 cm rhizosphere depth.

Table 53. Relationship between soil pH and fungal population at 30 cm rhizosphere depth

SOIL TYPE	SOIL PH	FUNGAL POPULATION 30 CM DEPTH	CORRELATION
Ambassador silt loam	4.4[b]	9,971 [a]	-0.60 [ns]
Bakakeng clay	4.4[a]	22,761 [b]	0.97 [ns]
Bineng Sandy clay	5.2 [a]	26,129 [b]	-0.87 [ns]
Buyagan clay loam	5.2 [a]	57,712 [a]	0.90 [ns]
Halsema clay loam	4.3 [b]	20,923 [a]	0.77 [ns]
La Trinidad loam	5.6 [a]	22,568 [b]	-0.24 [ns]
Puguis gravelly loam	5.2 [a]	31,143 [b]	-0.96 [ns]
Rough mountainous land	5.1 [b]	65,268 [a]	0.72 [ns]
Tacdian clay loam	4.6 [b]	39,309 [a]	-0.29 [ns]

Means with the same letter/s are not significantly different by 5% DMRT

Relationship Between
OM and Bacterial Count
at 30 cm Rhizosphere Depth

The OM content of the soil at 30 cm rhizosphere depth has no relationship to the bacterial count under a wild sunflower ecosystem in any of the La Trinidad soil types.

Table 54. Relationship between OM and bacterial population at 30 cm rhizosphere depth

SOIL TYPE	ORGANIC MATTER	BACTERIAL POPULATION 30 CM DEPTH	CORRELATION
Ambassador silt loam	0.51[b]	226,725[a]	0.48 [ns]
Bakakeng clay	2.49[a]	1,873 [a]	0.86 [ns]
Bineng Sandy clay	1.91 [a]	130,856 [a]	-0.41 [ns]
Buyagan clay loam	7.48 [a]	115,711 [a]	-0.44 [ns]
Halsema clay loam	2.05 [a]	118,022 [a]	0.36 [ns]
La Trinidad loam	8.23 [a]	164,270 [a]	0.03 [ns]
Puguis gravelly loam	3.14 [a]	397,724 [a]	0.99 [*]
Rough mountainous land	3.20 [a]	30,635 [a]	-0.90 [ns]
Tacdian clay loam	3.08 [b]	147,629 [a]	0.87 [ns]

Means with the same letter/s are not significantly different by 5% DMRT

Relationship Between
OM and Fungal Count
at 30 cm Rhizosphere Depth

Table 55 shows the relationship between organic matter and fungal population at 30cm rhizosphere depth. Fungal population is not affected by the OM content of the soil in all the La Trinidad soil series.

Table 55. Relationship between OM and fungal population at 30 cm soil depth

SOIL TYPE	ORGANIC MATTER	FUNGAL POPULATION 30 CM DEPTH	CORRELATION
Ambassador silt loam	0.51[b]	9,971 [a]	-0.07[ns]
Bakakeng clay	2.49[a]	22,761 [b]	0.26 [ns]
Bineng Sandy clay	1.91 [a]	26,129 [b]	-0.84 [ns]
Buyagan clay loam	7.48 [a]	57,712 [a]	0.95[ns]
Halsema clay loam	2.05 [a]	20,923 [a]	0.94 [ns]
La Trinidad loam	8.23 [a]	22,568 [b]	0.97 [ns]
Puguis gravelly loam	3.14 [a]	31,143 [b]	-0.97 [ns]
Rough mountainous land	3.20 [a]	65,268 [a]	0.81 [ns]
Tacdian clay loam	3.08 [b]	39,309 [a]	0.77 [ns]

Means with the same letter/s are not significantly different by 5% DMRT

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The study aimed to evaluate a *Tithonia diversifolia* (wild sunflower) ecosystem by; describing a wild sunflower ecosystem; determining some soil chemical properties; determining the microbial growth and population; and, relating some soil chemical properties to microbial population.

Tithonia diversifolia (wild sunflower) grows well on La Trinidad, Benguet soil series in any vacant area, garbage pits, levees, road cuts, and in suburbs whether flat, hilly, and steep slopes (1,113-1,430 cm). Further observations show that wild sunflower ca thrive alone on limestone parent material provided that there is light and water indicative of the plant's sequestering or scavenging ability for nutrient elements. Moreover, the only weed growing together with *Tithonia diversifolia* is *Pennisetum pupureum* (Napier of Uganda grass) implying a weedical effect. *Tithonia diversifolia,* however, does not thrive well on extensively cultivated or acidic soils.

Wild sunflower has an acidifying effect on the soil as proven by the extremely acidic rhizosphere compared to the slightly acidic lateral distance away (no wild sunflower). Likewise, the soil OM depends on the growth stage, weather, and soil type.

Population of microorganisms was found to be greater on the subsoil than on the soil surface. Wild sunflower has an influence on the number of microorganisms because of its root density and distribution. The plant droppings like the leaves that are easily decomposed serve as source of energy for microorganisms. Streptomyces which has the ability to produce antibiotics was also observed and is abundant at wild sunflower rhizosphere. In addition, there are possible beneficial bacterial growths observed in the

samples taken from a wild sunflower ecosystem as shown in the assay test which inhibit the growth of other microorganisms.

Soil pH and OM content of the soil showed no relationship at all on the bacterial and fungal population both at 15 cm and 30 cm rhizosphere depth under a wild sunflower ecosystem on La Trinidad, Benguet soil series.

Conclusions

Wild sunflower growing under the La Trinidad, Benguet soil series is abundant in any vacant area, garbage pits, road cuts, levees, and in suburbs whether flat hilly and steep slopes (1,113-1430m) that are rich in OM. Further, *Tithonia diversifolia* can thrive alone on limestone parent material provided that there is light and water. The only weed growing simultaneously with *Tithonia diversifolia* (wild sunflower) is *Pennisetum pupureum (*Napier or Uganda grass).

Regardless of soil type, wild sunflower has an acidifying effect on the soil due to its sequestering and scavenging ability.

Growth and abundance of microorganisms like fungi and bacteria was on the subsoil compared to the surface soil on a wild sunflower ecosystem and is influenced more by the plant's growth stage, root density and distribution, and root depth.

Growth of streptomyces and possible beneficial bacteria was also observed. The organisms mentioned have the ability to produce antibiotics and can inhibit the growth of other microorganism, respectively.

Soil pH and SOM showed no relationship on the microbial growth under wild sunflower ecosystem.

Recommendation

Further study should be conducted especially on the observed growth of streptomyces and possible beneficial bacteria that has inhibitionon the microorganisms. This is indicative of the production of antibiotics and as a Biological Control Agent (BCA).

Researchable areas deduced from the study are:

1. The sequestering or scavenging ability of wild sunflower based on soil and plant tissue analysis to confirm the results;

2. The weedical effect of *Tithonia diversifolia;* and

3. The possible production of a Biologocal Control Agent (BCA) to confirm the growth of streptomyces and possible beneficial bacteria that showed inhibition with other bacteria in assay test.

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