BIBLIOGRAPHY

CAMINGAWAN, JOVELYN GUINGABAN. MARCH 2012. Characterization of Powdery Mildew Infecting French Beans (*Phaseolus vulgaris* L.) and The Weeds (*Galinsogaparviflora* and *Ageratum conyzoides*).Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The study was conducted at the Plant Pathology Laboratory Department, Benguet State University, La Trinidad, Benguet from November to February 2012 to characterize the powdery mildew infecting French bean (*Phaseolus vulgaris* L.) and the weeds (*Galinsogaparviflora* and *Ageratum conyzoides*) and determine if the same type of powdery mildew infects Bokod variety and the weeds.

Results revealed that the powdery mildew infecting French bean and *Galinsogaparviflora* is close to *Oidiumpolygoni*DC., while powdery mildew infecting *Ageratum conyzoides*is close to *Oidiumcichoracearum DC.* This indicates that the *Galinsogaparviflora* is an alternative host of the powdery mildew (*Oidiumpolygoni*DC.) infecting beans while *Ageratum conyzoides*is an alternative host of *Oidiumcichoracearum*DC.causing powdery mildew of cucurbits.

The following are the characteristics of *O.polygoni*DC.: conidia measures 16.45-17 µm; ellipsoidal in shape; hyaline and borne singly; conidiophore on superficial hyphae attached to the epidermal cell of the host and base of conidiophore not twisted. On the other hand, the characteristics of the *O.cichoracearum* DC.are the following: the conidia measures 11.7-12 µm, ellipsoidal in shape; hyaline and borne in chain;conidiophore on superficial hyphae attached on host surface and base of the conidiophore is not twisted.

Based on the results, *O. polygoni* DC.and*O. cichoracearum* DC. differ in the size of conidia and number of conidia attached to the conidiophore (single or in chain). It was observed that *Oidiumpolygoni* DC. hasbigger conidia ranging from 16-17 µm while *O. cichoracearum* DC. has a smaller conidia ranging from 11-12 µm.

Since both species of powdery mildew were found associated with *G. parviflora*and *A. conyzoides*, these weeds should be eradicated if found in fields grown with beans and cucurbits.

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INTRODUCTION

Powdery mildew has a long history in green house production that contributes to significant economic losses in many greenhouse floriculture and vegetable crops. It reduces crop aesthetic and value but do not do not kill the plant. In greenhouses, powdery mildews usually survive between crops as hyphae or fungal strands in living host plants or weedy host. Under certain circumstances, some powdery mildew fungi produce small, black, pepper-like chasmotecia (formerly cleistothecia). These structures allow the fungus in the absence of the suitable host.However, the role of these resistant structures is probably insignificant in greenhouse situations since continuous cropping usually provides a constant source of living host. Powdery mildews are easily recognized by the white, powdery growth of the fungus on infected portions of the plant host. Colonies vary in appearance from fluffy and white to sparse and gray. Powdery mildew fungi usually attack young developing shoots, foliage, stems, and flowers but can also colonize mature tissues (Douglas, 2008).

Powdery mildew belongs to the kingdom fungi, phylum ascomycota, class loculoascomycetes, order erysiphales, and genus erysiphe (Quimio*et al.*, 2001).

Powdery mildews are probably the most common, conspicuous, widespread and easily recognizable plant diseases. The fungi causing powdery mildews are obligate parasite: they cannot be cultured on artificial nutrient media. They produce mycelium that grows only on the surface of the plant tissues, never invading the tissues themselves. They obtain nutrients from the plants by sending haustoria (feeding organs) into the epidermal cell of the plant organs (Agrios, 1997).

Powdery mildew is a common disease on many types of plants. There are many different species of powdery mildew fungi and each species only attacks specific plants. A wide variety of vegetable crops are affected by powdery mildews, including beans, beets, carrot, cucumber, eggplant, lettuce, peas, peppers, radishes, squash, tomatoes, and turnips. Powdery mildews generally do not require moist conditions to establish and grow, and normally do well under warm conditions; thus they are more prevalent than many other leaf-infecting diseases (Davis *et al*., 2008).

According to (Edmunds and Pottorff, 2009), powdery mildew fungi produce similar symptoms on plant parts. It is characterized by spots or patches of white to grayish, talcum-powder-like growth. Tiny, pinhead-sized, spherical fruiting structures that are first white, later yellow-brown and finally black, may be present singly or in a group. These are the cleistothecia or overwintering bodies of the fungus. Infected leaves may become distorted, turn yellow with small patches of green, and fall prematurely and the infected buds may fail to open.

French beans *(Phaseolus vulgaris* L.) are fast-growing annuals, and as they originate from a tropical climate require warm soil in which to germinate and grow. It is self – pollinating, and generally produces heavy yields, provided that the young beans are picked regularly and the plants are growing well (Phillips and Martyn, 1993).

According to (Sahadevan, 1987), per 100g edible portion of French beans, it is composed of 36.0 calories of Food energy, 2.3 g protein, 6.2 g Carbohydrate, 54.0 mg of Calcium, 6.0 mg Phosphorus, 1.8 mg Iron, 0.1 mg Vitamin B1, 0.2 Vitamin B2 and 15.8 mg Vitamin C.

