BIBLIOGRAPHY

CODOD, CLARENCE BAGAYAO. APRIL 2013. Survey, Assessment, and Characterization of Banana Fusarium Wilt *(Fusarium oxysporum* f. sp. *cubense)* in Two Barangays of Kapangan, Benguet. Benguet State University, La Trinidad, Benguet.

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ABSTRACT

Survey and sampling of banana plants infected with Fusarium wilt were done in the Municipality of Kapangan barangay Sagubo, sitio Timoc, Ampongot, and Dosco, and barangay Gadang sitio Namun- ao, Gadang Proper, Namat- ikan, Copias, and Lib – libeng, Benguet from September 2012 to November 2012 to confirm the occurrence of the disease in the locality; assess the incidence and severity of Fusarium wilt infection in affected banana plants; isolate and characterize the causal pathogen *Fusarium oxysporum* f. sp. *cubense* from infected samples; and compare the effect of bio control agent and chemicals in inhibiting the growth of *F. oxysporum* f. sp. *cubense* through assay.

Results revealed that Fusarium wilt incidence in barangay Sagubo and Gadang was 16.82 % and 13.57 % respectively. In terms of severity, variety Lakatan was the most susceptible to Fusarium wilt infection having the most intense discoloration on the Pseudostem followed by the variety Cavendish (Tomoc) and Bungulan (Kantong) with mean severity ratings of 5.0, 4.0 and 3.67 respectively. Varieties Saba (Balayang) and Cardaba (Dippig) did not incur any infection.

Isolates of *F. oxysporum* f. sp. *cubense* from Lakatan, Cavendish and Bungulan designated as isolate 01, 02 and 03 differed in their colony growth in Potato Dextrose Agar with 02 isolate having the widest mean growth of 65 mm. Isolates 01 and 03 had 62.67 and 59.83 mm growth diameter respectively.

Microscopic measurements of the macro conidia of the three isolates were 30.42 x 3.64 µm, 31.20 x 4.68 µm and 33.80 x 4.81 µm and were found to be within the range of the published measurement of *F. oxysporum* which is 27-55 x 3.3-5.5 µm. The micro conidia of the three isolates measured 8.77 x 2.73 µm, 8.06 x 2.86µm and 7.80 x 3.25 µm which is also within the range of 5-16 x 2.4-3.5 µm.

Bioassay results showed that Benomyl inhibited the growth of the three isolates of *F.oxysporum* f. sp. *cubense*. It significantly provided the widest zone of inhibition of 32.33mm. *Trichoderma* KA on the other hand, offers an alternative to chemical control having inhibited the growth of the fungal isolates at 15.61 mm after seven days of incubation.

RESULTS AND DISCUSSION

A. Field Survey

Area surveyed. The survey on the occurrence of Fusarium wilt was done in two banana growing barangays of Kapangan namely Sagubo and Gadang.

In barangay Sagubo, three sitios that include Ampongot, Dosco, and Timoc were surveyed for the presence of banana Fusarium wilt. Barangay Gadang on the other hand included sitiosCopias, Gadang Proper, Lib-libeng, Namon-ao, and Namat-ikan. Fig. 1 shows that the sitios surveyed varied in terms of elevation, and the areas situated in the lower part of Kapangan (Ampongot and Copias) with higher temperature had higher Fusarium wilt incidence of 20% and 16.17% (Table 2).

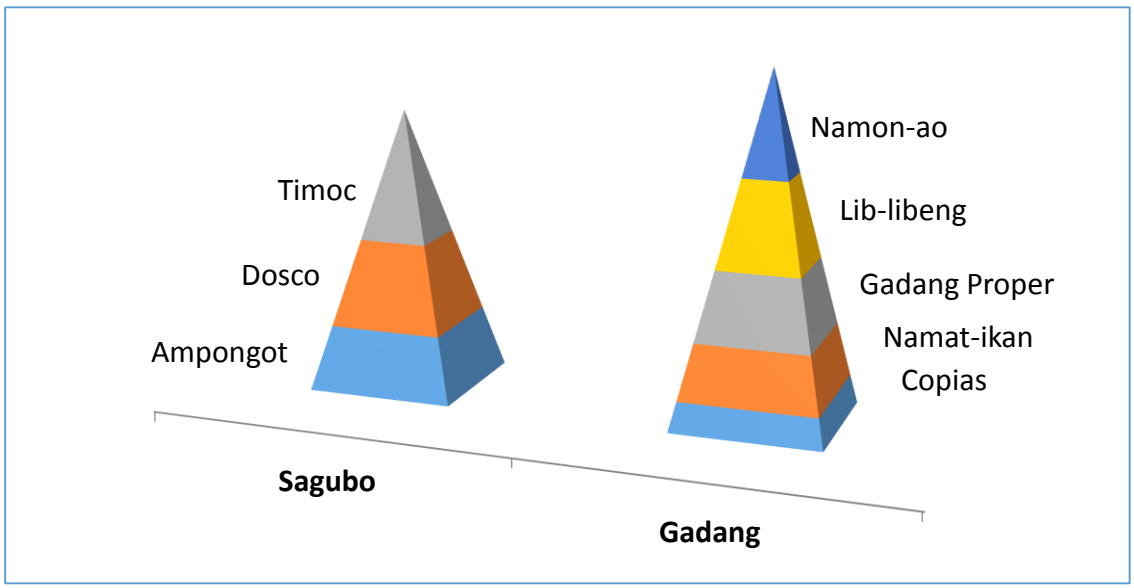

Figure 1. Areas surveyed at barangay Sagubo and barangay Gadang

Area planted with banana. Barangay Sagubo has a total of 13,275 m² area planted with banana broken down to 4,070 m² in sitio Ampongot (Fig. 3), 2, 285 m² in sitio Timoc (Fig. 4) including sitio Mocgo, 5,120 m² in sitio Dosco (Fig. 2), and 1,800 m² along the road. Fig. 10 shows the estimated area planted with bananas in the different sitios.

