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ABSTRACT

Pathogenicity of *Fusarium oxysporum* isolated from strawberry obtained from Balili, Pomology, and Swamp was inoculated to chrysanthemum, tomato and the source plant to evaluate the ability of the isolates to cause root rot and discoloration of crowns on all the test plants.

At spore concentrations of $6.46x10^6$/ml (Balili isolate), $8.53x10^6$/ml (Pomology isolate) and $1.60x10^6$/ml (Swamp isolate), root rotting symptom and crown discoloration was observed in strawberry plants dipped in the fungal suspension for one hour before planting after two to four weeks. Chrysanthemum and tomato dipped at the same time and the same amount of spore suspension did not develop root rotting or crown discoloration. Both plants did not also show any form of above ground symptoms after two to four weeks.

Based on this result, *Fusarium* isolated from strawberry is *Fusarium oxysporum f sp*. *Fragariae* which infected strawberry only.

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INTRODUCTION

Strawberry, *Fragaria x ananassa* Duch originated in Europe, around 1750. It is a hybrid between the pistillate South American *F.chiloensis* Duch. and North American *F. virginiana* Duch. For many centuries strawberry is still a favorite fruit of the temperate world. The fruit was valued for its delicious flavor and fragrance, and for health restoring qualities. Today in the United States strawberry is being grown in home gardens and in every state of the Union. The crop is also produced commercially in different climatic zones of the country like Atlantic Coast, South Atlantic and Gulf, Florida, East Central and Northeast, Great Plains and Rocky Mountains, North Pacific Coast or Pacific Northwest and California (Wilhelm and Nelson, 1996).

In Benguet, there is about 35 percent of the farming populations engaged in strawberry industry. According to the Municipal Agriculturist office (MAO) of the municipality of La Trinidad, the average production per hectare on November 2005 to April 2006 was 18.5 metric tons, but declined 14 metric tons on 2006 to 2007. This decline in production was attributed due to improper growing practices of farmers, poor quality of planting materials, and most of all, the presence of pest and diseases.

Strawberries are high-valued export crop that are grown in the temperate areas of Western Australia. Soil born fungal pathogens such as root and crown rots are important diseases of commercial strawberry crops and causes considerable yield reduction worldwide. Survey done in Swan Coastal Plain North Perth on root and crown rot during 2005 and 2006, showed high incidence of the disease. Crown and roots of individual plants including soil surrounding roots were tested for the presence of soil pathogens. Research showed that *Fusarium oxysporum f. sp. fragariae* was consistently isolated

from crowns and roots and *Phytophthora cactorum* was detected from roots, crowns and soil. Other pathogens associated with the crown and roots of strawberry are *Pythium spp., Phoma spp., Rhizoctonia spp., Colletotrichum spp.,* and *Mycrophomina spp*. (Golzar, et al., 2007).

Morocko,(2006) also stated that strawberry cultivation in many regions of the world is constrained by serious disease that can affect the root system, crown, and the basal part of the petioles causing death of the host and considerable reduction of the yield. Among these are root rot and crown rot caused by *Fusarium spp., Verticillium spp, Phytophthora spp*., and disorders caused by *Colletotrichum spp*.

In Japan the pathogen *Fusarium* shares in the black root rot disease complex on strawberries together with *Pythium spp., Rhizoctonia spp.,* and the lesion nematode *Pratylenchus penetrans.* Its is a very serious disease of cultivated strawberries and the damage caused by this disease has spread to open -culture farming in cooler regions such as Akita Prefecture (Takashaki et al, . 2006). Pecnold (2001) also stated that black root rot is the most common of all root disease in Indiana, United States. Since temperature in Benguet is closely similar to weather conditions of this countries it's no wonder that in (2001), Ngitew first reported the occurrence of *Fusarium* wilt in the growing areas of Benguet and recently, Reyes (2008) characterized the species infecting strawberry as *Fusarium oxysporum* based on cultural and morphological traits but pathogenicity of the isolate was not done.

Differentiating between *Fusarium* species responsible for the strawberry vascular wilt and rotting of crown and roots through patogenicity is vital in the development and implementation of effective control strategies. It is there for necessary to conduct

pathogenicity test of the *Fusarium* associated on the crown and roots of strawberry for the formulation proper management of the disease. Correct diagnosis will help strawberry growers to improve their strawberry production thereby increasing their yield.

Objectives of the Study

1. Test the pathogenicity of *Fusarium oxysporum* isolated from strawberry,
2. Test the pathogenicity of *Fusarium oxysporum* on tomato, and chrysanthemum, and strawberry

Time and Place of the Study

The experiment was conducted at Benguet State University, Department of Plant Pathology Laboratory and Greenhouse from August to September 2008.