Bokod variety (NSIC 2009 BSnBn2) is a selection from an introduced accession from the International Center for Tropical Agriculture (CIAT) in Cali, Columbia. It has an average yield of 9.29 t/ ha. It has shorter and tastier straight green pod and is very much liked by farmers and consumers. It has a comparable moderate resistance to bean rust and better resistance to weevil, pod borer, stem breakage and lodging. The number of flower cluster per plant is 9, with 5 pods per cluster. It flowers after 42 days of planting. The first harvest could be after 50 days and the last harvest is after 74 days. The pod length is 13.4 cm with 6 seeds per pod that is black in color. Bokod variety could also be grown in high, mid and low – elevation areas (Tandang*et al*., 2001) as cited in The Philippine Journal of Crop Science, December 2010.

According to (Fryer and Makepeace, 1997), weed species are hosts of many organisms that attack crops, including insects, nematodes, fungi, bacteria and viruses. It act as sources of infection, or reservoirs which tend to defeat the purpose of crop rotation. Its chief effect is to decrease yields by depriving the crop from light, water and nutrients which would otherwise be available to it.

In a survey done at Balili, La Trinidad, Benguet by Balaki in 1981 as cited in the Weed Control in Tropical crops (Moody, 1986), he reported a total of 56 species under 43 genera and 15 families. The dominant weeds were *Galinsogaparviflora*Cav., *G. quadriradiata*R. & P., *Ageratum conyzoides*L., *A. houstonianumMill.*,*Spilanthesacmella*(L.) Murr.,*Crassocephalumcrepidioides*(Benth) S. Moore,*Commelinabenghalensis*L., *Portulacaoleracea*L., *Oxalis corymbosa*DC., and *Bedenspilosa*L. Although these weeds are mainly observed during the rainy season, their

abundance could be in dry seasons due to ambient conditions which favored their germination.

Considering its economic and nutritional value, French beans are a healthy option for many health conscious people as they are rich in many vital nutrients that are considered essential for the proper growth and metabolism of the body. French beans are filled with healthy dietary fibers that help in the prevention of cholesterol. These fibers are also beneficial for diabetic people as they help in preventing the sugar levels from rising up immediately after having a meal. It is also helpful in energizing the body as they are rich in iron, the nutrients found in hemoglobin which helps in giving energy to the body. It has many anti-inflammatory nutrients like beta-carotene and, Vitamin C. These nutrients help in preventing many disease and ailments where there are chances of inflammation, such as asthma, rheumatoid arthritis and osteoarthritis. They also contribute in preventing fatal diseases like colon cancer (Anonymous, 2008).

Powdery mildews (Erysiphales) on plant species regarded as weeds are of potential practical importance because weeds can function as alternative hosts for powdery mildews affecting crop plants and because some species might have a potential use for biological control agents against weeds (Dugan and Glawe, 2007).

The study aimed at characterizing the powdery mildew infecting French bean (Bokod variety) and the weeds (*Galinsogaparviflora*and *Ageratum conyzoides*); and determine if the same type of powdery mildew infects the Bokod variety and theweeds.

Time and Place of the Study

The study was conducted from November 2011 to February 2012 at the the Plant Pathology Department, Benguet State University La Trinidad, Benguet.

REVIEW OF LITERATURE

The Crop

French beans are half-hardy annuals. There are two types that are available, the dwarf type and the climbing. Dwarf type is commonly called as 'bush' bean or 'sitting' beans and the climbing type is commonly called as 'pole' beans. French beans are sometimes known as string beans or kidney beans. It is valuable for their vitamin and mineral content. It is best grown in a well-drained fertile soil with a soil pH of 6.5 – 7.0 (Biggs, 1994).

According to (Kmetijstyo, 2000), beans and pea represent high-protein food of plant origin. Both plants improve soil as in root nodules nitrogen fixation is done by bacteria fixing up to 200kg/ha of nitrogen gas from the atmosphere and live in symbiotic relationship.

Leguminous crop has a high capacity for nitrogen fixation by *Rhizobium* bacteria in the root nodule. Nitrogen fixation depends on the efficiency of leaf photosynthesis and nitrogenase activity (Maiti, 1997).

Neismeth and Hartman (2009), mentioned that bean diseases includes bean yellow mosaic virus, stem and root rots, *Rhizoctonia* Root Rot (*Rhizoctoniasolani*), *Fusarium* Root Rot (*Fusariumsolani*f. *phaseoli*), *Pythium* Root Rot (*Pythium* spp.), Anthracnose (*Colletotrichumlindemuthianum*), Bacterial Blights, Common Blight (*Xanthomonasphaseoli*), Wilt (*Corynebacteriumflaccumfaciens*), Halo Blight

(*Pseudomonas phaseolicola*), Brown Spot (*Pseudomonas syringae*) and Bean Rust (*Uromycesphaseoli*).

The Weed

Weeds are like pathogens, pests of crops and some of the worst are parasites which are closely analogous to some fungal diseases in their mode of attachment to the host and in the production of phytotoxins. Most weeds have a less close association with the crop but can cause severe losses by competition for the available nutrients or water in the soil or for light. A further cause of damage is allelopathy, where toxic exudates from weeds have an inhibitory effect on crop germination or growth. The overall direct losses due to weeds are often underestimated as the first 10-20% of crop loss may be accompanied by no visible damage symptoms. There are also indirect effects of weed growth which includes effects on crop quality, increased cost of harvesting and influence on pests and diseases (Waller *et al*., 2001).

According to (Fryer and Makepeace, 1977), weed vegetation can be useful at particular times on arable land in preventing soil erosion, preserving soil structure or regulating fertility. However, if these weeds produce seeds, they can cause trouble in subsequent crops. On uncultivated lands, weed spp. form a part of a community of organisms of all kinds and any change in the diversity of the vegetation may have profound effects on wildlife, for good or ill. Crops that are slow to establish and cover the ground are particularly susceptible to weed competition. Weed seeds are spread mainly by man's activities, especially in inadequately – cleaned crop seed. Farm machinery can spread weed seeds, either inside it, derived from the crop it was last used for, or in mud

on wheels and other parts in contact with soil. It could also be spread by man, birds and other animals.