Figure 2. Banana plants (mixed cultivars), barangay Sagubo, sitio Dosco

Figure 3. Banana plants (mixed cultivars), barangay Sagubo, sitio Ampongot

Figure 4. Banana plants (mixed cultivars), barangay Sagubo, sitio Timoc

Barangay Gadang, on the other hand, has a total of 10,920 m² area planted with banana. As presented in Fig. 10, 2,880 m² is planted with banana in sitio Lib – libeng (Fig. 9), 4,520 m² in sitio Namon – ao (Fig. 5), 2,100 m² in sitio Gadang Proper (Fig. 6), 600 m² in sitio Namat –ikan (Fig. 7), and 820 m² in sitio Copias (Fig. 8).

Figure 5. Banana plants (mixed cultivars), barangay Gadang, sitio Namon- ao

Figure 6. Banana plants (mixed cultivars), barangay Gadang, sitio Gadang Proper

Figure 7. Banana plants (mixed cultivars), barangay Gadang, sitio Namat- ikan

Figure 8. Banana plants (mixed cultivars), barangay Gadang, sitio Copias

Figure 9. Banana plants (mixed cultivars), barangay Gadang, sitio Lib - Libeng

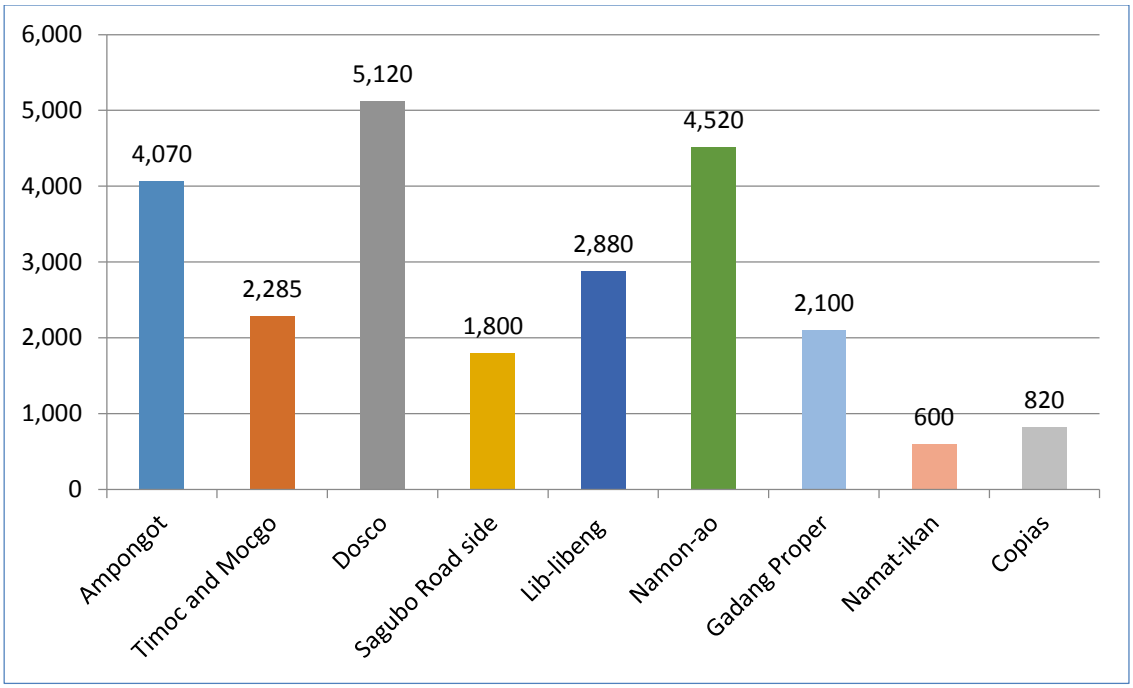

Figure 10. Area (m^2) grown with bananas in barangay Sagubo and Gadang

The banana plants in the areas surveyed are mixed with other economic crops such as "boyboy" or tiger grass (which is processed to soft broom), chayote, corn, ginger, sweet potato, "pa-o" or bamboo canes, and chili which is either for home consumption or for market. The farmers say that in the past, when Fusarium wilt and banana bunchy top diseases were not yet prevalent in their farms, banana was their primary crop; but now it is only second from tiger grass. Some farmers also planted bananas around their rice fields as a barrier from strong winds as observed in Fig. 5.

Banana varieties grown. The common banana varieties grown are Lakatan, Kantong (Bungulan), Lem – en, Cavendish (Tomok), Saba (Balayang), Cardaba (Dippig), Gloria, Señorita, Malagambang (violet colored), and Latundan. Dippig and Balayang are less preferred by farmers because they have lower price when sold as compared to Lakatan.

Farmers knowledge about the Fusarium wilt disease. The farmers of barangay Sagubo claimed that aside from Dippig and Balayang, all the other varieties are susceptible to Fusarium wilt.

According to Mr. Peter Sangioa (farmer) the disease occurred in the year 2000 with no known source. Another farmer, Mrs. Remy Anno said that in a sloping farm like the mountain side, there is higher infection of Fusarium wilt in the lower part as compared to the upper part. This can be attributed to temperature since it is higher at lower elevation which could be more favorable to the development of Fusarium wilt thus increasing the incidence and severity. Mrs. Saenay Fermin also added that the infection is most severe during the month of May.

During the interview, most of the farmers claimed that Fusarium wilt symptom appears after eight to twelve months from planting. This is the stage when the banana starts to flower and develop its fruit. In most case, the fruit will not continue to develop or it may develop but the fruits will not ripen. Other farmers also claimed that Fusarium wilt infection will start on the second generation of new planting materials. In this case, the farmers will have a good harvest during the first year of planting but on the second year, 30% to 40 % of the plants are infected with Fusarium wilt and other diseases such as banana bunchy top (BBTV) and moko disease. In addition Mr. Doroteo Balawen (farmer) said that Fusarium wilt infects old plants while BBTV infects young plants.