REVIEW OF LITERATURE

The Crop

Strawberry is a perennial herb of the genus *Fragaria* of the rose family. Strawberries are first grown in temperate regions throughout the world, but were first cultivated in the United States and have become widely distributed crop in farms and gardens. The white flower, have five calyx, five petals, many stamens, and numerous seeds distributed on the berries (Redmund, 2007).

According to Hermano (1999), strawberry is a subtropical plant grown for about a century as traditional crop in the high lands. Because of this crop, Baguio- Benguet has been noted and popularly known as "Strawberry Region" of the country. Strawberry production started in early years of the present century. This crop was introduced and was found to be adaptable to the region. The introduction and evaluation were done probably by Americans who established an Agricultural School in 1916 at La Trinidad, Benguet as cited by (Reyes, 2008).

Strawberries thrives best in well drained, clay loam, loamy soils at a soil pH ranging from 5.5-6.5 and temperature ranging from 14^0C to 23^0C (Ngitew, 2003).

The Pathogen

Reyes (2008) cited that *Fusarium* is a filamentous fungus widely distributed on plants and in the soil. It is found in normal micro flora of commodities, such as rice, beans, soybean, and other crops. While most species are common at tropical and subtropical areas, some inhabit the soil in cold climates. The fungus can stay in the soil for the whole season or plant debris as a dormant mycelium or black-speck-sized bodies

(microsclerotia).This microsclerotia can remain viable in the soil for many years. Under favorable environmental conditions, they germinate and produce threadlike fungal structures (hyphae).The hyphae can penetrate the root hairs or through wounds in the rootlets, once inside the root the fungus invades and destroys the water-conducting tissue. Destruction of water-conduction tissue results in reduced water uptake by the plant; thus plants wilt and wither. As fungal colonies grow older, they produce microsclerotia in infected host tissue and the disease cycle is completed (Anonymous, 2008).

According to Ellis (2006), the genus *Fusarium* currently contains over 20 species of *Fusarium solani, F. oxysporum,* and *F. chlamydosporum* as the most common. Some are plant pathogens causing root and stem rot, vascular wilt or fruit rot. Other species causes storage rot and are important mycotoxin producers. Several species, notably *F. oxysporum, F. soloni, F. moniliforme*, are recognized being pathogenic to man and animals *causing mycotic kertitis, onychomycosis and hyalohyphomycosis.*

General Characteristics of *Fusarium sp.*

Colonies of *Fusarium* are fast growing, pale or brightly colored (depending on the species) and may not have a cottony aerial mycelium. The color of the thallus varies from whitish to yellow, brownish, pink, reddish or lilac shades. Species of *Fusarium* typically produce both macro-and micro conidia from slender phialides. Microconidia are hyaline, two- to several- celled, fusiform-to sickle shaped, mostly with an elongated apical cell pedicellate basal cell. Microconidia are 1- to 2-celled, hyaline, pyriform to avoid, straight or curved. Chlamydoconidia may be present or absent (Ellis, 2006).

Reyes (2008) characterizes *Fusarium oxysporum as* fast growing (4.1 cm colony diameter in 1 week at 28^0 and 30^0 c) and produced white and pale violet pigment on PDA.

Macroconidia has 3 septations and falcate to almost straight in shape. Abundant microconidia that are oval, ellipsoidal and kidney-shaped and were formed in false heads from short phailides. Chlamydospores were formed after three weeks of incubation in Carnation leaf agar (CLA). While *Fusarium solani* is a slow growing (2.9 cm at 28^0 and 2.05 at 30^0 colony diameter after three weeks) and produce cream to pale brown and white pigment in PDA. Its macroconidia has three septation, and sausage-shaped. It produced very few microconidia that are oval and ellipsoidal in shape and were formed in false–heads from long phailides. Chlamydospores were formed after two weeks of incubation on PDA. The result of the cultural and morphological characterization of *Fusarium oxyporum* done by Reyes (2008) is inconformity with the description of *Fusarium* in the published laboratory manual for *Fusrium* by Burgess et al., (1994).

On the other hand, Nagarajan et al., (2004), added that *Fusarium oxysporum f. sp. fragariae* is a fungal pathogen causing strawberry wilt disease. Research done on the genetic variation of the 22 *F. oxysporum f. sp. fragariae* isolates showed a high level of genetic variations.

