COMBINED EFFECTS OF BOTANICALS ON MYCELIAL GROWTH OF PATHOGENIC FUNGI OF MAIZE - *ZEA MAYS* L.

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Abstract: Several botanical extracts have been evaluated singly on many pathogenic fungi causing diseases of maize (*Zea mays* L.), but their combined effect is yet to be evaluated. This study investigates the combined effect (in vitro) of Rice Husk Extract (RHE), Wood Extract (WE) and Bamboo Extract (BE) at different levels of concentration (0.0, 0.1, 0.5, 1.0 and 1.5%) on *Fusarium oxysporum, F. equiseti, F. solani, F. verticillioides, Macrophomina phaseolina*, *Curvularia lunata*, *Dreschlera* sp. and *Bipolaris maydis*. The treatment combinations (RHE *x* BE, RHE *x* WE, BE *x* WE and RHE *x* BE *x* WE) were prepared in a completely randomized design. Combination of RHE *x* BE *x* WE completely inhibited the mycelial growth of all the fungal pathogens at 1.5% concentration level compared to 0.5 and 1.0%. Similarly, combination of RHE *x* WE completely inhibited the mycelial growth of *F. equiseti, F. verticilloides, M. phaseolina*, *Dreschlera* sp. and *B. maydis*. Combined effect of RHE *x* BE and that of BE *x* WE showed significant ($p<0.05$) reduction in mycelial growth of the fungal pathogens. Thus, these botanical extracts at 1.5% concentration level could be useful in the control and management of maize diseases on large scale farming.

Keywords: Maize; Extracts; Pathogenic fungi; Concentration; Botanicals

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereals in the world after wheat and rice with regards to cultivation area and total production (Akinbode, 2010). Diseases had been a major constraint to maize production among which are downy mildew, rust, leaf blight, stalk and ear rots, leaf spot, maize streak virus, seedling root rot, stalk rot, and collar rot of seedlings (Andrés-Ares *et al*., 2004). Diseases affecting maize plants reduce the value and quality of the maize grains produced (Lamprecht *et al.* 2008) and may definitely increase the cost of harvesting. There are diverse diseases of maize which include but are not limited to seed rots and seedling blights (Crous *et al.* 2006), Northern corn leaf blight, Anthracnose, *Pythium* and *Fusarium* root rot and Southern rust (Gautan and Stein, 2011). Attempts have been made to develop maize cultivars that are resistant to diseases, and many other control measures have also been used to check fungal diseases of maize. Various approaches have been used over many decades to control maize diseases which include breeding for resistance and chemical pesticides (Tagne *et al*., 2008). The problems of chemical pesticides include resistance, pest resurgence, environmental pollution, and risks to human health. Most of the pesticides and inorganic fertilizers are not environmentally friendly, apart from the fact that health hazards may loom as a result of the consumption of their residues in food. These agrochemicals are expensive and may not be available for farmers use when needed. Also, there are legislations against massive use of agrochemicals in crop protection (Oyekanmi *et al*., 2008).

In view of this, national and international bodies have raised a global call to promote maize production through biological approaches, being environmentally friendly and cost-effective (Abiala *et al*., 2011). The control of maize diseases is very important as a

complementary technology to boost maize production. Biological control is on the increase but the use of natural bioprotectants like botanical extracts has not really received significant attention. Therefore, encouraging the use of botanical extracts as a promising alternative is a good step towards the controlling and managing of fungal pathogens of maize in Nigeria. Rice husk, bamboo and wood extracts have been used singly and reported to be effective on mycelial growth of *Mycosphaerella fijiensis* Morelet (Abiala *et al*., 2011). Similarly, rice husk extract alone was also reported by Killani *et al*. (2011) to be effective in vitro and in vivo on pathogenic fungi isolated from rhizosphere soil of cowpea. To further support the effectiveness of rice husk, bamboo and wood extracts, this study basically focused on effects of combinations of botanical extracts on mycelia growth of fungal pathogens of maize (in vitro) prior to field application.

MATERIAL AND METHODS

Source of fungal pathogens and source of plant extracts

F. oxysporum, F. solani and *F. equiseti* were obtained from Plant Pathology Unit, Department of Botany, University of Ibadan, while *M. phaseolina*, *C. lunata*, *Drechslera* sp., *F. verticilloides* and *B. maydis* were obtained from the Plant Pathology Unit of Institutes of Agricultural Research & Training, Ibadan. The plant extracts: rice husk, wood and bamboo extracts were obtained from Dr. H. Kikuno of Plant Physiology Unit, International Institute of Tropical Agriculture (IITA) Ibadan.

