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# Inoculum source of *Phytophthora palmivora*, jackfruit seedlings health in response to potting media porosity, sanitation, inoculation and phosphonate application

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## Abstract

Seedling dieback caused by *Phytophthora palmivora* (Butler) is a significant problem in jackfruit (*Artocarpus heterophyllus* Lam.) nurseries in Eastern Visayas, Philippines. It has been linked to insufficient knowledge of inoculum sources and possible factors contributing to seedlings' health. This study was conducted to identify potential sources of *Phytophthora* inoculum in representative nurseries in Eastern Visayas and evaluate the effect of possible factors that contribute to seedling health. *Phytophthora* detection was conducted from random samples of potting media, irrigation water, germination beds, and roots of seedlings from representative nurseries supplying seedlings in the region. Detection was done through tissue baiting and the use of a *Phytophthora*-specific diagnostic kit. The effect of the air-filled porosity (AFP) of potting media, sanitation, pathogen inoculation, and phosphonate on plant growth and seedlings' health was evaluated. *Phytophthora* propagules were positively detected in most samples, suggesting that seedlings most likely already harbor the pathogen when distributed to farms in the region. Among the factors, AFP of the potting medium had the most profound effect on seedlings' growth and health. The tallest plants with the largest stem diameter, highest dry weight biomass, and least disease rating were grown in the most porous medium (21 % AFP) consisting of 20 % garden soil, 20 % carbonized rice hull, 20 % rice hull, 20 % coco coir dust, 10 % sand, and 10 % chicken dung. The benefit of a highly porous medium was, however, seen only when external fertilization was undertaken. Unsterilized media resulted in healthier seedlings compared to sterilized media. Sterilized potting media that were inoculated with the pathogen after sterilization resulted in more severe disease. Sterilized potting media was beneficial for jackfruit seedlings when supplied with adequate nutrients and as long as contamination with the pathogen does not occur. Sterile media, therefore, should be kept away from recontamination with the pathogen otherwise more severe disease may occur. The addition of the plant defense regulator phosphonate showed no effect on the growth and health of seedlings under the trial's conditions.

**Key words**: *Phytophthora*, jackfruit, seedling dieback, porosity, sanitation, inoculation, phosphonate

## Introduction

Jackfruit (*Artocarpus heterophyllus* Lam.) is an important fruit crop in the tropics with various uses. It is mostly eaten as fresh ripe fruit or preserved. It can also be used as a vegetable when green, feed for animals, wood for timber and lumber, and some used as medicine (Haq, 2006). Jackfruit is widely grown in the Philippines (Acedo, 1992; Lina, 2012), but the production volume has continuously declined from 46,099 metric tons in 2013 to 43,666 metric tons in 2015 and 41,591 metric tons in 2018 (PSA, 2019). There was a minimal increase in area planted from 14,419 ha in 2008 to 14,526 ha in 2013, with an average annual growth rate of 0.15 % (Espino and Espino, 2018). The average yield slightly declined from 3.59 tons $ha^{-1}$ in 2008 to 3.17 tons $ha^{-1}$ in 2013 at an average annual rate of 2.45 %.

A significant constraint to local jackfruit production is tree decline, a disease caused by *Phytophthora palmivora* (Butler), which devastated large scale plantations in Eastern Visayas (Borines *et al.*, 2014; Daniel *et al.*, 2014). Symptoms include leaf yellowing, dieback, wilt, and tree death. Seedling dieback due to the same pathogen is also rampant in local nurseries. Poor nursery management practices, inherent susceptibility of 'EVIARC Sweet,' the recommended variety, and lack of adequate, environment-friendly chemicals for disease control have resulted in the disease being a severe threat to jackfruit nurseries producers. It is common among farmers that the field infection may have started in seedlings and nurseries; thus, there is a need to confirm the possible sources of *P. palmivora* inoculum in the nursery and identify the factors that lead to high incidence.