The farmers of barangay Gadang observed that the banana varieties Lakatan and Kantong or Bungulan are the most susceptible to Fusarium wilt while variety Gloria and Malagambang are slightly resistant, with Cardaba and Saba varieties as highly Resistant. During the interview, Mr. Thomas Atoway, a farmer stated that Fusarium wilt of banana

was first observed in 1998. According to Virginia Dizon (farmer) they acquired planting materials of variety Señorita from Aurora Province, Ilocos Sur in 1995 and they suspected these planting materials to have been the source of inoculum of Fusarium wilt infection.

The farmers also confirmed that at lower elevation of Kapangan, a higher Fusarium wilt infection was observed. According to Mr. Nobel Catalio, a farmer, the disease is most severe during the months of April to May when the temperature is high. According to a publication by Wikipedia.org, Fusarium wilt progresses rapidly in soil that is 70 ºF or warmer. The months of April to May is already summer season, which means the temperature is higher than normal thereby enabling fast development of Fusarium wilt infection.

Management practices done by the farmers. As soon as the symptom of Fusarium wilt is observed, the farmers eradicate the banana tree by cutting and use it as supplement feeds for cattle and carabao. They also noted that when the mother plant is Fusarium wilt infected, the suckers when planted will later show Fusarium wilt infection.

Incidence and Severity of Fusarium Infected Bananas.

Incidence. Four (4) randomly selected survey profiles, in each sitio, were statistically analyzed to determine if there is a significant difference of Fusarium wilt incidence. Data presented in Table 2 shows that barangay Sagubo had 16.82 % while barangay Gadang had 13.57 % Fusarium wilt infected plants.

On the other hand, sitio Ampongot had the highest Fusarium wilt incidence of 20.21 % among the sitios surveyed while 16.17 % was noted in sitio Copias (Table 2). Recorded incidence of Fusarium wilt between Sagubo and Gadang, and the different sitios surveyed did not vary significantly from each other.

Table 2. Banana Fusarium wilt incidence (%) in the different areas surveyed

AREAS SURVEYED	PERCENT (%) INCIDENCE
BARANGAY	
Barangay Sagubo	16.82
Barangay Gadang	13.57
SITIO	
Barangay Sagubo, Sitio Ampongot	20.21
Barangay Sagubo, Sitio Timoc and Mocgo	12.56
Barangay Sagubo, Sitio Dosco	14.98
Barangay Gadang, Sitio Lib-libeng	13.44
Barangay Gadang, Sitio Namon-ao	14.17
Barangay Gadang, Sitio Copias	16.17
Barangay Gadang, Sitio Gadang Proper	10.72
Barangay Gadang, Sitio Namat-ikan	15.88
	C.V. = 17.40 %

Fusarium wilt severity. As shown in Table 3, the severity of Fusarium wilt in the different banana variety is significantly different. Fusarium wilt is most severe in Lakatan (Fig. 12) with an infection rate of 5 which describe a Fusarium wilt infected banana having all leaves brown/ dried and reddish – brown discoloration on the pseudo stem. Severity of infection on variety Lakatan of 5.00 is significantly different to infection on variety Kantong (Fig. 11) with a rate of 3.67.

Meanwhile, Fusarium wilt infection was not observed on Saba and Cardaba (Dippig) throughout the survey period in all areas. It appears that the existing race of Fusarium wilt in does not infect Saba and Dippig. Based from the result, it appeared that the race responsible in affecting Dippig and Saba are not present in Kapangan. Dippig and Saba were identified by PCARRD (2004) to be susceptible only to *F. oxysporum* f. sp. *cubense* Race 2 and Race 4.

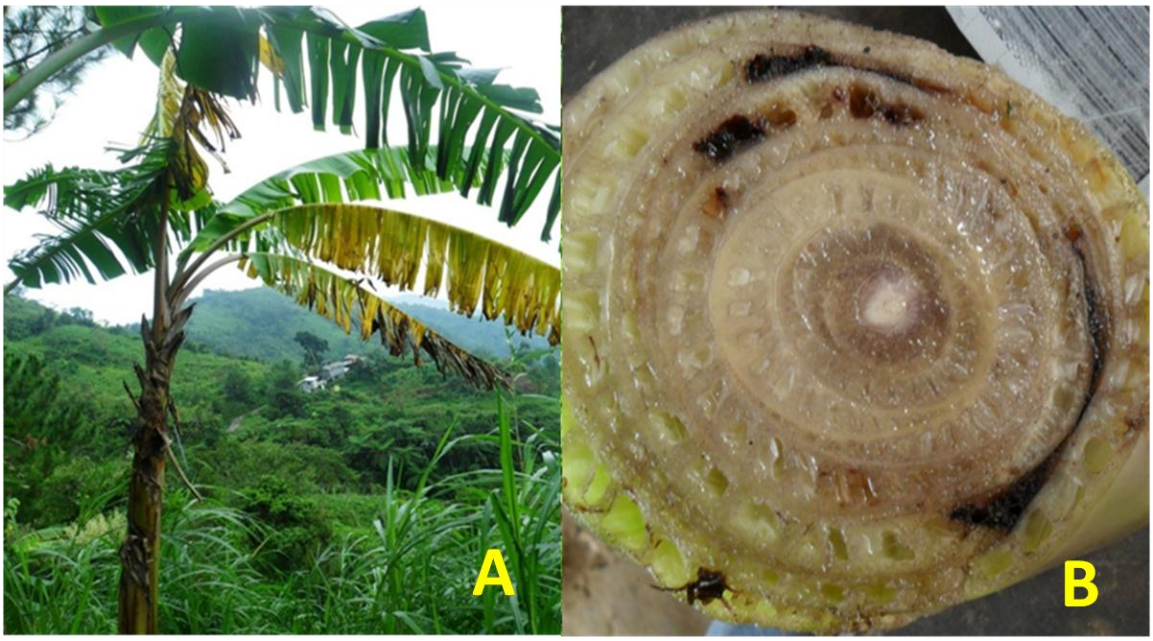

Figure 11. (A) Kantong or Bungulan variety showing infection of *F. oxysporum* f. sp. *cubense*; (B) Pseudo stem showing vascular discoloration