Galinsogaparviflora is an herbaceous plant in the Asteraceae (daisy) family. It has several common names including Guasca (Colombia), Mielcilla (Costa Rica), Galinsoga (NZ), gallant soldier (USA). It is also known by the taxonomic name *Tridaxparviflora*. *Galinsogaparviflora* was brought from Peru to Kew Gardens in 1796, and later escaped to the wild in Britain. In Britain its name *Galinsoga* is sometimes popularly rendered as "gallant soldiers", and then sometimes altered to "soldiers of the Queen". In Colombia it is used as a spice herb in the soup Ajiaco. It can also be used as an ingredient in leaf salads. In much of the world it is considered as a weed but it is extremely effective in treatment of wounds. Its juice helps blood to coagulate faster and also acts as an antibiotic agent. Some people claim that usage of *Galinsoga* helps wounds heal faster. Even though it is considered a weed, it is an extremely useful herb (Anonymous, 2007**).**

Nagpala*et al*., (2003) reported that *Galinsogaparviflora* was infected with powdery mildew but the species was not characterized.

Ageratum conyzoides is also an herbaceous plant in the Asteraceae family. It is known as Billygoat-weed, Chick weed, Goatweed, Whiteweed; *A. conyzoides*L., *Ageratum obtusifolium* Lam., and *Cacaliamentrasto*Vell is a native to Tropical America, especially Brazil. It is an herb which is 0.5–1 m high, with ovate leaves 2–6 cm long, and the flowers are white to mauve. In Vietnam, the plant is called cứtlợn (Pig Feces) due to its growth in dirty areas. It has medicinal plant properties. However, it's limited for external use due to toxicity issues. It is also an insecticide and nematicide.Ingesting*A. conyzoides* can cause liverlesions and tumors. The plant contains the pyrrolizidine

alkaloidslycopsamine and echinatine (Anonymous, 2011).

Similarly, Nagpala et al., (2008) observed that *Ageratum conyzoides*growing at La Trinidad Balili Experimental Field were infected with powdery mildew and the causal pathogen is *Oidium* sp. The symptom is a powdery white mold that appears on the leaf surface. Infection starts with the older leaves and progresses to younger ones as the infection develops and become severe.

A. conyzoides is prone to becoming a rampant environmental weed when grown outside of its natural range. It is an invasive weed in Africa, Australia, Southeast Asia and USA. It is considered a moderate weed of rice cultivation in Asia (Anonymous, 2011).

According to (Iqbal*et al*., 2004) *Ageratum conyzoides* L. is an annual herb in the tropics and subtropics whose extracts are known to possess pharmacological and biocidal activity. They reported on the bioactivity of a secondary metabolite (a chromene) isolated from the shoots of *A. conyzoides* against some plant pathogenic fungi. Organic solvent extracts from the shoots were tested for antifungal activity against the plant pathogenic fungi *Rhizoctoniasolani, Sclerotiumrolfsii, Botryodiplodiatheobromae, Phomopsistheae*and *Fusarium* species growing *in- vitro* on potato dextrose agar medium. The cruden-hexane extract completely inhibited the growth of *R. Solani*and *S. rolfsii*. The growth of *R. solani*and *S. rolfsii* was completely inhibited by precocene II at a concentration of 80–100 ppm. The sclerotia of *R.solani*and *S. rolfsii* were also completely suppressed by 150 ppm of precocene II. Sub-culture of these inhibited fungi onto precocene II-free medium restored growth of the fungus, indicating that precocene II is fungistatic. Crude or refined extracts from *A. conyzoides* offer the possibility of

biocontrol of plant pathogenic fungi. *Ageratum conyzoides* has an antifungal activity or fungistasis on *Rhizoctoniasolani*and *Sclerotiumrolfsii.*

The Pathogen

Powdery mildew typically begins rapid growth on the lower leaves and sheaths when plants begin to joint. It is usually favored by temperatures between 10 and 22°C. The infection and disease development decline when temperatures increase above 25°C. Conidia are the primary inoculum source for dissemination of the fungus. They are easily dislodged from lesions by wind and rain. Production of conidia is optimal at 20°C and declines rapidly above and below that temperature. Although conidia only survive for several days, they are capable of disseminating the fungus long distances. New pustules with conidia are produced every seven to ten days at optimal conditions and provide repeating cycles of spores. Conidia germinate most rapidly at 97 to 100 percent relative humidity, but their high water content allows them to germinate when humidity declines below 50 percent. Frequent light rain removes conidia from leaves and thus reduces the number of new colonies that form. After crop maturity, ascospores in cleistothecia serve as survival structures, but their role in initiating disease is much less important than that of the conidia in most environments (Cunfer, 2002).

According to (Quimio and Hanlin, 1999), erysiphales has a septated superficial mycelium anchored to the epidermal host cells by haustoria. Sexual reproduction is distinguished by a close ascocarp (cleistothecium) within globose or pyriformasci while asexual reproduction is by chained conidia on long erect conidiophores.