*Phytophthora* infection is linked to high relative humidity and free moisture for the spores' encystment and germination (Drenth and Guest, 2014). The factors tentatively identified that contribute to high disease incidence in nurseries, include the inherent presence of the pathogen in local nurseries, high moisture content, less porous and unsanitized potting medium, and the lack of a compound that potentially control the pathogen. A formal investigation of the effect of these factors on jackfruit seedling health is lacking.

A compound that has been reported effective against *P. palmivora* in jackfruit trees is potassium phosphonate (AGRI FOS®) 600); Daniel *et al.*, 2014; Borines *et al.*, 2013), but it is not

commercially available in the Philippines. A similar compound Phospro (4-40-2), N-$P_2O_5$-$K_2O$ + 887 g $L^{-1}$ Potassium Phosphite, became available during this research. As yet, the formulation has not been tested to control *P. palmivora* in jackfruit.

This paper reports on identifying the likely sources of inoculum in representative jackfruit nurseries and the results of the evaluation of the effect of sanitation, inoculation, phosphonate, and air-filled porosity of potting media on the growth and health of jackfruit seedlings. The information will justify the need for improving jackfruit nursery practices and produce healthy planting materials, thus reducing the negative impact of the disease in the orchard.

## Materials and methods

**Nursery detection of *P. palmivora*:** Samples of potting mixes, soil from germination beds, roots of jackfruit seedling, and irrigation water were collected from Department of Agriculture-Abuyog Experiment Station (DA-AES), Abuyabor's farm in Mahaplag and Visayas State University (VSU) in Leyte, San Jorge Experiment Station and Pedroso's farm in San Jorge and Calbayog, Samar, respectively.

Samples were placed in sterile containers and brought to the Plant Disease Diagnostic Laboratory (PDDL, VSU) for *P. palmivora* baiting and detection. Flower petals of *Catharanthus roseus* freshly washed and disinfected with 1 % NaOCl were used as baits for *Phytophthora*. Two to three days later, petal baits were examined under the microscope for the presence of the pathogen's vegetative and reproductive propagules. A *Phytophthora*-specific detection kit (Pocket Diagnostic®) was further used to confirm the pathogen's presence.

**Air-filled porosity (AFP) of potting media and its effect on seedling health:** Potting media mixes were procured from DA-AES Station nursery, the primary source of jackfruit seedlings in the region. The potting mixes were brought to VSU, where media with different air-filled porosities (AFPs) were generated by varying amounts of alluvial soil, partially decomposed rice hull, carbonized rice hull, and chicken dung. The potting media used at VSU fruit nursery was also included.

Two AFP trials were conducted. In the first trial, only the AFP of the potting medium was the variable. Media with different AFPs were prepared following the Australian Standard AS3743 (2003) catalog. They were sterilized for two hours for two consecutive days, planted with germinated jackfruit seeds, 'EVIARC Sweet,' and maintained in the screen-house for 30 days before inoculation with *P. palmivora*. The inoculum was first grown in onion agar (200 g of sliced, peeled onion bulbs boiled in one L water + 17 g agar) and mass-produced in sterile mungbean seeds for 14 days and introduced to the base of each seedling.

The specific potting media treatments, their AFPs and percentage composition were the following: T1) DA1 - (AFP 16.39 %) -72 % soil, 14 % rice hull, 7 % carbonized rice hull and 7 % chicken dung; T2) DA2 – (AFP 22.13 %) – 60 % soil, 20 % rice hull, 13 % carbonized rice hull and 7 % chicken dung; T3) DA3 (AFP 27.49 %) – 50 % soil, 25 % rice hull, 18 % carbonized rice hull and 7 % chicken dung; T4) DA4 – (AFP 29.46 %) – 40 % soil, 30 % rice hull, 23 % carbonized rice hull and 7 % chicken dung; T5) DA5 – (AFP 34.40 %) – 30 % soil, 35 % rice hull, 28 % carbonized rice hull and 7 % chicken dung; T6) DA6 – (AFP 3.42 %) – 93 % soil and 7 % dried chicken dung; and, T7) VSU (control) – (AFP 16.47 %) – 25 % soil, 25 % rice hull matting for poultry, 25 % fly ash and 25 % mudpress.