Diseases Caused by *Fusarium spp.*

According to Agrios (1997), *Fusarium* causes vascular wilts primarily on annual vegetables and flowers, herbaceous perennial ornamentals, plantation crops, weeds and of mimosa tree (silk tree). Most of the vascular wilt- causing *Fusaria* belongs to the *Fusarium oxysporum*. Different host plants are attacked by special forms or races of the fungus.

Black root rot is caused by complex interactions of environmental factors, soil fungi, nematodes such as *Pratylenchus penetrans*, fertilizer burn, soil compaction,

herbicide damage, drought, and excess salt, water or improper soil pH. Several fungi are implicated in the disease, including *Rhizoctonia spp., Pythium spp.,* and *Fusarium spp.* (Los and Schroeder, 2007).

A research in Oregon in 1930's and 1940's by Pscheidt (2007), implicated *Rhizoctonia spp., Fusarium spp.,* and *Ramularia spp.* with root rot of strawberry. He also added that winter injury to roots encourages infection by *Fusarium spp*.

Symptoms Caused by *Fusarium oxysporum*

Agrios (2005) described the symptoms caused by *Fusarium oxysporum* as follows:

Fusarium oxysporum causes vascular wilt and rotting of crown and roots. The leaves of infected plants or of parts of infected plants lose turgidity, become flaccid and lighter green to greenish yellow, droop and finally wilt, turn yellow then brown and die. Wilted leaves maybe flat and curled. Young tender shoots also wilt and die. In cross sections of infected stems and twigs, discolored, brown areas appear as a complete or interrupted ring consisting of discolored vascular tissue. In xylem vessels of infected stems and roots, mycelium and spores of the causal fungus maybe present. Some of the vessels maybe clogged with mycelia, spores, or polysaccharide produced by the fungus. Clogging is increased further by gels and gums formed by the accumulation and oxidation of breakdown of products of plant cells attacked by fungal enzyme. The oxidation and translocation of such breakdown of product seem to be responsible for the brown discoloration of affected vascular tissue.

Management of *Fusarium* Disease

Black root rot is favored by wet soils and soils low in organic matter. As a result, proper site selection and preparation are both important management tools for this disease complex. Soil drainage should be good, low-lying areas that have a tendency to be poorly drained should not be planted with strawberries.

Crop rotation by planting the area into cover crops for at least one growing season, even if strawberries were not grown previously, to build organic matter in the soil. Annual ryegrass, sudan grass and sorghum sudan can be grown after strawberry.

In the absence of a site with good soil drainage, the strawberry should be planted in raised beds. The raised beds will allow excess soil water to drain from the strawberry root system, creating an environment less favorable to disease causing fungi, and lessen soil compaction that will occur near the root system. When planting, use only white rooted plants which have been purchased from a reputable nursery.

Cultural practices which favor good plant growth and development must be done. Soil and or tissue analysis should be performed each year to determine optimum fertilizer application, and minimize soil compaction. Over or under irrigation of strawberry field should be avoided (Pritts and Handley, 1991).

MATERIALS AND METHODS

A. Isolation of *Fusarium*

Following the standard procedure in isolating *Fusarium* wilt, roots with infection were cut into 1-2 mm sections, sterilized in10 % sodium hypochlorite (Clorox) for 1 minute, blot dried on sterile tissue paper and plated in water agar. The plates were incubated for two to three days to allow the pathogen to grow. The pathogen was sub-cultured unto carnation leaf agar (CLA) after one week.

B. Microscopic Observation

The characterization done by Reyes (2008) on Fusarium *oxysporum* from strawberry which was based on the laboratory manual for *Fusarium* (Burgess et al., 1994) was used as basis during the microscopic observation. These are: presence of sickle-shaped macroconidia and oval shaped microconidia formed in false heads on short monophialides; chlamydospores formed after 2-3 weeks; presence of septa on the macro conidia formed on hyphae and branched conidiophore and the formation of the conidogenoues cells.

C. Standardization of Inoculum

Pure-culture isolates obtained from strawberry plants grown from Balili, Pomology, and Swamp was added with 10 ml sterile distilled water. Sterilized wire loop was used to scrape the fungal growth to detach the spore and mycelia on the surface of carnation leaf agar (CLA). An amount of 0 .1 ml. of *Fusarium* inocula was deposited on the ridge of the haemacytometer after which, spores were counted. Standardization was done thrice. The average count of the three trials from the five squares was multiplied

with 20,000 to obtain the total spore count/ 0. 1ml.