Figure 12. (A) Lakatan variety showing infection of *F. oxysporum* f. sp. *cubense*; (B) Pseudo stem showing vascular discoloration

Figure 13. (A) Tomok or Cavendish variety showing infection of *F. oxysporum* f. sp. *cubense;*(B) Pseudo stem showing vascular discoloration

Table 3. Fusarium wilt severity as observed on the infected pseudo stems

Banana Variety	Severity of Infection
Lakatan	5.00[a]
Bungulan(Kantong)	3.67[b]
Cavendish (Tomok)	4.00[ab]
Saba (Balayang)	0.00[c]
Cardaba (Dippig)	0.00[c]

C.V. = 26.97 %

B. LABORATORY ACTIVITIES

Colony diameter. *F. oxysporum* f. sp. *cubense* that was isolated from banana varieties Cavendish (Tomok), or Bungulan (Kantong), and Lakatan were designated as isolate 01, 02, and 03.

Table 4 presents the mean colony diameter of the three isolates after three, five, and seven days. Based on the result isolate 02 had the highest colony diameter of 65.00 mm, followed by isolate 01 with 62.67 mm. Isolate 03 gave the smallest colony diameter of 59.83 mm. In terms of pigment in Potato Dextrose Agar (PDA) isolate 01 had a light purple pigment, dark purple on isolate 02, and light orange on isolate 03.

Table 4. Colony diameter of *F. oxysporum* f. sp. *cubense* in fresh Potato Dextrose Agar (PDA) after three, five, and seven days

	COLONY DIAMETER (mm)				
Isolates	3 day	5 day	7 day	MEAN	Pigment in PDA
Isolate 01	55.50	63.50	69.00	62.67	light purple
Isolate 02	51.50	59.83	83.67	65.00	dark purple
Isolate 03	47.50	55.83	76.17	59.83	light orange

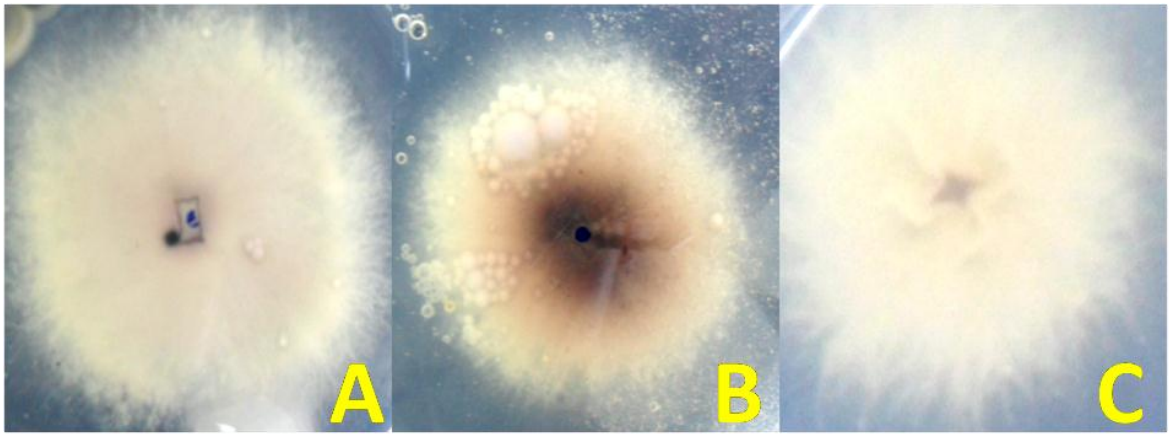

Figure 14. Three day old cultures of *F. oxysporum* f. sp. *cubense* on fresh Potato Dextrose Agar (PDA). (A) Isolate 01, (B) Isolate 02, (C) Isolate 03

Table 5 below shows the sizes of conidia of the three isolates. Based on microscopic observation, there are more macro conidia in isolate 03 compared to the other isolates, while more micro conidia was noted in isolate 02. Figures 15, 16, and 17 show the macro and micro conidia of each isolate. According to Ploetz (2000) *F. oxysporum* f. sp. *cubense* has a micro conidia measuring 5 - 16 x 2.4 - 3.5 µm while the macro conidia measures 27 - 55 x 3.3 - 5.5 µm.

Microscopic measurement of the macro conidia of the three isolates were 30.42 x 3.64 µm, 31.20 x 4.68 µm and 33.80 x 4.81 µm, while micro conidia of the three isolates measured 8.77 x 2.73 µm, 8.06 x 2.86 µm and 7.80 x 3.25 µm. The result was found to be within the range of the measurement reported by Ploetz in 2000.

Table 5. Morphological characteristics of *F. oxysporum* f. sp. *cubense.*

Isolates	Size of Macro conidia (µm)	Size of Micro conidia (µm)	No. of Septation of Macro conidia
Isolate 01	30.42 um x 3.64 um	8.77 um x 2.73 um	3-4
Isolate 02	31.20 um x 4.68 um	8.06 um x 2.86 um	3-4
Isolate 03	33.80 um x 4.81 um	7.80 um x 3.25 um	3-4

Figures 15, 16, and 17 show the macro and micro conidia of the different isolates under 400X magnification, it is clearly shown that isolate 3 had more macro conidia than isolate 01 and 02. The macro and micro conidia have green color. Further, the macro conidia of the three isolates have three to four septations.