The treatments were arranged in a Completely Randomized Design (CRD) with six replications per treatment with one seedling per replicate. The plants were watered daily, but no external fertilizer was added. Plant height and plant health ratings were gathered weekly using the following disease rating scale: 1-no disease/healthy; 2- the presence of pin-sized water soak lesion on leaves; 3-discoloration (yellowing) and or drooping of leaves; 4-drying of leaves to leaf defoliation, and 5-totally wilted/dead. Data were subjected to ANOVA, and treatment means were compared using Tukey's HSD.

**Effect of potting media porosity, sterilization, inoculation, and phosphonate on seedling health:** Another AFP trial was conducted with additional variables (*i.e.,* potting media sanitation or sterilization, inoculation, and phosphonate on growth and seedling health. The same potting media mixes were procured from DA-AES, but only three AFP treatments were formulated (*i.e.,* 4 %, 11 %, and 21 %). The specific treatments are combinations of the following, arranged in 2x2x2x3 split-split-plot with six replications with one seedling per replicate: Factor A-Sterilization (A1- Unsterilized, A2- Sterilized); Factor B- Phosphonate **(**B1- No Phosphonate, B2- With Phosphonate; Factor C –Inoculation **(**C1-Uninoculated, C2-Inoculated**);** Factor D- Potting media Air Filled Porosity and composition (DA1 - AFP- 4 % - 90 % garden soil + 10 % chicken dung), (DA2 - AFP- 11 % - 30 % garden soil + 30 % carbonized rice hull + 30 % sand + 10 % chicken dung), and, (DA3- AFP- 21 % - 20 % garden soil + 20 % carbonized rice hull + 20 % rice hull + 20 % coco coir dust + 30 % sand + 10 % chicken dung).

The phosphonate used was PhosPro-4-40-2, N $P_2O_5$ $K_2O$ + 887 g $L^{-1}$ Potassium Phosphite) from Sagrex Corporation. Soil pH and electrical conductivity (EC) of the different potting mixes were determined using a pH and electrical conductivity meter. Sterilization was done by soil steaming at 80 °C for an hour for two consecutive days. The media were potted in labeled 7.6 x 7.6 x 20.3 cm standard polybags. One germinated jackfruit seed (EVIARC Sweet variety) was transplanted into each pot and maintained in the greenhouse. All plants were watered two times daily with 100 mL water and received two g Osmocote (14-14-14) starting one week after transplanting and monthly after that until the 6th month. A weekly foliar fertilizer, Supergrow (15-15-30 +ME) at 6 g $L^{-1,}$ was sprayed to run-off applied early in the morning.

*P. palmivora* inoculation was done by adding four pieces of nine mm onion agar discs of the 4-day old culture of the pathogen grown in onion agar. The inoculum was applied upside down on the potting mix's surface at four equidistant points near the stem base. Another treatment consisted of spraying phosphonate at two m $L^{-1}$ water on designated plants at one month after transplanting and monthly after that until the 5th month from planting. The data gathered includes growth parameters such as plant height, stem diameter initiated two weeks after transplanting, and monthly after that. Plant health was assessed monthly using the disease rating scale described in the first trial. Oven dry weight biomass

was also taken at the termination of the experiment at six months after transplanting.