D. Pot Bioassay

To confirm if the *Fusarium* isolated and identified by Reyes in 2007-2008 from strawberry which is *Fusarium oxysporum f. sp fragariae*, the different isolates from strawberry grown in Balili, Pomology, and Swamp, was inoculated in four week old seedlings of *Fragaria x ananassa* cv. Sweet Charlie, Chrysanthemum (*Dendrathema x grandiflorum*) and Tomato (*Lycopersicun esculentum*) to test their pathogenicity. Chrysanthemum, Tomato, and Strawberry runners were dipped separately for one hour in 500 ml volume suspension of *Fusarium oxysporum* at a spore concentrations / ml of 6.46 $x10^6$(Balili), 8.53 $x10^6$ (Pomology), and 1.60 $x10^6$ (Swamp). The test plants after dipping were planted on a black polyethylene bags (5"x 6" diameter) containing 800g of sterilized soil. Untreated plants were dipped in tap water. The experiment was laid out following the Complete Randomized Design (CRD) with three (3) replicates and with a five (5) sample plants per replicate. The treatments are as follows:

Fusarium Isolate

T0- Un-inoculated (Control)

T1 –*Fusarium oxysporum* isolated from strawberry obtained from Balili area

T2 – *Fusarium oxysporum* isolated from strawberry obtained from Pomology area

T3 – *Fusarium oxysporum* isolated from strawberry obtained from Swamp area

E. Assessment of Symptoms on Inoculated Plants

Assessment of symptoms was done two weeks after planting. Presence of above ground symptoms such as wilting, yellowing, stunting and death of seedlings were carefully noted. Infected plants was counted and recorded. Below ground symptoms like crown discoloration and root rotting were observed after two (2) and five (5) weeks.

Data Gathered

1. Above ground symptoms- yellowing, wilting stunting and seedling death was observed two weeks after inoculation until the termination of the study.

2. Below ground symptoms- black root rot and crown discoloration was observed and recorded at termination of the experiment.

3. Number of infected plants- number of wilted and dead plants were counted and recorded after two weeks and thereafter.

4. Re-isolation of *Fusarium* from inoculated strawberry plants.

Experimental Set-up

RESULTS AND DISCUSSION

Above Ground of Symptoms

Wilting, yellowing and stunting and death of strawberry plants inoculated with the different isolates of *Fusarium* appeared two weeks after planting. The symptoms progressed on the third until the fourth week of the experiment. Golzar, et al., (2007) described that the infected strawberry plants wilt and die either slowly or rapidly soon after the first symptoms are noted due to destruction of the roots. Affected plants die more rapidly in very dry than in moist soils. Infected young plants often wither and die without producing any fruits.

Morocko (2006) also stated that the common symptoms of root rot on strawberries shows patchy appearance of stunted plants in the field, and discoloration of leaves that turns yellow. Similarly, Pritts and Handley (1991) described strawberry infected plants to have general lack of vigor with poor runner growth and small berries. Plants may collapse when water demand is high during spring growth, during or after fruiting, or during drought stress. Figure 1 shows wilted, yellowing and stunted plants.

Figure 1. Strawberry plants showing wilting, yellowing and stunting: **(a)** inoculated with 6.46 x10^6 /ml spores (Balili isolate), **(b)** inoculated with 1.60x10^6spores / ml (Swamp isolate), **(c)** inoculated with 8.53 x 10^6 spores/ ml (Pomology isolate)

Except for strawberry that showed above ground symptoms of infection after inoculation, pathogenicity test showed that *Fusarium* isolated from strawberry is not pathogenic to the other test plants, (Table 1) Chrysanthemum and tomato dipped in different spore concentrations of *Fusarium* (6.46 $x10^6$, Balili isolate), (8.53$x10^6$, Pomology isolate) and (1.60x^6 Swamp isolate) were not infected by the fungus *Fusarium oxysporum* (Figure 2).

Table 1. Above ground symptoms observed two weeks after inoculation until the fifth week

SYMPTOM	INOCULATED PLANTS		
Balili Isolate	Chrysanthemum	Tomato	Strawberry
• Wilting	-	-	+
• Yellowing of leaves	-	-	+
• Stunting	-	-	+
Pomology Isolate			
• Wilting	-	-	+
• Yellowing of leaves	-	-	+
• Stunting	-	-	+
Swamp			
• Wilting	-		+
• Yellowing of leaves	-	-	+
• Stunting	-	-	+

This result corroborates the findings of Freeman and Rodriguez (1993) in their wilt – screening for resistance against *Fusarium. Fusarium oxysporum f. sp. melonis* which is specific to muskmelon (*Cucumis melo* L.) is unable to cause disease in watermelon (*Citrullus lanatus* (Matsuma and Nakai).