Morphological Features Used in Distinguishing Genera of Erysiphales

Determination of Erysiphales is based on a variety of morphological structures produced throughout their life cycles. Erysiphales are pleomorphic fungi typically involving both sexual (teleomorphic) and asexual (anamorphic) states. In most taxa, hyphae primarily are formed superficially on host tissue. Conidiophores are formed from superficial mycelia or in taxa with internal mycelia that emerges through stomata or epidermal cells to produce conidia. Two basic kinds of conidiophores are recognized (Braun *et al.*, 2002); one kind is conidia matures singly, dehiscing upon maturation at which time a conidium develops; in the other kind, a series of conidia mature more gradually, resulting in a chain of conidia exhibiting increasing maturity distal to the conidiogenous cell. In the absence of disturbance, conidia formed singly may accrue in false chains. In most taxa, conidia produced from a single conidiophore are morphologically similar (Glawe, 2006).

Erysiphepolygoni is a widespread and numerous hosts in *Rumex*and *Polygonum*. It was also seen repeatedly on *Polygonumaviculare*L. (prostrate knotweed) in Washington and Idaho. *E. polygoni* mycelia were amphigenous, conidia were (28-) 31-48 (-50) x 13-17 µm, lacked fibrosin bodies and were borne singly on conidiophores (Dugan and Glawe, 2007). Braun *et al*., (2002) defined fibrosin bodies as refractive, cytoplasmic structures that occur within conidia and exhibit varied shapes including comma's, cones or rods.

Salmon (1900) defined *E. polygoni* DC. broadly to include a wide range of morphological characters and occur on a number of host families including *Apiaceae* (=*Umbelliferae), Chenopodiaceae*and *Polygonaceae.*

Golovinomycescichoracearum has been reported (as *Erysiphecichoracearum* DC) from *Coreopsis* species in Europe and New Zealand, as well as from California, Illinois, Maryland, Minnesota, New York, and Wisconsin. *Golovinomycescichoracearum* hyphae were superficial, produced nipple-shaped appressoria, conidiophores with foot cells measuring 23.0-52.5 × 10.5-13.5 µm, and chains of conidia. Conidia were hyaline, short-cylindrical to ovoid, lacked fibrosin bodies, and measured 26.5-40.5 × 12.5-18 µm. The teleomorph included sphaeroidalchasmothecia measuring 125-220 µm with mycelioid appendages, and multiple short-stipitateasci measuring 49.0-58.0 × 29.5-43.5 µm. Ascospores were subhyaline to pale yellow, ellipsoid-ovoid, two per ascus, and measured 24.5-31.5 × 16.0-21.0 µm (Glawe*et al*., 2006).

According to (Braun, 1987) as cited by (Glawe and Duffield, 2007), the powdery mildew fungus *Golovinomycescichoracearum*DC. V.P Heluta (*Erysiphecichoracearum*DC.) (Erysiphales) occur on a wide range of Asteraceae.

Quimio and Hanlin (1999) in a simple provisionary key to powdery mildew genera and species based mainly on the anamorphs presented by Boesewinkel (1980) and von Arx (1987) and similarly with the key presented by Spencer (1978). *Erysiphepolygoni*DC.have a conidia borne singly, conidiophore on superficial hyphae, conidia ellipsoidal, on herbaceous plants. On the other hand, *Erysiphecichoracearum*DC.have a conidia in chains, base of conidiophore not swollen and without fibrosin bodies.

Management of Powdery Mildew Disease

According to (Davis, 2008) the best method of controlling powdery mildew is prevention. Planting resistant varieties when available, or avoiding the most susceptible varieties, and following good cultural practices will adequately control powdery mildew in many cases. However, very susceptible vegetables such as cucurbits (cucumber, melons, squash, and pumpkins) may require fungicide treatment. Several least-toxic fungicides are available but must be applied not later than the first sign of disease. Plant in sunny areas as much as possible, provide good air circulation, and avoid applying excess fertilizer. A good alternative is to use a slow-release fertilizer. Overhead sprinkling may help reduce powdery mildew because spores are washed off the plant. However, overhead sprinklers are not usually recommended as a control method in vegetables because their use may contribute to other pest problems. Use least – toxic fungicides that are available, including horticultural oils, neem oil, jojoba oil, sulfur, and the biological fungicide Serenade. With the exception of the oils, these materials are primarily preventive. Oils work best as eradicants but also have some protectant activity. Sulfur products have been used to manage powdery mildew for centuries but are only effective when applied before disease symptoms appear. Biological fungicides (such as Serenade) are commercially available beneficial microorganisms formulated into a product that, when sprayed on the plant, destroys fungal pathogens. The active ingredient in Serenade is a bacterium, *Bacillus subtilis,* that helps prevent the powdery mildew from infecting the plant. While this product functions to kill the powdery mildew organism and is nontoxic to people, pets, and beneficial insects, it has not proven to be as effective as the oils or sulfur in controlling this disease.

Malinias (2011) found out in her study that 37.50 ml cooking oil mixed with 1 egg yolk blended in 100 ml of water can provide protection against powdery mildew provided it was applied before the onset of the disease. The COY mixture (cooking oil plus egg yolk) was added in distilled water to bring 20L spray solution. Cooking oil and yolk mixture can be used as an alternative for fungicide because it is effective and simply prepared. It is edible and environment, thus recommended for organic production. Weed control are widely practiced in developing countries where herbicides are not available or beyond resources of the farmers. It is the preferred methods in organic agriculture. Cultural methods includes sowing of clean seed, avoiding introduction of weeds through manure, fodder, soil on transplanted crop plants and contaminated equipment or irrigation water. Immediate planting after preparation of seed bed reduces early competition from weeds. Crop rotation can be manipulated to prevent or avoid the build- up of weed problems. Physical methods include primary and secondary tillage, cutting of weeds, hand pulling or rouging which is laborious, and flooding. Biological control includes mycoherbicides particularly for perennial aquatic and rangeland species. Chemical control generally involves use of different herbicides (Waller *et al*., 2001).