## Results and discussion

**Sources of *Phytophthora* inoculum in the nursery-** *P. palmivora* was detected in most samples taken from different jackfruit nurseries and farms in Samar and Leyte, Philippines (Table 1; Fig. 1). *Phytophthora* zoospores, sporangia, and mycelia were detected in all nurseries sampled except for samples from San Jorge, Samar nursery. Positive and negative control samples from the PDDL laboratory confirmed that the baiting and diagnostic kit techniques were accurate. The VSU nursery seedling potting mix was also *P. palmivora* positive, and the irrigation water (faucet) tested negative and the faucet sample at PDDL-VSU. At Pedroso's farm in Calbayog, all samples (potting mix, germination bed, and water from well 1 and 2) tested positive. At the DA-AES nursery, potting mixes 1 and 2, and soil from the germination bed tested positive. Only one of three water samples (faucet 1) tested positive. At the DA San Jorge nursery, both water samples and a jackfruit root sample tested negative, whereas seedling from DA-AES, seedling roots from Abuyabor Farm tested positive. DA-AES jackfruit nursery is the primary source of jackfruit seedlings in major jackfruit farms in Leyte and Samar farms and is reported having a high incidence of jackfruit decline (Borines *et al.,* 2014). The nurseries are selling jackfruit seedlings to the public.

Table 1. *P. palmivora* detection results in various samples in selected nurseries in Samar and Leyte Philippines

| Type of sample | Source | Flower bait | Diagnostic kit |
|---|---|---|---|
| Negative control (sterile water) | PDDL laboratory | (-) | - |
| Positive Control (*P. palmivora* (VSU007) | PDDL laboratory | (+ ) | + |
| Seedling potting medium | VSU Nursery | (+) | + |
| Irrigation water (faucet) | VSU Nursery | (-) | - |
| Potting Mix | Calbayog, (Pedroso Farm) | (+) | + |
| Soil from Germination Bed | Calbayog, (Pedroso Farm) | (+) | + |
| Irrigation water (shallow open well1) | Calbayog (Pedroso farm) | (+) | + |
| Irrigation water (shallow open well2) | Calbayog (Pedroso farm) | (+) | + |
| Potting Mix 1 | DA-AES nursery Abuyog | (+ ) | + |
| Potting Mix 2 | DA-AES, nursery Abuyog | (+) | + |
| Soil germination bed | DA-AES, nursery Abuyog | (+) | + |
| Irrigation water (faucet 1) | DA-AES, nursery Abuyog | (+) | + |
| Irrigation water 2 (faucet 2) | DA-AES, nursery Abuyog | (-) | - |
| Irrigation water 3 (faucet 3) | DA-AES, nursery Abuyog | (-) | - |
| Roots of Seedling | Mahaplag (Abuyabor's Farm) | (+) | + |
| Roots of Seedling | DA nursery San Jorge | (-) | - |
| Irrigation water 1 (barrel 1) | DA nursery San Jorge | (-) | - |
| Irrigation water 2 (barrel 2) | DA nursery San Jorge | (-) | - |
| Water (faucet) | PDDL, VSU | (-) | - |

This simple detection activity confirmed that seedlings sold to the public from jackfruit nurseries are sources of *P. palmivora*. Pre-infection of seedlings may be contributing to a high incidence of tree decline and dieback in jackfruit orchards in the region. It called for an identification of the factors that might contribute to jackfruit seedling health.

**Effect of Air-filled porosity of potting media on jackfruit seedlings' growth and health**: Data was collected only on plant height (cm) and plant health ratings in the first AFP trial. Significant differences in mean plant height and health rating of seedlings was observed at three months after injection. DA6, the least porous potting medium (AFP 3.4) containing 93 % soil and 7 % dried chicken dung) produced the tallest (94.1 cm) and the healthiest seedlings (Table 2). On the other hand, the highly porous media from DA-AES (DA4-29.5 % AFP and DA5 (34.4 % AFP) produced the shortest seedlings and with high disease severity, as well as in VSU0 potting mix (16.5 % AFP).