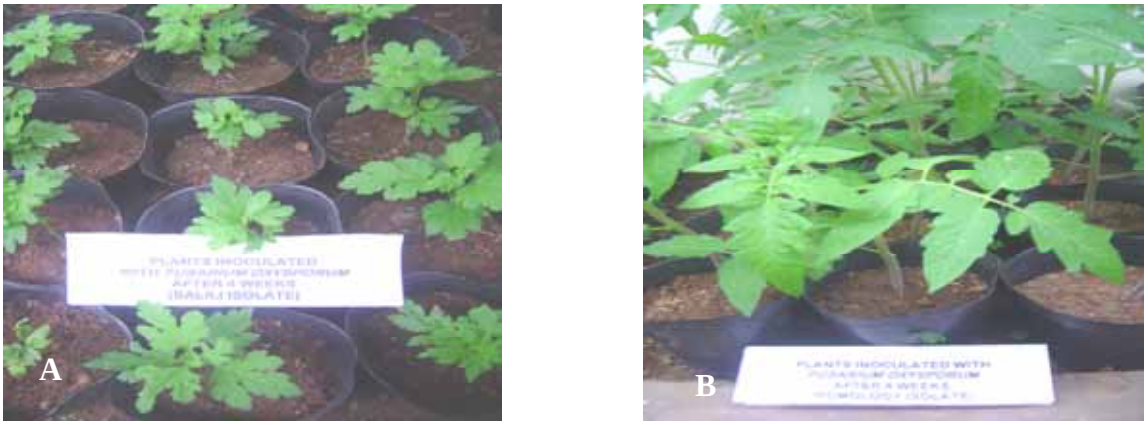


Figure 2. Chrysanthemum **(a)** and tomato **(b)** inoculated with the same amount of spore concentration of *Fusarium oxysporum* without above ground symptoms after two to four weeks.

Below Ground Symptoms

Strawberry plants that showed wilting, yellowing and stunting also exhibited rotting on roots that is colored black. The crown of infected plants also showed brown to black discoloration. According to Pritts and Hardley (1991), infected roots are rotted at their tips or appear mottled with black lesions among the white roots and blackening of the entire root system. In the early stage of black root rot, the root core is white (Figure 3), if the plants are severely affected, both the core and the tissue will be black.

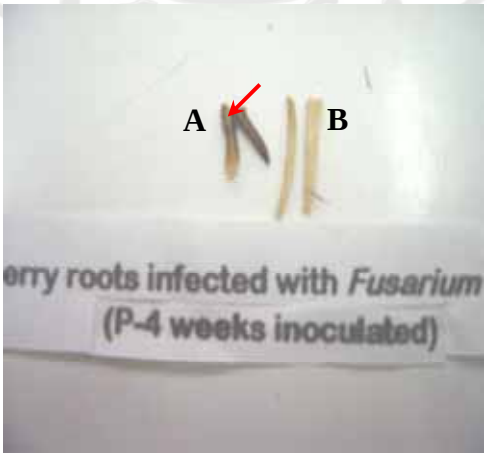


Figure 3. Sample of infected roots with white core, pointed with arrow **(a)** and **(b)** healthy roots