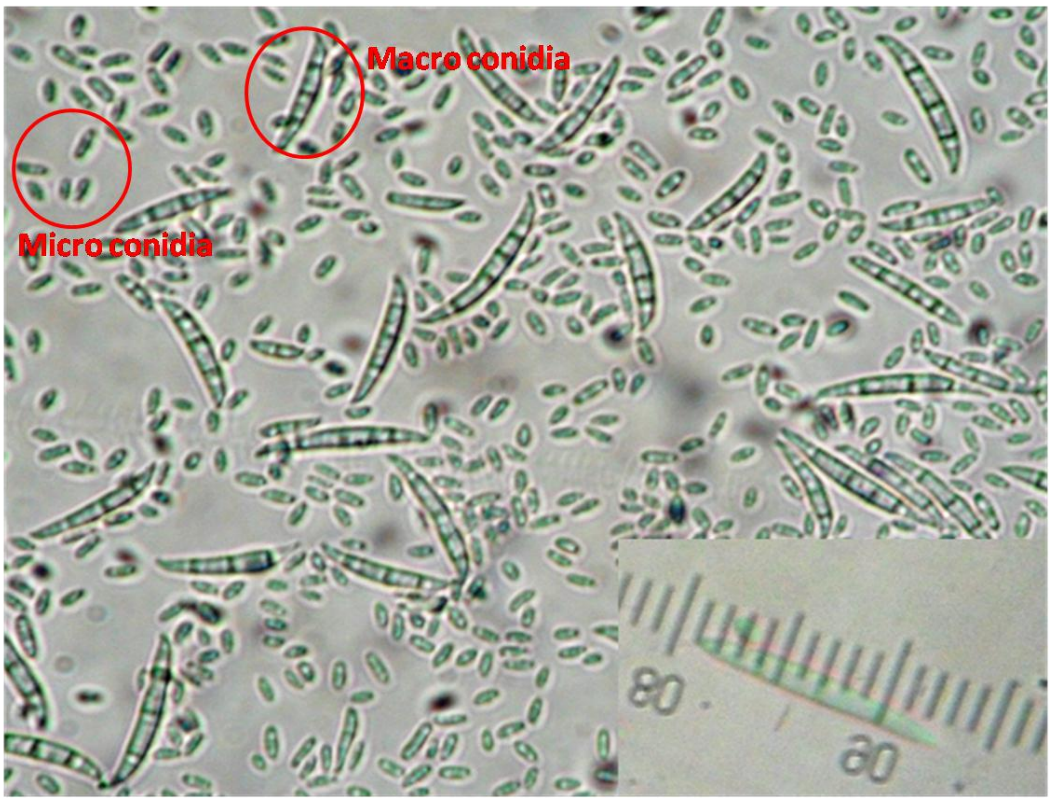

Figure 15. Macro and micro conidia of isolate 01 (400X)

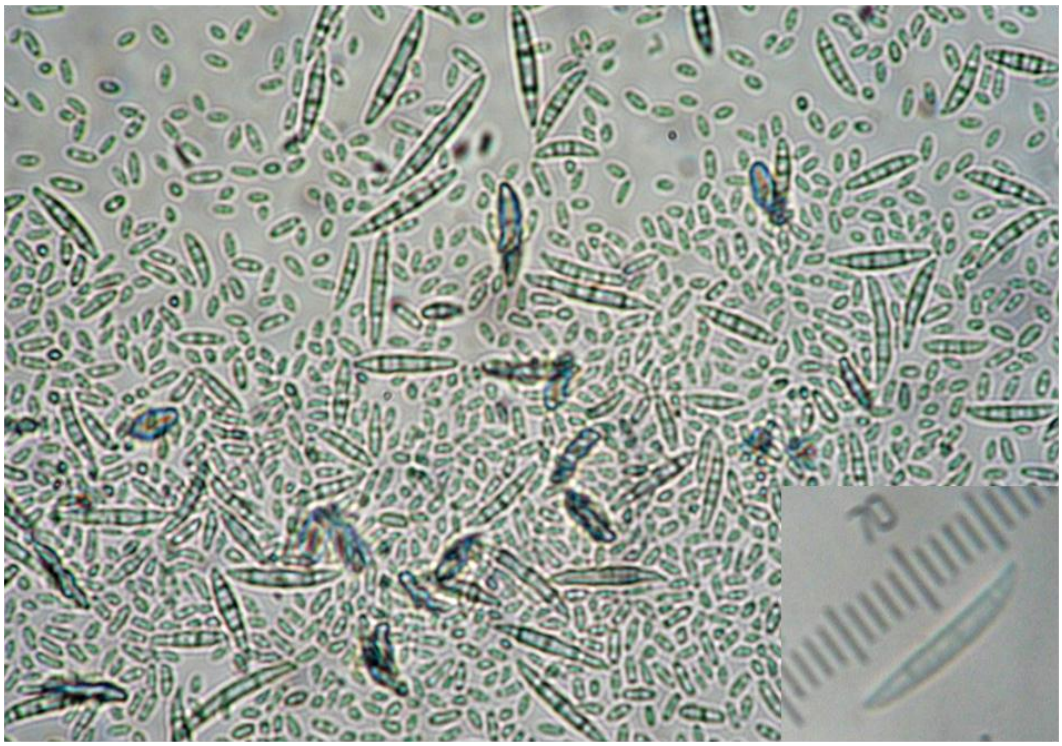

Figure 16. Macro and micro conidia of isolate 02 (400X)