This trial's results contradicted the expected benefits of high

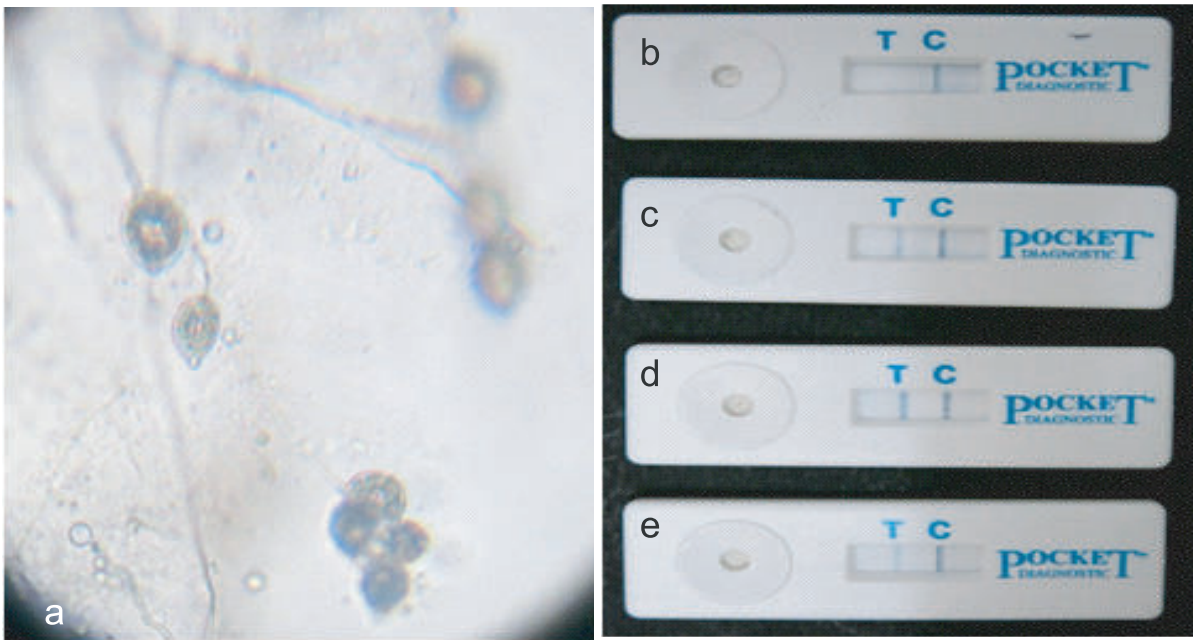


Fig.1. a. *P. Palmivora* sporangia, hyphae and encysted zoopores from *C. roseus* flower bait as seen under the compound microscope (400x) and *Phytophthora* confirmation using Pocket diagnostic kit (b- negative control (Sterile water), c- Positive Control (*Phytophthora* VSU007 isolate), d- Potting mix from VSU Nursery, e-Potting Mix at DA-RIARC, Abuyog, Leyte, Philippines).

Table 2. Mean plant height, stem diameter, and plant health rating at three months after inoculation as affected by different AFPs

| Air-filled porosity (%) | Plant height (cm) | Plant health rating* |
|---|---|---|
| DA6 (3.4) | $94.1_{a}$ | $1.50^{b}$ |
| DA5 (34.4) | $57.1_{bc}$ | $3.50^{a}$ |
| DA4 (29.5) | $38.1_{c}$ | $4.67^{a}$ |
| DA3 (27.5) | $80.3_{ab}$ | $2.83^{ab}$ |
| DA2 (22.1) | $87.9_{a}$ | $2.83^{ab}$ |
| DA1 (16.4) | $72.7_{ab}$ | $3.50^{a}$ |
| VSU0 (16.5) | $35.6_{c}$ | $4.67^{a}$ |
| CV | 20.6 | 15.79 |

Means within a column followed by the same letter are not significantly different at 5 % Tukey's HSD.