Evaluation of plant extracts

One liter Potato Dextrose Agar (39 g/l) was prepared in media bottle and dispensed at varying volumes of 99.9ml, 99.5ml, 99ml, 98.5ml, and 100ml into 250ml sterile conical flasks. The contents were sterilized in the autoclave at temperatures of 121^{o}C for 15 minutes at 1.2 bars. After autoclaving, the medium was allowed to cool to the temperature of 45^{o}C. Equal volume of RHE, BE and WE were combined to make different treatment combinations; RHE *x* BE, RHE *x* WE, BE *x* WE and RHE *x* BE *x* WE. Thereafter, 0.1ml, 0.5ml, 1.0ml, and 1.5ml of each of the combined botanical extracts were aseptically pipette with a calibrated 250ml pipette into sterilized PDA medium to represent concentration of 0.1, 0.5, 1.0, and 1.5% respectively. These were slowly mixed together by rolling each bottle in the palm to allow homogenous mixture of medium and the extract. Fifteen milliliters (15ml) of this mixture was poured aseptically and in three replicates into 9cm sterile disposable Petri dishes and allowed to solidify at room temperature inside the laminar flow hood. Mycelial disc of young actively growing cultures of each pathogen was cut separately with a sterile cork borer and inoculated at the center of already prepared plates containing the mixture (botanical extracts+medium) and the control plates (medium alone). The experiment was carried out in three replicates. The plates were incubated at 28±2^{0}C and periodically observed at 3 days interval for nine days to allow antagonist-pathogen interactions.

Data collection and statistical analysis

Laboratory data were collected on the 3rd, 6th, and 9th days. The mycelial growth diameter (cm) of each pathogen was measured and the percentage growth inhibition was calculated according to Awuah (1989) and Odebode *et al*. (2004) as follows:

$$\% \text{ of growth inhibition} = \frac{(D_o - D_t) \times 100}{D_o}$$

Where D_o = Diameter of mycelial growth of fungal pathogen in the control plates; D_t = Diameter of mycelial growth of fungal pathogen in the treatment plates.

All statistical analyses were performed using SAS System for Windows Version 9.1 (SAS, 2009). The data collected were analysed using the analysis of variance (ANOVA) procedures and the least significant difference test (LSD) at 0.05 was used to compare treatment means for each parameter.

RESULTS

At day 3, combination of RHE *x* BE at 1.5% concentration completely inhibited the mycelial growth of all the fungal pathogens. Mycelial growth of *C. lunata*, *F. verticillioides* and *F. oxysporium* were also completely inhibited by combination of RHE *x* BE at 1.0% concentration, while mycelial growth of *F. equiseti* was significantly ($p<0.05$) reduced. Further observation at day 3 showed that there was no complementary effect of RHE *x* BE at 0.1 and 0.5% levels on mycelial growth of *M. phaseolina*, *F. equiseti* and *F. solani* in comparison to the significant ($p<0.05$) variation observed on *B. maydis* and other fungal pathogens. At day 6, RHE *x* BE (1.5% concentration) showed effect on mycelial growth of *B. maydis, C. lunata, F. verticillioides, F. equiseti* and *F. oxysporium*, while significant ($p<0.05$) reduction was exhibited on mycelial growth of *Dreschlera* sp., *M. phaseolina* and *F. solani*. Comparative effect of RHE *x* BE at day 6 showed that 0.1% concentration was more effective on *C. lunata* and *F. oxysporium* in comparison to other fungal pathogens. It was observed that RHE *x* BE at 0.1% concentration reduced the mycelial growth of *B. maydis*, *F. verticillioides* and *F. equiseti*. At day 6, a clear distinction on the effectiveness of RHE *x* BE at 0.5 and 1.0% concentration with respect to the mycelial growth of all the fungal pathogens was observed. Observation at day 9 showed that RHE *x* BE at 1.5% concentration completely inhibited the mycelial growth of *C. lunata*, *F. verticillioides*, *F. equiseti* and *F.oxysporium* (Table 1). Interestingly, RHE *x* BE at 1.0% concentration consistently maintained complete mycelial growth inhibition on *C. lunata* from day 3 to day 9.