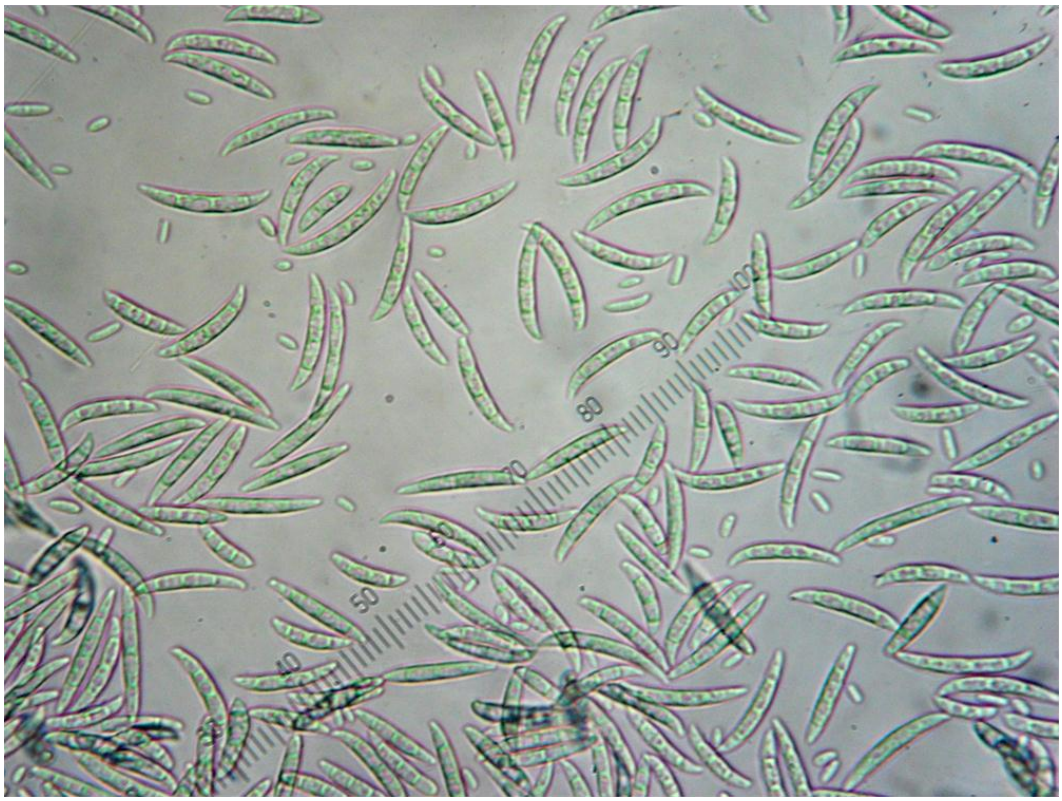

Figure 17. Macro and micro conidia of isolate 03 (400X)

Bioassay

Table 6 shows the result of bioassay of isolate 01 after three, five, and seven days of incubation. On day three, Benomyl had the highest inhibition zone with 38.67 mm diameter which is significantly different to Lysol with an inhibition zone of 26.17 mm diameter. The inhibition zone produced by *Trichoderma*, Mancozeb (Dithane M45), Mancozeb (Parafungus), and Captan which measured 16.17 mm, 20.00 mm, 18.50mm, and 19.17 mm did not vary significantly. Sterilized distilled water did not produce inhibition zone.

On day five, Benomyl still had the highest inhibition zone of 31.33 mm, which is significantly different to the rest of the treatments. The inhibition zone produced by *Trichoderma*, Mancozeb, and Captan still did not vary significantly.

Table 6. Inhibition zones (mm) formed on Potato Dextrose Agar (PDA) by isolate 01 after three, five, and seven days

TREATMENTS	DAY 3	DAY 5	DAY 7	MEAN
Sterile Distilled Water (SDW)	0.00[d]	0.00[e]	0.00[d]	0.00
Trichoderma (biocon)	16.17[c]	15.67[d]	15.00[c]	15.61
Mancozeb (Dithane M45)	20.00[c]	18.67[c]	16.17[c]	18.28
Lysol	26.17[b]	25.50[b]	21.67[b]	24.45
Mancozeb (Parafungus)	18.50[c]	17.67[cd]	17.33[c]	17.83
Benomyl (Benlight)	38.67[a]	31.33[a]	27.00[a]	32.33
Captan	19.17[c]	17.33[cd]	16.67[c]	17.72

On day seven, the inhibition zones produced by Benomyl and Lysol remained significantly different with the inhibition zones of *Trichoderma*, Mancozeb, and Captan.

Table 7 shows the result of the bioassay on Isolate 02, after 3, 5, and 7 days incubation using biological control agent, disinfectant, and fungicides. On day three, the inhibition zones of Benomyl and Lysol having a diameter of 24.00 mm and 25.83 mm are the widest and were significant compared to the inhibition zone of 20.67 mm and 21.17 mm formed by Dithane M45 and Parafungus. *Trichoderma* and Captan produced inhibition zones that are almost equal (15.67 mm and 18.00 mm).

The same trend was observed after five days, the inhibition zones of Benomyl and Lysol slightly decreased but were still the widest, having a diameter of 23.00 mm and 24.50 mm. The inhibition zones of Dithane M45, Parafungus, Trichoderma and Captan were comparable to each other.

Table 7. Inhibition zones (mm) formed on Potato Dextrose Agar (PDA) by isolate 02 after three, five, and seven days

TREATMENTS	DAY 3	DAY 5	DAY 7	MEAN
Sterile Distilled Water (SDW)	0.00^{e}	0.00^{e}	0.00^{d}	0.00
Trichoderma (biocon)	15.67^{d}	15.17^{d}	15.17^{c}	15.61
Mancozeb (Dithane M45)	20.67^{bc}	18.67^{bc}	16.83^{c}	18.28
Lysol	25.83^{a}	24.50^{a}	20.00^{b}	24.45
Mancozeb (Parafungus)	21.17^{bc}	19.50^{b}	17.17^{c}	17.83
Benomyl (Benlight)	24.00^{a}	23.00^{a}	22.17^{a}	32.33
Captan	18.00^{cd}	16.50^{cd}	15.67^{c}	17.72

On day seven, the inhibition zone of Benomyl 22.17 mm, continued to decrease slightly but still the widest and is significantly higher than the inhibition zone of Lysol which is 20.00 mm. The inhibition zones of *Trichoderma*, Dithane M45, Parafungus, and Captan remained comparable.