*Rating Scale: 0 = no disease, 1 = mild loose of turgidity and mild yellowing, 2 = moderate yellowing, 3 = severe yellowing, 4 = defoliated leaves and 5 = dead.

porosity to plants. The suspected cause for the contrary result is that the least porous media (DA6 – 93 % soil and 7 % manure) has a higher moisture-holding capacity and nutrient supply for the duration of the trial. Although better from a plant growth perspective, the more porous mixes require regular watering and fertilizer to deliver. In this trial, the highly porous potting medium did not produce the healthiest seedlings because no external fertilizer was added to the media. Rice hull and carbonized rice hull are the materials used by DA-AES as fillers for their potting media, which are not augmented with fertilizers other than 10 % chicken dung; hence seedlings distributed to farmers may not be at their optimum health.

The medium's porosity's beneficial effect was demonstrated in the second trial, where acceptable nursery management practices were utilized and included, such as potting media sterilization, phosphonate application, and the regular addition of fertilizer. Pathogen inoculation was included as one of the factors. The second experiment was purposely arranged in split-split-plot design to see the individual effects of the said factors and possible interaction among them.

**Air-filled porosity of potting mixes, sterilization, inoculation and phosphonate application effect on seedling health:** In the second trial, only three potting mixes with varying AFPs were formulated, which represented a low, medium, and high porosity (4 , 11 and 24 % AFP, respectively). The pH, electrical conductivity and water holding capacity of the new formulated potting media are shown in Table 3.

All potting mixes have favorable pH (pH 6.0-6.8), but only potting mix 1 and 3 had good electrical conductivity (EC 1.3 and 1.0 dS $m^{-1}$; Table 3) based on values considered favorable by Tripepi (2018). The optimum electrical conductivity (EC) value for seedlings lies in the range of 0.75-1.99 dS $m^{-1}$ (suitable for seedlings and media with high organic matter) and 2.0-3.45 $m^{-1}$ (satisfactory for most plants except sensitive ones). Simultaneously, the soil pH for a mineral soil has maximum nutrient availability around pH 6.0 to 6.8. In terms of porosity, the DA2 potting mix (11 % AFP) has met the optimum minimal porosity. In comparison, the DA3 potting mix (24 % AFP) was the most favorable based on Meyer and Cunliffe's standard (2004) and which also had the highest water holding capacity (99.9 %).

Table 3. pH, electrical conductivity, and water holding capacity of the formulated potting mixes

| Air filled porosity (%) | pH | Electrical conductivity (dS/m)* | Water holding capacity (%) |
|---|---|---|---|
| DA1 (4.0) | 6.1 | 1.3 | 70.8 |
| DA2 (11) | 6.8 | 0.7 | 66.2 |
| DA3 (21.0) | 6.0 | 1.0 | 99.9 |

*deci-Siemens/meter

The effect of sanitation, inoculation, phosphonate, and porosity on plant height, stem diameter, oven-dry weight biomass, and plant health rating and jackfruit seedlings is summarized in Table 4. The potting media's sterilization showed no significant effect on plant height, but jackfruit seedlings grown in the unsterile medium were healthier because of bigger stem diameter, higher dry weight biomass, and better plant health rating than seedlings grown in a sterile medium.

Pathogen inoculation and phosphonate showed no significant effect on stem diameter, disease rating, and dry weight of seedlings, but the media's porosity affected all the dependent variables measured. DA3, the most porous medium (21 % AFP), produced the tallest plants, the biggest stem diameter, and the significantly highest oven-dry weight. Although no significant difference was observed on plant health rating among the three different porosities, DA3 still had the lowest disease rating and the fact that it gave the tallest seedlings with bigger stem diameter and highest dry weight, it was considered as the best in producing the healthiest seedlings. This result agrees with the most favorable porosity standard according to Meyer and Cunliffe (2004).