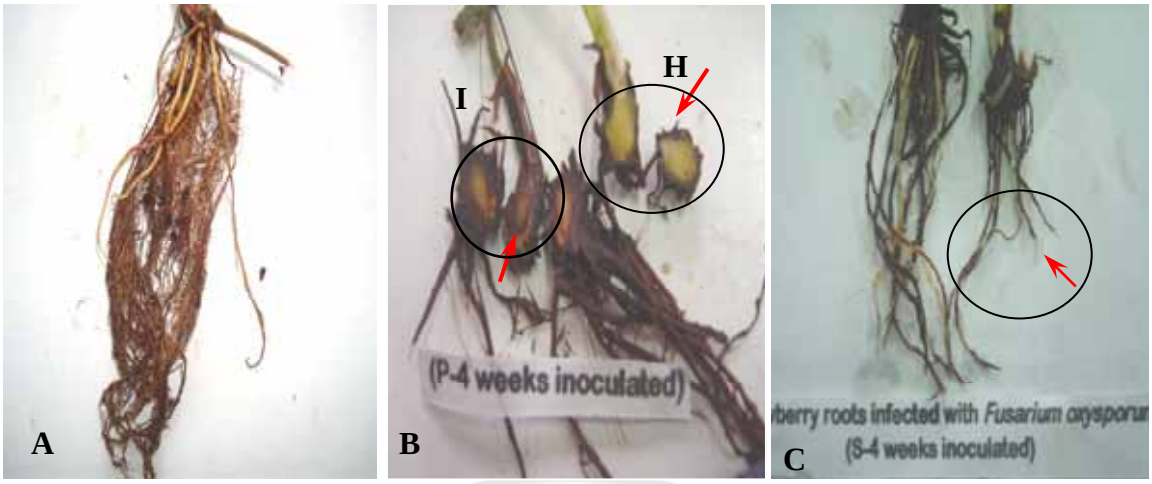


Figure 4. Healthy and infected strawberry roots and crown **(a)** Healthy strawberry roots (un-inoculated) **(b)** healthy and infected crowns inoculated with 8.53 x 10^6 spores/ ml (Pomolog isolate) **(c)** with root rot, inoculated with 1.60 x10^6 spores /ml (Swamp isolate)

Number of Dead Strawberry Plants

Table 2 shows the number of dead strawberry plants, three weeks after planting and until the termination of the experiment. Out of fifteen sample plants per treatment, four from those inoculated with Balili isolate, six inoculated with Pomology isolate, and five from those inoculated with Swamp isolate, wilted and died. Number of dead plants increased after 28 days with three additional from Balili isolate, four from Pomology isolate and one from Swamp Isolate. The highest total infected plants were recorded from the treatment inoculated with the Pomology isolate, (Figure 5). This also showed that the higher the spore concentration used, the more number of plants died.

Figure 5. Sample of dead strawberry seedling

Table 2. Wilted plants observed and recorded 21 and 28 days after inoculation

TREATMENTS	21 DAYS	28 DAYS	TOTAL
Control/ un-inoculated	-	-	-
Balili Isolate	4	3	7
Pomology Isolate	6	4	10
Swamp Isolate	5	1	6

Chrysanthemum Inoculated Plants

No above and below ground symptoms on chrysanthemum were noted after three and four weeks after panting and until the termination of the experiment. (Table 3 and Figure 6).

Table 3. Chrysanthemum plants inoculated with the different isolates of *Fusarium Oxysporum*

TREATMENTS	21 DAYS	28 DAYS	TOTAL
Control(un-inoculated)	-	-	-
Balili Isolate	-	-	-
Pomology Isolate	-	-	-
Swamp Isolate	-	-	-

Figure 6. Inoculated roots of chrysanthemum with out symptoms **(a)** Un- inoculated **(b)** healthy roots inoculated with 6.46 $x10^6$, spores/ ml (Balili isolate) **(c)** healthy roots inoculated with 8.53 x 10^6 spores/ ml (Pomology isolate **(d)** healthy roots inoculated with 1.60 $x10^6$ spores /ml (Swamp isolate)

Tomato Inoculated Plants

Similarly, tomato plants inoculated with the different isolates of *Fusarium* did not show any symptom of infection on leaves, stems and roots (Table 4). This corroborates the findings of Golzar, et al., (2007), whereby *Fusarium* isolated from strawberry and inoculated to tomato and cucumber plants did not cause infection, (Figure 6).

Table 4. Tomato plants inoculated the different isolates of *Fusarium oxysporum*

TREATMENNTS	3rd WEEK	4th WEEK	TOTAL
Control/ untreated	-	-	-
Balili Isolate	-	-	-
Pomology Isolate	-	-	-
Swamp Isolate	-	-	-