Table 8 shows the result of bioassay on Isolate 03, after 3, 5, and 7 days of incubation. On day three, the inhibition zones of Benomyl and Lysol of 26.83 mm and 27.33 mm were significantly different over the other treatments. The inhibition zone of Captan (21.33 mm) was next to Benomyl and Lysol, while the rest were comparable in inhibiting *F. oxysporum* f. sp. *cubense.*

The same observation was noted after five days. Benomyl and Lysol still provided the best inhibition zones measuring 25.17 mm and 24.67 mm followed by the inhibition zone produced by Captan which is 19.83 mm, the rest of the treatments remained comparable.

Table 8. Inhibition zones (mm) formed on Potato Dextrose Agar (PDA) by isolate 03 after three, five, and seven days

TREATMENTS	DAY 3	DAY 5	DAY 7	MEAN
Sterile Distilled Water (SDW)	0.00[e]	0.00[d]	0.00[d]	0.00
Trichoderma (biocon)	15.17[d]	15.00[c]	14.33[c]	14.83
Mancozeb (Dithane M45)	17.00[d]	15.50[c]	14.33[c]	15.61
Lysol	27.33[a]	24.67[a]	22.33[a]	24.78
Mancozeb (Parafungus)	17.50[d]	15.83[c]	14.35[c]	15.89
Benomyl (Benlight)	26.83[a]	25.17[a]	23.00[a]	25.00
Captan	21.33[b]	19.83[b]	18.00[b]	19.72

On day seven, Benomyl and Lysol still had the highest inhibition zones measuring 23.00 mm and 22.33 mm. Captan had an inhibition zone of 18.00 mm which is significantly different with the inhibition zones of *Trichoderma,* Dithane M45, and Parafungus.

Other observations

Laboratory. Table 9 shows the colony growth of *F. oxysporum* f. sp. *cubense* grown in a commercially prepared Potato Dextrose Agar (PDA). Results revealed that isolates 01, 02, and 03 had lower colony growth of 32.75 mm, 32.78 mm, and 39.53 mm compared to the colony growth of 62.67 mm, 65.00 mm, and 59.83 mm obtained from the fresh PDA (Table 4). The pigment on PDA also varied from light purple to light pink, dark purple to pink, and light orange to dark pink.

Table 9. Colony diameter of *F. oxysporum* f. sp. *cubense* in commercially prepared Potato Dextrose Agar (PDA) after three, five, and seven days

	COLONY DIAMETER (mm)				
Isolates	3 day	5 day	7 day	MEAN	Pigment on PDA
Isolate 01	28.67	32.50	37.08	32.75	light pink
Isolate 02	28.92	34.25	35.17	32.78	pink
Isolate 03	34.83	40.33	43.42	39.53	dark pink

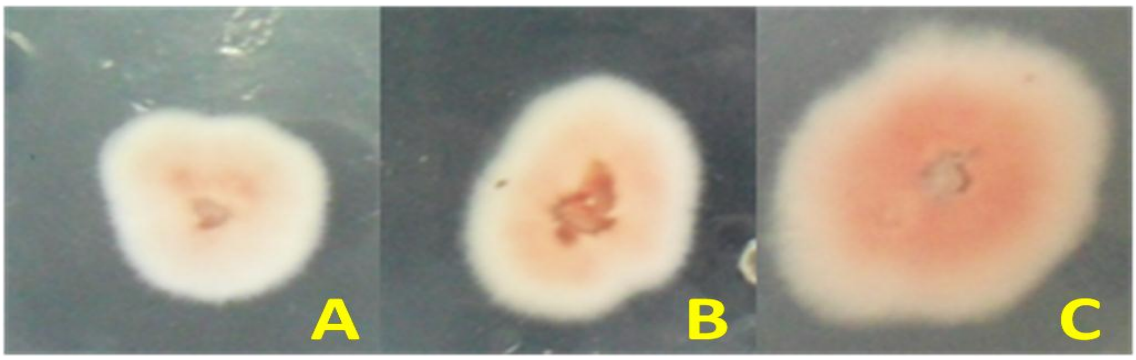

Figure 18. Three day old cultures of *F. oxysporum* f. sp. *cubense* on the commercially prepared Potato Dextrose Agar(PDA); (A) Isolate 01, (B) Isolate 02, (C) Isolate 03

Incidence of Banana Bunchy Top Virus (BBTV). As presented in Table 10, bunchy top disease is also present in the areas surveyed. The incidence recorded in the barangays and the different sitios showed that while the virus disease exists, the distribution does not differ significantly.

Table 10. Incidence (%) of Banana Bunchy Top Virus (BBTV) in the areas surveyed

AREAS SURVEYED	PERCENT (%) INCIDENCE
BARANGAY	
Barangay Sagubo	14.76
Barangay Gadang	14.36
SITIO	
Barangay Sagubo, Sitio Ampongot	19.79
Barangay Sagubo, Sitio Timoc and Mocgo	7.94
Barangay Sagubo, Sitio Dosco	15.69
Barangay Gadang, Sitio Lib-libeng	19.25
Barangay Gadang, Sitio Namon-ao	18.46
Barangay Gadang, Sitio Copias	16.33
Barangay Gadang, Sitio Gadang Proper	7.61
Barangay Gadang, Sitio Namat-ikan	10.63

CV= 1.5064 %

Banana Bugtok or Blood disease. This disease was noted in barangay Gadang, sitio Lib-libeng. The disease was observed to infect the banana variety Dippig or Cardaba. Infected fruits do not ripen and are not fit for consumption.

According to Soguilon et.al (1995) bugtok is an endemic and a widely distributed bacterial disease of cooking banana cultivars in the Philippines. Bugtok is a local term in the southern Philippines used to describe the infected fruit which are discolored and hard even when ripe. It was noted as a minor disorder more than 40 years ago, but was reported by Roperos in 1965 as a developing problem of importance. It is caused by *Pseudomonas solanacearum* E. F. Smith.