Combination of RHE *x* WE at day 3, significantly ($p<0.05$) varied on the fungal pathogens most especially at 0.1, 0.5 and 1.0% concentration levels. RHE *x* WE at 1.5% concentration level, completely inhibited the mycelial growth of all the fungal pathogens with the exception of *F. solani*. Even at 1.0% concentration, RHE *x* WE completely inhibited mycelial growth of *Dreschlera* sp., *F. verticillioides* and *F. equiseti*. Consistent observation at day 3 showed that RHE *x* WE at 0.5% concentration completely inhibited *F. verticillioides* and as well reduced the mycelia growth *M. phaseolina* and *F. equiseti*. Observation at day 6 showed that the mycelia growth of the fungal pathogens was completely inhibited with the exception of *C. lunata, F. solani* and *F. oxysporium*. Further observation revealed that RHE *x* WE at 1.0% concentration completely inhibited the mycelial growth of *Dreschlera* sp. and *F. equiseti* (Table 2) though, with reduction in mycelial growth of other fungal pathogens. At day 9, mycelial growth of *B. maydis*, *Dreschlera* sp., *F. verticillioides*, *M. phaseolina* and *F. equiseti* were completely inhibited by RHE *x* WE at 1.5% concentration. In our observation, RHE *x* WE at 1.0% consistently maintained complete mycelial growth inhibition of *Dreschlera* sp. and *F. equiseti* from day 3 to 9 (Table 2).

The inhibitory effect of BE *x* WE at day 3 was effective at 1.0 and 1.5% concentration on *B. maydis*, *Dreshlrea, F. verticillioides, M. phaseolina* and *F. equiseti*. The effect of WE *x* BE on *C. lunata* were significantly ($p<0.05$) similar at concentration of 0.5, 1.0 and 1.5% while *F. oxysporium* was not inhibited at these concentration levels. Similar observation was recorded at

day 6 and 9; *F. oxysporium* defiled BE *x* WE at all the concentration levels. Less effect of BE *x* WE was observed on *B. maydis, C. lunata*, *Dreschlera* sp., *F. verticillioides, M. phaseolina* and *F. solani* (Table 3). However, an outstanding mycelial growth reduction was recorded for *C. lunata* (3.40cm) compared to the control (7.30cm).

The effect of RHE *x* BE *x* WE on the fungal pathogens was highly encouraging most especially at 1.0 and 1.5% concentration levels. This study showed that RHE *x* BE *x* WE inhibited all the fungal pathogens at both the lower (0.1 and 0.5%) and higher (1.0 and 1.5%) levels of concentration throughout the days of observation (Table 4). From table 5, it could be deduced that 1.5% was the best concentration level with respect to different botanical extracts combinations. However, RHE *x* BE *x* WE was observed as the best combination of botanicals, followed by RHE *x* WE, and then RHE *x* BE, while the least was recorded for BE *x* WE.

DISCUSSION

Eco-friendly approaches for plant disease management have been exploited worldwide. There are many known abiotic and biotic inducers of resistance against various phytopathogens. However, the use of botanical extracts for disease management is limited and presently, management of plant diseases by botanical extracts is gaining worldwide importance and acceptance (Chandrashekhara *et al*., 2010). Evaluation of botanicals individually has been the norm in plant pathology with respect to biological control of plant diseases, but in this study, we evaluated the significant effect of three crude botanical extracts in their combinations on mycelia growth of pathogenic fungi of maize. The combination of RHE x BE x WE, RHE x BE and RHE x WE extracts significantly inhibited the mycelial growth of the pathogenic fungi of maize evaluated in this study. Combinations of botanical extracts may contain bioactive naturally occurring compounds that have antimicrobial properties which can inhibit the mycelial growth of pathogenic fungi of maize. This conforms with the work of Odebode *et al*. (2004) that tested two annonaceous plants *Isolana cualifora* verdc and *Cleistochlamys krikii* Berth (Oliv) of which the crude extract and pure compounds inhibited both bacterial and fungal pathogens tested. This is also in line with the report of Mudalige *et al*. (2011) that botanical extracts are natural plant products that belong to the so called secondary metabolites which include alkaloids, phenolics and saponins (secondary chemicals). Saponins are steroidal or triterpenoid glycosides found in many different plant species and these substances have biological activity against fungi. It has been demonstrated that many plants and plant products possess pest control properties and plant extracts and essential oils are effective antimicrobials against various foliar and soil-borne phytopathogens (Lawson and Kennedy, 1998).