MATERIALS AND METHODS

Collection of Specimens

Beans from the Bokod variety (NSIC 2009 BSnBn2) and the weeds *Galinsogaparviflora* and *Ageratum Conyzoides*infected with powdery mildew were collected from the Organic farm at Balili, La Trinidad, Benguet. These specimens were brought in the laboratory for microscopic observation.

Preparation of Mounts and Characterization of Powdery Mildew

The symptoms of powdery mildew were described based on its appearance on the actual specimens. The mounts were prepared through thin tissue sectioning and simple scraping. The structures were morphologically characterized based on its structure on the temporary and permanent mounts prepared and observed under the microscope. Characterization was done using the illustrated genera of plant pathogenic fungi in tropics (Quimio and Hanlin 1999) and the powdery mildews (Spencer, 1987) based on the following criteria: size and shape of the conidia, color of the conidia, number of conidia (borne singly or in chain), base of the conidiophore and mode of attachment of the

conidia from the conidiophores. The conidial measurement was done by the use of an ocular micrometer. There were 20 conidia measured in each specimen and the average mean was obtained.

Measurement of Conidia

The conidia were measured exactly with the use of a calibrated microscope. The ocular micrometer was inserted in the eyepiece of the microscope and the mounts of conidia were placed on the stage of the microscope. Focusing was done at the lower power objective (LPO) and shifting to the high power objective (HPO). The ocular divisions were counted from 0 µm – 100 µm as cited by Esiong (2004).

Data Gathered

1. Shape of the conidia. The observations were done based on the appearance of the conidia on the focused specimens under the microscope. It was characterized whether pointed, barrel-shaped or ellipsoidal.

2. Color of the conidia. The observations were done based on the appearance of the conidia on the focused specimens under the microscope. It was characterized whether it is hyaline, light to dark brown and others.

3. Size of the conidia. A total of twenty conidia were measured using the ocular micrometer inserted on the eyepiece of the microscope. The total mean was obtained after the measurement.

4. Number of conidia. The observations were done based on the appearance of the conidia on the focused specimens under the microscope. It was characterized whether the conidia was borne singly or in chains.

5. Base of the conidiophore. The observations were done based on the appearance of the base of the conidiophore on the focused specimens under the microscope. It was characterized whether it is twisted or not.

6. The manner of attachment of the conidiophores to the host cell. The observations were done based on where the conidiophore was attached on the focused specimens under the microscope; whether it is attached on the epidermal host cell or arises from the stomata.

RESULTS AND DISCUSSION

Characterization of Powdery Mildew Infecting French Bean and the Weed *Galinsogaparviflora*

The powdery mildew infecting French bean (Bokod variety) and the weed Galinsogaparviflora was characterized as follows (Table 1).

Table 1. Characteristics of powdery mildew infecting French bean and *Galinsoga parviflora*

CRITERIA	FRENCH BEAN (BOKOD VARIETY) AND THE WEED *G. parviflora*
Size of Conidia	16.45 to 17 µm
Shape of Conidia	Ellipsoidal
Color of Conidia	Hyaline
Number of Conidia Attached to Conidiophore	Conidia borne singly
Base of the Conidiophore	Not twisted
Attachment of Conidiophore to the Host	On host epidermal cells

Table 2 below shows the size of the measured conidia of *Oidiumpolygoni*DC.infecting French bean (Bokod variety) and the weed *G. parviflora*. Based from the result, most of the conidia of *O. polygoni*DC.on the Bokod varietymeasured 16 µm to 17 µm but some measured 15 to 18 µm (Figure 1b-c).

On the other hand, *O. polygoni*DC.on*G. parviflora* has a conidia 13, 14, 15, 18, 19 and 22 µm; although the dominant size is 16 µm (Figure 2c).

The size of the conidia measured in the study is close to the 15 µm size of conidia as cited by Dugan and Glawe (2007) (Figure 3a-b).

Table 2. Number and size of measured conidia (µm) of powdery mildew infecting French bean (Bokod variety) and the weed *G. parviflora*

NUMBER OF CONIDIA MEASURED	SIZE (µm)	
	FRENCH BEAN (BOKOD VARIETY)	*G. parviflora*
1	16	19
2	17	16
3	18	13
4	17	17
5	17	17
6	16	17
7	17	14
8	18	15
9	16	14
10	18	18
11	16	19
12	16	17
13	16	16
14	16	22
15	16	15
16	16	14
17	16	19
18	16	17
19	16	14
20	15	15
MEAN	16.45	16.4