Bugtok can be controlled by bagging the inflorescence at the bending stage just after emergence. The bagging material can be a polyethylene bag, muslin cloth, or a fine nylon mesh bag. Bags can be removed after all the fruits have set followed by removal of the male inflorescence. This practice should also include mat and field sanitation, and removal of old, dead leaves.

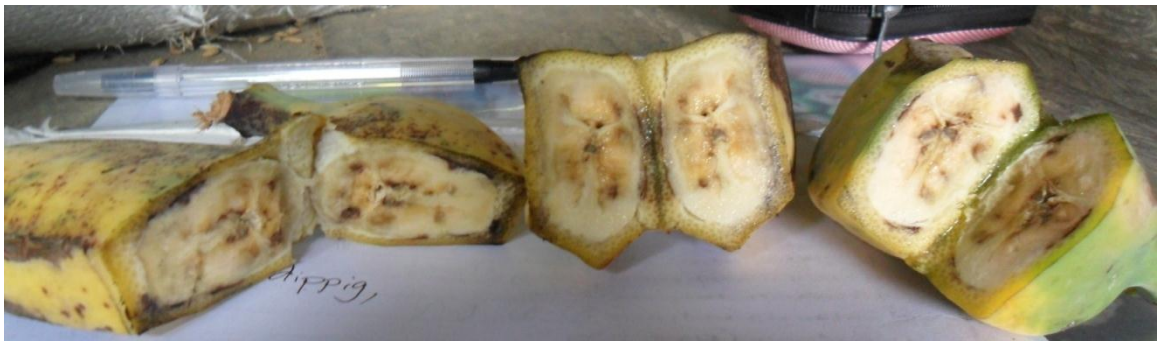

Figure 17. Banana bugtok or blood disease on Cardaba (Dippig)

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The study was conducted to survey the occurrence of Fusarium wilt in two banana producing barangays of Kapangan, Benguet, namely Gadang, and Sagubo; asses the incidence and severity of infection of the affected banana plants; isolate and characterize the causal pathogen *Fusarium oxysporum* f. sp. *cubense* from infected samples, and compare the effect of bio control agent and chemicals in inhibiting the growth of *F. oxysporum* f. sp. *cubense* through assay.

Results show that Fusarium wilt of banana is prevalent in the areas surveyed. Fusarium wilt incidence of 16.82% and 13.57 % in barangays Sagubo and Gadang including the incidence noted on the different sitios does not vary significantly. Among the different sitios surveyed, sitio Ampongot has the highest incidence of 20.21 % while sitio Gadang Proper has the lowest incidence of 10.72 %.

Fusarium wilt severity based on a five point rating scale showed that Lakatan was severely affected followed by Tomok or Cavendish and then Kantong or Bungulan. Banana cultivars Dippig and Balayang were not infected by Fusarium wilt in the area surveyed.

Based on the result of the cultural and morphological characterization of *F. oxysporum* assigned as isolate 01, 02, and 03, isolate 02 had the highest colony diameter of 65.00 mm, followed by isolate 01 with 62.67 mm. Isolate 03 gave the smallest colony diameter of 59.83 mm. In terms of pigment on fresh Potato Dextrose Agar (PDA) isolate 01 has a light purple pigment, dark purple on isolate 02, and light orange on isolate 03.

Macro conidia measurements of isolate 01, 02, and 03 of 30.42 x 3.64 µm, 31.20 x 4.68 µm, and 33.80 x 4.81 µm are statistically comparable. On the other hand, the micro

conidia of the three isolates that measured 8.77 x 2.73 µm, 8.06 x 2.86 µm, and 7.80 x 3.25 µm was found to be within the range of the reported measurement size of *F. oxysporum*.

The results of the bioassay on isolate 01 revealed that Benomyl and Lysol significantly produced the highest inhibition zones of 32.33 mm and 24.45 mm. The inhibition zones of *Trichoderma*, Dithane M45 (Mancozeb), Parafungus (Mancozeb), and Captan were comparable.

On the other hand, the result of bioassay on isolate 02 showed that the widest average inhibition zones were observed on Benomyl and Lysol having 23.06 mm and 23.44 mm, respectively. The inhibition zones produced by *Trichoderma*, Dithane M45 (Mancozeb), Parafungus (Mancozeb), and Captan were also comparable.

The same trend was observed on isolate 03 where in Benomyl and Lysol still provided the widest inhibition zones measuring 25.00 mm and 24.78 mm. Captan had higher inhibition zone as compared to the inhibition zones produced by *Trichoderma*, Dithane M45, and Parafungus after seven days.

Conclusions

Banana Fusarium wilt incidence in barangay Sagubo and Gadang is low ranging from 10 to 20 %. The varieties grown in the area are Lakatan, Kantong, Lemen, Tomok, Balayang, Dippig, Latundan, Gloria, Señorita, and Malagambang. Lakatan, Kantong, and Tomok are susceptible to the existing race of *F. oxysporum* f. sp. *cubense* existing in Kapangan.

Banana is a secondary crop in barangay Sagubo and barangay Gadang with a total area planted of 24,195 m².

Isolates 01, 02 and 03 of *F. oxysporum* f. sp. *cubense* differed in their colony growth in Potato Dextrose Agar including the size of macro and micro conidia.

Benomyl is effective in inhibiting the growth of *F. oxysporum. Trichoderma* is not as effective as benomyl but can be used as alternative for sustainable Fusarium wilt management.

Recommendations

Bioassay should be tested in pot experiments to confirm if the same results will be obtained. Planting materials should not be sourced out from areas, such as Mindanao, where Race 4 exists.

Similar study should be done to other banana producing areas of Benguet and Mountain Province to determine the presence and incidence of *F. oxyporum* f. sp. *cubense.*

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