Interaction effects were observed between the medium's porosity and sanitation on stem diameter, total dry weight and plant health rating of seedlings (Table 5). The stem diameter increased significantly from 4.8 mm at 4 % AFP to 7.4 mm at 21 % AFP in the unsterilized media but remained unchanged in the sterilized media. The unsterilized media appeared to confer a growth

Table 4. Mean plant height (cm) of jackfruit seedling as affected by sterilization, inoculation phosphonate and AFP of the potting medium at 6 months after inoculation

| Treatment | Plant height (cm) | Stem diameter (cm) | Total dry weight biomass (g/plant) | Plant health rating* |
|---|---|---|---|---|
| A. Sanitation | | | | |
| A1- Unsterilized | 39.7 | $0.6^{a}$ | $16.0^{a}$ | $2.0^{b}$ |
| A2- Sterilized | 37.5 | $0.5^{b}$ | $6.1^{b}$ | $2.8^{a}$ |
| B. Inoculation | | | | |
| B1- Uninoculated | 38.2 | 0.5 | 10.7 | 2.2 |
| B2- Inoculated | 39.1 | 0.5 | 11.0 | 2.7 |
| C. Phosphonate | | | | |
| C1- No Phosphonate | 39.4 | 0.5 | 11.3 | 2.6 |
| C2- With Phosphonate | 37.8 | 0.5 | 10.8 | 2.3 |
| D. Air filledporosityy | | | | |
| DA1- 4 % AFP | $33.8^{c}$ | $0.4^{b}$ | $8.6^{b}$ | 2.4 |
| DA2 - 11 % AFP | $38.0^{b}$ | $0.5^{b}$ | $9.4^{b}$ | 2.7 |
| DA3 - 21 % AFP | $44.0^{a}$ | $0.6^{a}$ | $15.2^{a}$ | 2.2 |
| CV. (%) | 22.5 | 22.5 | 52.1 | 26.8 |

Means with the same letter are not significantly different at 5 % level of significance using Tukey's HSD.

*Rating Scale: 0 = no disease, 1 = mild loose of turgidity and mild yellowing, 2 = moderate yellowing, 3 = severe yellowing, 4 = defoliated leaves and 5 = dead.

advantage as measured by stem diameter and total dry weight. Yet, in terms of disease rating, the most porous medium produced the healthiest trees. The least disease rating was shown by plants in the treatment 21 % AFP – unsterilized media. It indicates that the most porous medium produced the healthiest seedlings. The medium's benefits are illustrated in this AFP trial, where external fertilizers were supplied to the seedlings.

Table 5. Interaction effect between porosity and sanitation on stem diameter (mm), porosity and sanitation on disease rating and porosity and mean dry weight (g) of seedlings at 6th month after planting.

| Porosity/ Sanitation | Stem diameter (mm) | | Total dry weight (g/plant) | | Plant health rating* | |
|---|---|---|---|---|---|---|
| | Unsterile | Sterile | Unsterile | Sterile | Unsterile | Sterile |
| DA1-4 % AFP | 4.8$^{b}$ | 3.9 | 9.8$^{bA}$ | 3.4$^{B}$ | 1.8$^{abB}$ | 3.6$^{aA}$ |
| DA2-11 % AFP | 5.2$^{b}$ | 5.1 | 9.3$^{b}$ | 4.9 | 2.5$^{a}$ | 2.5$^{b}$ |
| DA3-21 % AFP | 7.4$^{aA}$ | 4.7$^{B}$ | 18.0$^{aA}$ | 5.5$^{B}$ | 1.5$^{b}$ | 2.3$^{b}$ |

Means in a column with the same small letter are not significantly different at 5 % level of significance. Means in a row with the same capital letter not significantly different at 5 % level of significance.

*Rating Scale: 0 = no disease, 1 = mild loose of turgidity and mild yellowing, 2 = moderate yellowing, 3 = severe yellowing, 4 = defoliated leaves and 5 = dead.