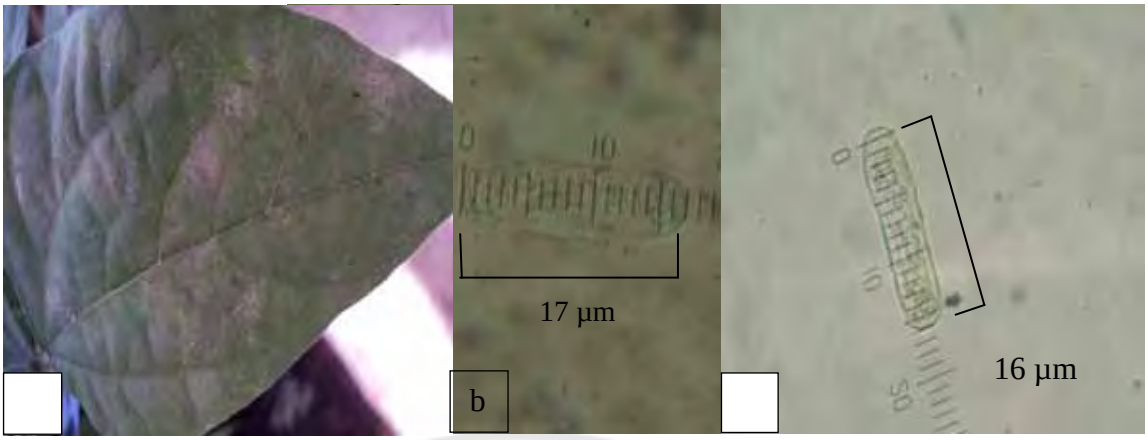


Figure 1a. Powdery mildew on French bean (Bokod variety)
b-c. Conidia of *Oidiumpolygoni*DC. (16.45-17 µm) at 400x;

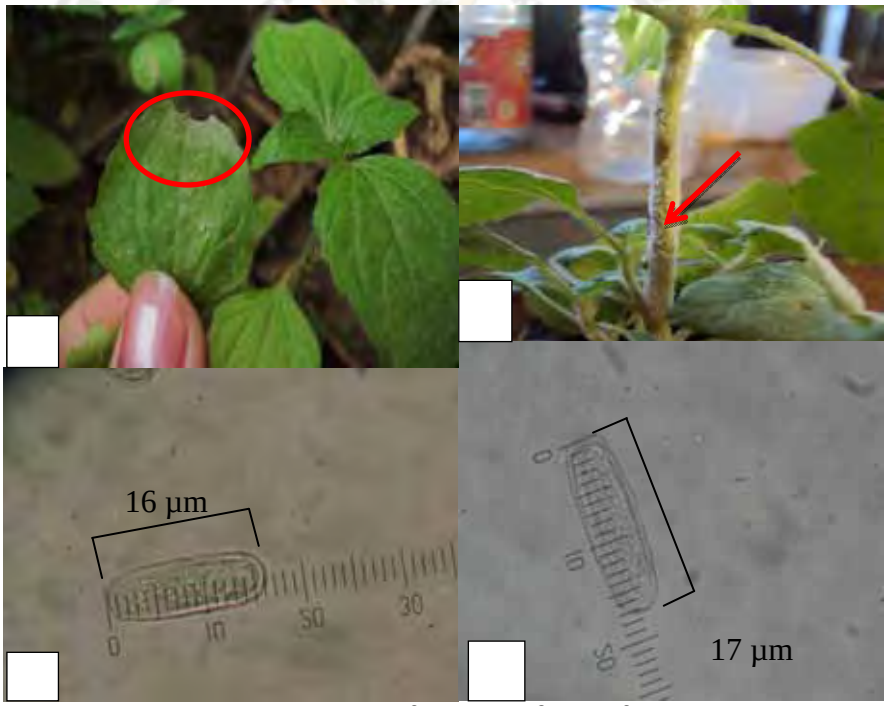


Figure 2a-b. Stems and leaves of *G. parviflora*infected with powdery mildew as shown by circle and arrow
c-d. Conidia and size (16,17 µm) of *O. polygoni*DC. infecting*G. parviflora* (400x)

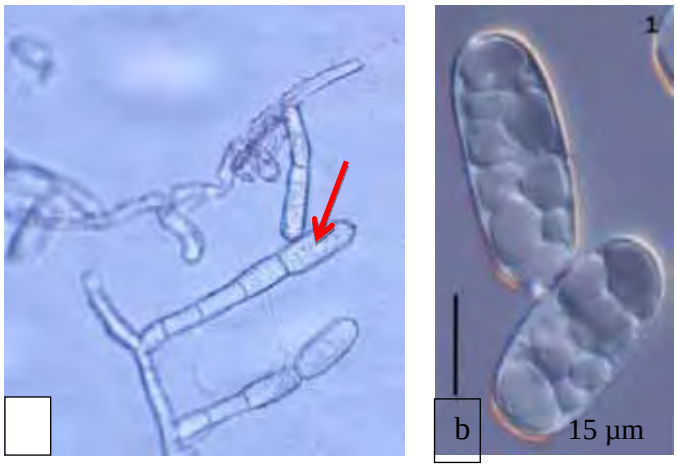


Figure 3a. Conidia attached to Conidiophore as indicated by arrow (Pantaky, 2010)
b. Conidia of *O. polygoni*DC. (15 µm) by (Dugan and Glawe,2007)

Shape of the conidia.Based on microscopic observation, the conidia of *Oidiumpolygoni* DC.areellipsoidal and hyaline as shown in Figure 4.

Figure 4.Single, ellipsoidal conidia of *O. polygoni*DC. attached to conidiophore as indicated by arrow (400x)

Base of conidiophore. It was observed that the base of conidiophore of *O. polygoni* DC.was not twisted (Figure 5).

Figure 5.Conidia of *O. polygoni*DC.attached to the Conidiophore as indicated by arrow(400x)

Mode of attachment of the conidiophore to the host cell. It was observedthat the conidiophore of the powdery from French bean (Bokod variety) and *G. parviflora*was anchored to the epidermal cell of the host or it has a superficial mycelia attached to the host cell. The conidiophore is septated (Figure 6).