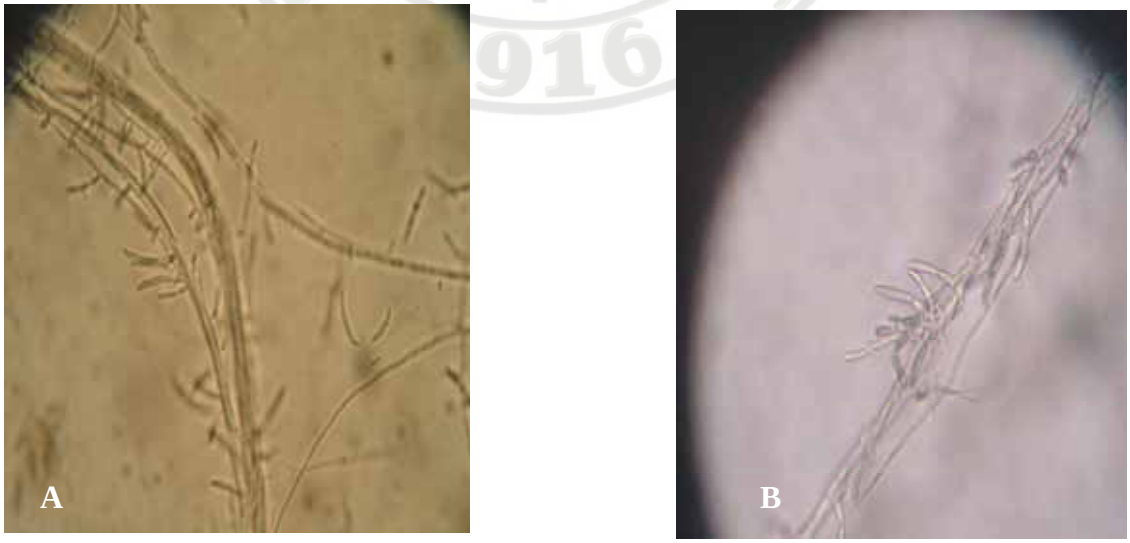
A

B

Figure 7. Inoculated roots of tomato with out symptoms**(a)** Un- inoculated **(b)** healthy roots inoculated with 6.46 x10^6, spores/ ml (Balili isolate) (b) healthy roots inoculated with 8.53 x 10^6 spores/ ml(Pomology isolate) **(c)** healthy roots inoculated with 1.60 x10^6 spores /ml(Swamp isolate)

Fusarium oxysporum Isolates

Re-isolation of infected root and crown of strawberry inoculated with *Fusarium oxysporum was* done. Figure 8 shows the original culture and re- isolated *Fusarium oxysporum* from Balili, Pomology, and Swamp.