The effectiveness of the botanical extracts used in this study was observed to be dependent on the levels of concentration. Fungi mycelial growth inhibition was observed at higher concentrations (1.0 and 1.5%) by combination of RHE x BE x WE, compared to lower concentrations (0.1 and 0.5%). This conforms to the report of Webster *et al*. (2008) that crude extracts are generally a mixture of active and non-active compounds (crude fusions) and therefore higher Minimum Inhibitory Competition (MIC) are expected. Similarly, combination of BE *x* WE showed the least inhibitory effect as it was unable to completely inhibit the mycelial growth of the fungal pathogens even at 1.5% concentration. Observed variation of antifungal activities of these botanical extracts combinations suggests that there may be differences in the nature and chemical composition of the plants probably due to the extracting solvent, which determines the toxicity of the plant's disease resistance. This agreed with the report of Stanfford, (1974) that extracts from higher plants contain a considerable amount of inhibitory phenolic acids, which are

important in plant disease resistance. Increase in concentration levels may likely support the effectiveness of BE *x* WE on mycelial growth of the fungal pathogens. Also, significant variation in the effectiveness of botanicals agreed with Maobe *et al*. (2013) who evaluated 8 medicinal plants and proposed that the crude extracts may contain lots of phytochemical compounds that may be responsible for their effect on clinical pathogens. With respect to this, the inhibitory activity of botanical extracts may vary with the virulence of the pathogens and most likely with the chemical components of the plants. In addition, the significant effect of botanical extracts combinations on pathogenic fungi of maize is possible because the earlier report of Abiala *et al.* (2011) had justified the significant effect of bamboo, wood and rice husk extracts individually on mycelial growth of *Mycosphaerella fijensis* at different levels of concentration. Similar observation was also reported by Killani *et al*. (2011) on the potential effect of rice husk extract as phytopesticide against soil borne fungal pathogens of cowpea.

This study therefore justified that combinations of the botanical extracts significantly inhibited 90% of the fungal pathogens including *Curvularia lunata* at 1.5% concentration as was also reported by Akinbode (2010) on *C. lunata*, the causal organism of maize leaf spot. Similar observation of leaf extracts of *P. betle* L. were also reported to completely inhibit spore germination of *Ustilago tritici* and *U. hordei* (Mishra and Dixit 1979) and was found to be the best in reducing the growth of pathogens completely in vitro and in vivo against blast, brown spot and sheath blight diseases of rice (Tewari and Nayak 1999). Observation on significant effect of botanical extracts on *M. phaseolina* was also supported by Abhay *et al*. (1997) who showed the potency of leaf extracts of *Ocimum* and *Vitex* in the inhibition of *M. phaseolina* spore germination. Inhibition of mycelial growth of *Fusarium* sp. and *M. phaseolina* by the botanical extracts also agreed with the similar observation recorded by Ehteshamul *et al*. (1996) using extracts of *Prosopis fuliflora, P. glandulosa, P. cineraria* and neem. The *in vitro* antifungal properties of each extract reveals efficacy in the control of at least one of the pathogenic *Fusarium* species, as was also reported by Yoshida *et al*. (2000) that rice husk extract has the potential to completely inhibit mycelial growth of *Thanetephorus cucumeris* (MAFF305844) and *Fusarium solani* (MAFF306358). Taking advantage of these botanical extracts most especially in their combinations will be of significant importance to sustainable crop production and thus, support ecofriendly based agricultural management systems.

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Table 1. Combined effect of rice husk and bamboo extract on pathogenic fungi of maize