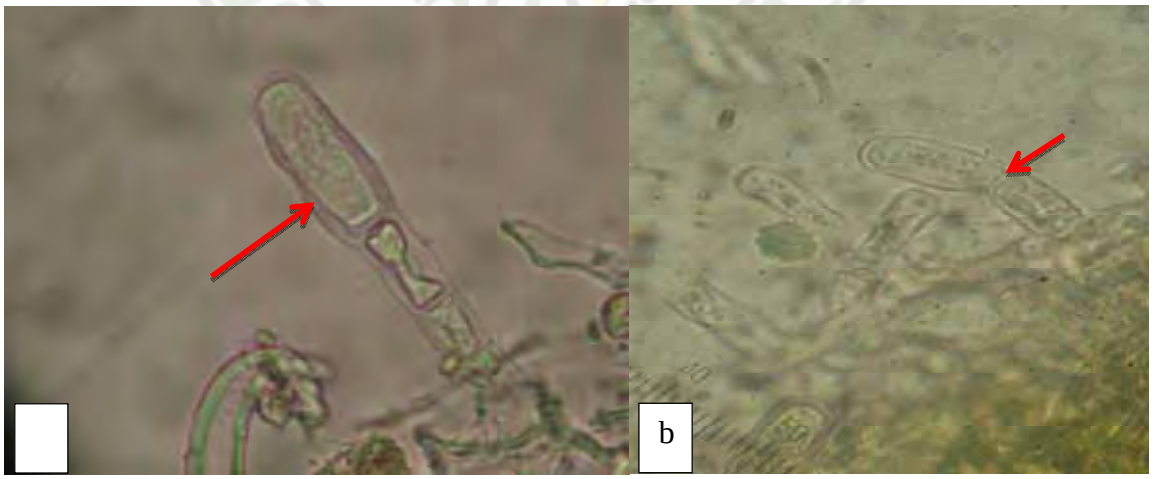


Figure 6 a. Conidiophore bearing the conidia of *O. polygoni*DC. attached to the host cell (400x); b. Conidia borne singly and detaches as it matures as shown by arrow (400x)

Characterization of Powdery Mildew
Infecting *Ageratum conyzoides*

The powdery mildew infecting *Ageratum conyzoides*was characterized as follows (Table 3.)

Table 3. Characteristics of powdery mildew infecting the weed *Ageratum conyzoides*

CRITERIA	*Ageratum conyzoides*
Size of Conidia	16.45o 17 µm
Shape of Conidia	Ellipsoidal
Color of Conidia	Hyaline
Number of Conidia Attached to Conidiophore	Conidia borne singly
Base of the Conidiophore	Not twisted
Attachment of Conidiophore to the Host	On host epidermal cells

This result was corroborated by (Quimio and Hanlin, 1990); (Dugan and Glawe, 2007) and (Spencer, 1987).

Table 4 below shows the size of the measured conidia from the powdery mildew infected leaves of *A. conyzoides*. Based the result, most of the conidia *Oidiumcichoracearum* DC.measured 11,12 and 13µm. The most dominant size is 11 µm (Figure 7).

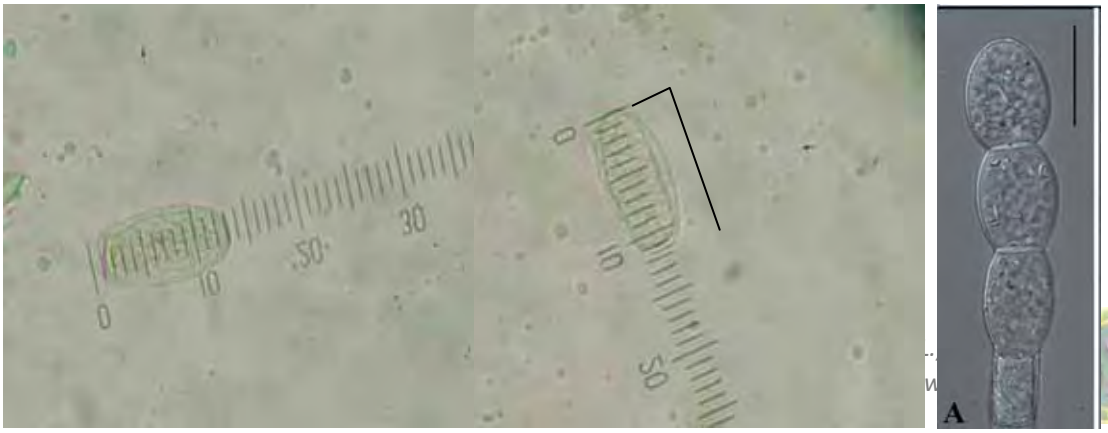
The size of the conidia measured in the study is close to the 12.5-18 µm size of conidia of *O. cichoracearum*DC. cited by (Glawe*et al*., 2006) as shown in Figure 7e.

Table 4.Number and size of measured conidia (µm) of powdery mildew on the weed *A. conyzoides*

NUMBER OF THE CONIDIA MEASURED	SIZE (µm)
1	12
2	11
3	11

4	11
5	11
6	11
7	12
8	13
9	12
10	11
11	12
12	12
13	13
14	12
15	11
16	12
17	11
18	12
19	13
20	11
MEAN	11.7

Figure 7 a-b. Powdery mildew on *A. conyzoides*



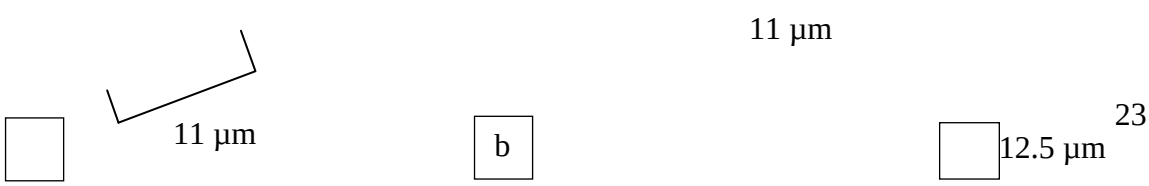


Figure 7 c-d. Conidia of Oidiumcichoracearum (400x)
e. Conidia attached to conidiophore (Glawe*et al*., 2006)

Shape of conidia. Based on microscopic observation, the conidia of *Oidiumcichoracearum*DC. are ellipsoidal and hyaline (Figure 8).