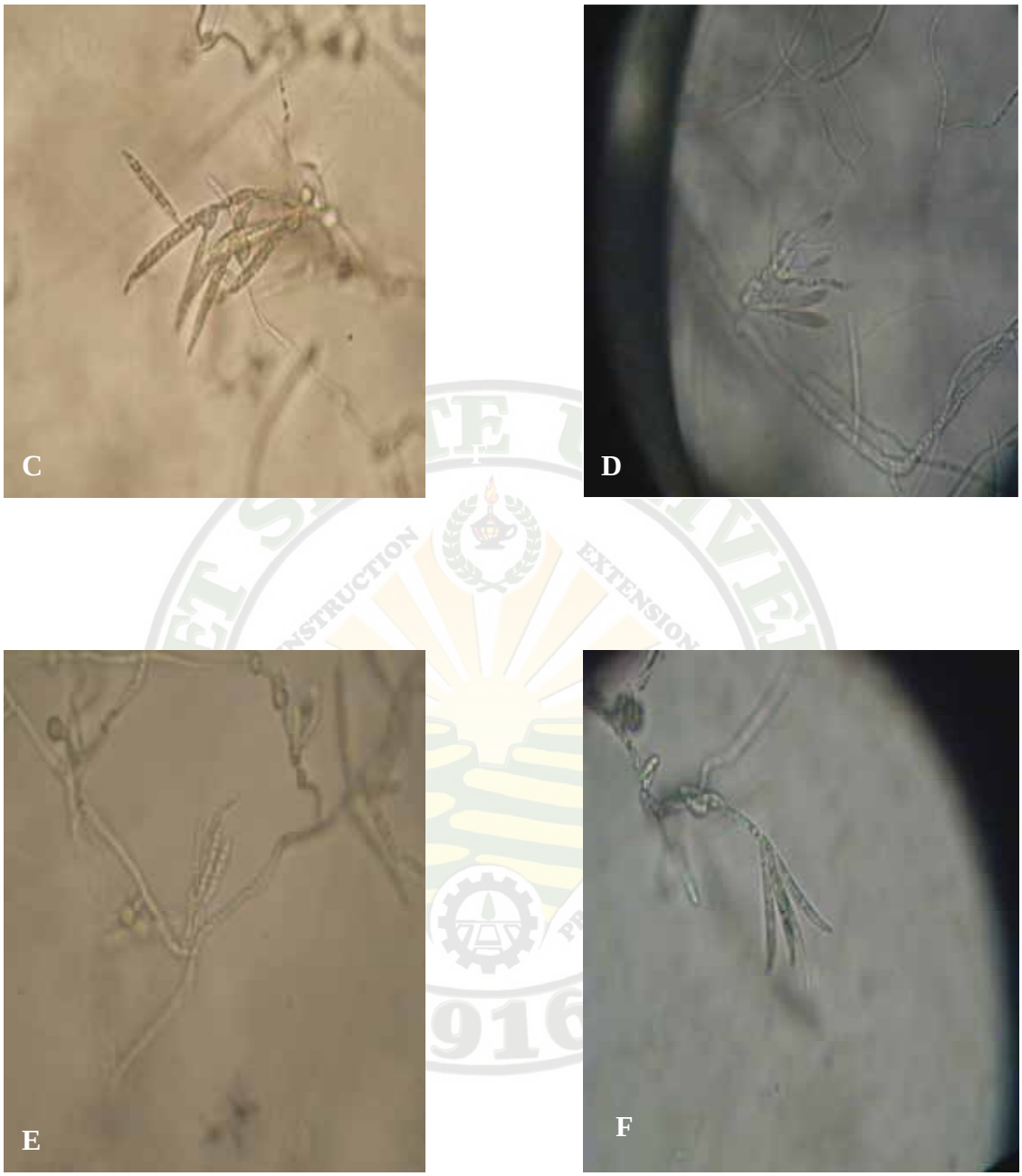


Figure 8**. (a)** Macroconidia in hypha from the original Balili isolate **(b)** Conidia in a developing branched conidiophore re- isolated from the inoculated strawberry**, (c)** Branched conidiophore with macroconidia from the original Pomology isolate **(d)** Branched conidiophore with macroconidia re-isolated from the inoculated strawberry, **(e)** Macroconidia in hyphae from the original Swamp isolate **(f)** Macrocnidia in hyphae re- isolated from the inoculated strawberry (400x)**.**

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

Pathogenicity test of *Fusarium oxysporum* isolated from Strawberry obtained from Balili, Pomology and Swamp was inoculated on chrysanthemum, tomato and strawberry to determine if root rot and crown rot or discoloration symptoms will develop in all the test plants.

Results of the study revealed that the three isolates of *Fusarium* from Balili, Pomology, and Swamp were pathogenic to strawberry only. No wilting, yellowing, stunting, and root rotting symptom developed both for chrysanthemum and tomato inoculated with spore concentrations of *Fusarium* at (6.46×10^6 /ml (Balili isolate), 8.53×10^6/ ml (Pomology isolate) and 1.60×10^6/ml (Swamp isolate). *Fusarium* above ground symptoms produced by strawberry inoculated plants was stunting, and wilting. Symptoms that developed in roots were in the form of root rot and brown to black discoloration of the crown.

Conclusion

From the results, the *Fusarium* obtained from strawberry caused infection only on the inoculated strawberry seedlings. Inoculated chrysanthemum and tomatoes were not infected. They did not show any symptoms of wilting, yellowing, stunting, and root rot on chrysanthemum and tomatoes, which indicates that *Fusarium* infecting strawberry is *Fusarium oxysporum f. sp. Fragariae* having infected strawberry only.

Recommendation

Based on the above findings, it is recommended that appropriate management of *Fusarium oxysporum f. sp. fragariae* be done in the areas where strawberries are grown to improve production.

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APPENDICES

Appendix Table 1. Above ground symptoms observed two weeks after inoculation until the fifth week.

SYMPTOM	INOCULATED PLANTS		
Balili Isolate	Chrysanthemum	Tomato	Strawberry
• Wilting	-	-	+
• Yellowing of leaves	-	-	+
• Stunting	-	-	+
Pomology Isolate			
• Wilting	-	-	+
• Yellowing of leaves	-	-	+
• Stunting	-	-	+
Swamp			
• Wilting	-		+
• Yellowing of leaves	-	-	+
• Stunting	-	-	+

Appendix Table 2. Wilted/dead plants observed and recorded 21 and 28 days after inoculation

TREATMENTS	21 DAYS	28 DAYS	TOTAL
Control/ un-inoculated	-	-	-
Balili Isolate	4	3	7
Pomology Isolate	6	4	10
Swamp Isolate	5	1	6

Appendix Table 3. Chrysanthemum plants inoculated with the different isolates of *Fusarium oxysporum*

Treatments	21 DAYS	28 DAYS	TOTAL
Control/un-inoculated	-	-	-
Balili Isolate	-	-	-
Pomology Isolate	-	-	-
Swamp Isolate	-	-	-

Appendix Table 4. Tomato plants inoculated the different isolates of *Fusarium oxysporum*

TREATMENTS	3rd WEEK	4th WEEK	TOTAL
Control/ untreated	-	-	-
Balili Isolate	-	-	-
Pomology Isolate	-	-	-
Swamp Isolate	-	-	-