Media sterilization did not result in healthier seedlings, as demonstrated in this trial. We speculate that the sterilization process may have killed beneficial microorganisms, which resulted in the media devoid of potential antagonists for *P. palmivora* that was introduced to the media after sterilization. It was further supported by an interaction effect between media sterilization and *P. palmivora* inoculation.

Significantly higher disease ratings occurred in seedlings grown in the inoculated sterilized medium (3.1) compared to the inoculated but unsterilized medium (1.9; Table 6). The disease rating in the sterilized and unsterilized uninoculated media was lower and not significantly different. Still, in the sterilized medium, the disease rating significantly increased in the inoculated media. Again, it was due to the post-sterilization inoculation of the *P. palmivora,* which allowed it to increase freely because all other microflora were killed during sterilization which could have competed with or antagonized the pathogen.

Table 6. Interaction effect between pathogen inoculation and plant health rating* of jackfruit seedling to plant health rating.

| Treatment | Unsterilized | Sterilized |
|---|---|---|
| Uninoculated | 2.3 | 2.0$^{b}$ |
| Inoculated | 1.9$^{B}$ | 3.1$^{aA}$ |

Means in a column with the same small letter are not significantly different at 5 % level of significance. Means in a row with the same capital letter not significantly different at 5 % level of significance.

*Rating Scale: 0 = no disease, 1 = mild loose of turgidity and mild yellowing, 2 = moderate yellowing, 3 = severe yellowing, 4 = defoliated leaves and 5 = dead.

This observation implies that plants produced in sterile media are of greater risk if contaminated by *P. palmivora*. It signifies the impact of preventing sterile media from recontamination. Daniel *et al.* (2014) and Borines *et al.* (2013) made suggestions on protecting the seedlings from pathogens. The result also suggests that the soil's suppressiveness in the potting medium may be more important in conditions of possible recontamination of the medium after sterilization.

The lower disease rating on the unsterilized but inoculated medium is also an effect of porosity. As discussed previously, even with the inoculum in unsterile media, seedlings grown in more porous media (DA3) were healthier. DA3 had 21 % AFP, favorable EC, favorable pH, and the highest water holding capacity. Such a condition makes plants' roots less stressed and may make it able to withstand the pathogen.

The addition of phosphonate had no effect on seedlings' growth and health status under the study's conditions despite reports of its effectiveness against *P. palmivora* either as antifungal or resistance inducer (Guest and Grant, 1991). Borines *et al.* (2013) reported phosphonate's effectiveness in reducing jackfruit decline caused by P. *palmivora* in the field. However, the phosphonate used in the trial was different, *i.e.,* potassium phosphonate (AGRI FOS® 600) and applied to trees as a spray with Pentrabark (a bark penetrant). In contrast, in this trial, Phospro (4-40-2) was applied as a soil drench. According to Adams and Conrad (1953) and Malacinski and Konetzka (1967), in the soil, phosphonate is oxidized to phosphate more rapidly by soil microbes and caused a delayed response of plants phosphonate application. In avocados, optimum control of *Phytophthora cinnamomi* root rot was achieved by trunk injection (Whiley *et al.,* 1986). Furthermore, it is also reported that phosphonate may be less productive if the disease is already well established and has more efficiency for preventive rather than therapeutic activity. In this experiment, inoculation was done two weeks in advance before spray application of phosphonate such that it was expected that the disease had been fully established already before phosphonate was applied.

The study discovered that *P. palmivora* was already present in seedlings distributed to farms in the Eastern Visayas region of the Philippines. The potting medium's air-filled porosity (AFP) had the greatest impact on seedling growth and health. Tallest plants had the largest stem diameter, highest dry weight biomass, and lowest disease rating in the most porous medium (21 percent AFP). However, the benefit of a porous medium was only seen when external fertilisation was used. When properly nourished and pathogen-free, sterilised potting media is beneficial for jackfruit seedlings.

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