Figure 8. Ellipsoidal conidia in chain as indicated by arrow(400x)

Base of conidiophore. It was observed that the base of the conidiophore was not twisted (Figure 9a-b).

Mode of attachment of the conidiophore to the host cell. It was observed that the conidiophore of the powdery from *Ageratum* was anchored to the epidermal cell of the host. The conidiophore is septated (Figure 9a-b).

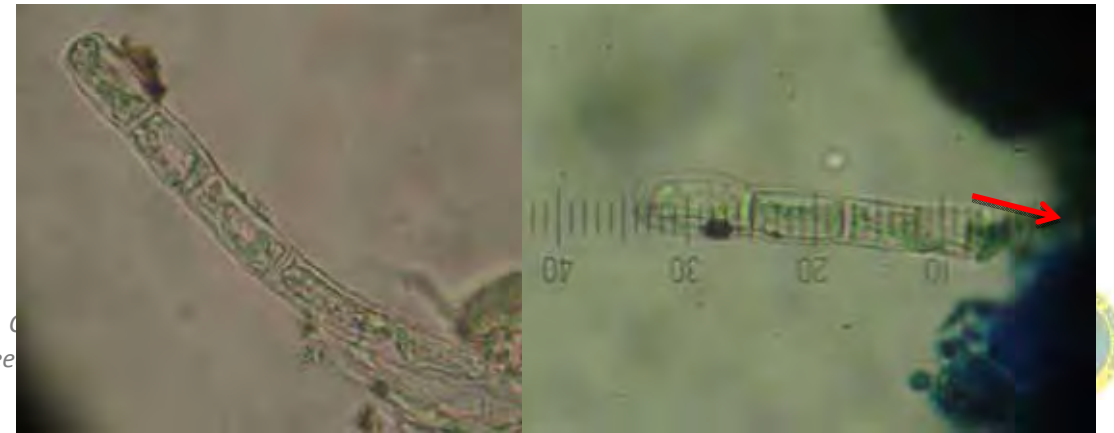


Figure 9a-b. Conidia borne in chain attached to the conidiophore that is anchored to the host cell as indicated by arrow.

Provisionary Key. Below is a simple provisionary key to separate powdery mildew genera on French bean (Bokod variety), *Galinsogaparviflora*and *A. conyzoides*using the taxonomic referred of Quimio and Hanlin(1999), Dugan and Glawe(2007) and Spencer 1987

Conidia borne singly

Conidiophore on superficial hyphae

Base of conidiophore not twisted

Conidial size ranges from 16-17 µm,

Conidia ellipsoidal

On herbaceous plants……*Oidiumpoygoni* DC.

On weeds under Asteraceae family…….*Oidiumpolygoni*DC.

Conidia borne in chain

Conidiophore on superficial hyphae

Base of conidiophore not twisted

Conidial size ranges from 11-12 µm

Conidia ellipsoidal

on herbaceous plants…….(*Oidiumcichoracearum*DC.)

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

This study aimed to characterize the powdery mildew on French bean (Bokod variety) and the weeds (*Galinsogaparviflora*and *Ageratum conyzoides*) and determine if the same type of powdery mildew infects the Bokod variety grown at BSU Experiment Station; organic farm and the weeds associated with the crop. Characterization of the powdery mildew was done by microscopic observation.

Results of the study revealed that the *Oidiumpolygoni* DC. was the type of powdery mildew that infects both the French bean (Bokod variety) and the weed *Galinsogaparviflora* while *Oidiumcichoracearum* DC. infects the weed *Ageratum conyzoides*.

The characteristics of *Oidiumpolygoni* DC.were based on the observation using the taxonomic key of Quimio and Hanlin, 1999; Dugan and Glawe, 2007 and Spencer 1987. The characteristics of *Oidiumpolygoni*DC.includes a conidia that is 16.45-17 µm, ellipsoidal in shape; hyaline and borne singly; conidiophore on superficial hyphae attached to the epidermal cell of the host and base of conidiophore not twisted. On the other hand, the characteristics of the *O. cichoracearum* DC.are the following: the conidia

measures 11.7-12 µm, ellipsoidal in shape; hyaline and borne in chain; conidiophore on superficial hyphae attached on host surface and base of the conidiophore is not twisted.

Conclusion

Based on the results, *O.polygoni* DC.and*O.cichoracearum* DC. differ in the size of conidia and number of conidia attached to the conidiophore (single or in chain). It was observed that *O.polygoni* DC. has bigger conidia ranging from 16-17 µm while *O. cichoracearum* DC. has a conidia whose size range from 11-12 µm.

Recommendation

In relation to disease management, it is recommended to eradicate the weed *Galinsoga* and *Ageratum* in the field and greenhouse especially when the crops grown are legumes which include peas, beans and cucurbits. Both harbor the powdery mildew *O.polygoni*DC and *O. cichoracearum*DC.These fungi serve as sources of inoculum for infection of legumes and cucurbits. In addition, these weeds must be disposed properly.

It is further recommended that studies be conducted on the characterization and identification other weeds serving as alternative host of powdery mildew diseases.

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