		Mycelial Mean Growth (cm)				
		Concentration (%)				
Days	Treatment	0.0	0.1	0.5	1.0	1.5
Day 3	*Bipolaris maydis*	3.20±0.00^{a}	2.80±0.00^{b}	2.43±0.06^{c}	1.27±0.06^{d}	0.00±0.00^{e}
	Curvularia lunata	2.93±0.12^{a}	2.67±0.12^{a}	1.83±0.40^{b}	0.00±0.00^{c}	0.00±0.00^{c}
	Dreschlera sp	3.03±0.25^{a}	2.90±0.17^{a}	2.10±0.10^{b}	1.47±0.15^{c}	0.00±0.00^{d}
	Fusarium verticilloides	2.80±0.10^{a}	2.87±0.12^{a}	1.73±0.38^{b}	0.00±0.00^{c}	0.00±0.00^{c}
	Macrophomina phaseolina	2.20±0.10^{a}	2.20±0.10^{a}	2.17±0.06^{a}	1.63±0.06^{b}	0.97±0.15^{c}
	Fusarium equiseti	2.17±0.06^{a}	2.13±0.12^{a}	1.77±0.15^{a}	0.27±0.46^{b}	0.00±0.00^{b}
	Fusarium solani	2.23±0.38^{a}	2.10±0.00^{a}	2.03±0.15^{a}	1.13±0.11^{b}	0.00±0.00^{c}
	Fusarium oxysporum	2.23±0.06^{a}	2.10±0.10^{b}	2.00±0.00^{b}	0.00±0.00^{c}	0.00±0.00^{c}
	LSD	0.30	0.18	0.37	0.31	0.09
Day 6	*Bipolaris maydis*	5.47±0.06^{a}	5.27±0.12^{a}	4.37±0.31^{b}	2.93±0.12^{c}	0.00±0.00^{d}
	Curvularia lunata	3.97±0.25^{a}	4.27±0.12^{a}	3.73±0.15^{b}	0.00±0.00^{c}	0.00±0.00^{c}
	Dreschlera sp	5.23±0.25^{a}	5.13±0.32^{a}	4.20±0.10^{b}	3.43±0.15^{c}	0.67±0.61^{d}
	Fusarium verticilloides	6.10±0.26^{a}	5.70±0.17^{a}	4.67±0.15^{b}	1.40±0.69^{c}	0.00±0.00^{d}
	Macrophomina phaseolina	5.57±0.06^{a}	5.30±0.26^{ab}	4.97±0.25^{b}	4.10±0.10^{c}	3.17±0.15^{d}
	Fusarium equiseti	5.67±0.06^{a}	5.33±0.06^{a}	4.47±0.06^{b}	2.47±0.72^{c}	0.00±0.00^{d}
	Fusarium solani	5.97±0.55^{a}	5.33±0.67^{ab}	5.07±0.12^{b}	3.70±0.26^{c}	2.43±0.40^{d}
	Fusarium oxysporum	5.53±0.06^{a}	5.03±0.06^{b}	5.00±0.00^{b}	0.00±0.00^{c}	0.00±0.00^{c}
	LSD	0.44	0.50	0.26	0.65	0.46
Day 9	*Bipolaris maydis*	7.33±0.21^{a}	7.50±0.10^{a}	6.83±0.12^{a}	5.47±0.38^{b}	1.63±1.42^{c}
	Curvularia lunata	7.80±0.40^{a}	7.63±0.06^{a}	7.00±0.17^{b}	0.00±0.00^{c}	0.00±0.00^{c}
	Dreschlera sp	7.30±0.20^{a}	6.87±0.45^{ab}	6.20±0.20^{b}	6.20±0.36^{b}	2.57±0.95^{c}
	Fusarium verticilloides	7.47±0.49^{a}	7.60±0.10^{a}	6.80±0.10^{a}	2.93±0.93^{b}	0.00±0.00^{c}
	Macrophomina phaseolina	7.37±0.06^{a}	7.30±0.10^{a}	6.87±0.32^{b}	6.07±0.12^{c}	4.90±0.20^{d}
	Fusarium equiseti	7.27±0.32^{a}	7.00±0.17^{a}	6.70±0.62^{a}	3.93±1.35^{b}	0.00±0.00^{c}
	Fusarium solani	7.67±0.72^{a}	7.37±0.67^{a}	7.30±0.26^{a}	5.93±0.42^{b}	4.37±0.50^{c}
	Fusarium oxysporum	7.30±0.10^{a}	6.70±0.10^{a}	6.60±0.10^{a}	1.17±1.01^{b}	0.00±0.00^{c}
	LSD	0.65	0.52	0.50	1.25	1.11

Data are presented as means for three replicates, followed by standard deviation within replicates. Values followed by the same letters in rows are not significantly different at P = 0.05. LSD = Least Significant Difference

Table 2. Combined effect of rice husk and wood extract on pathogenic fungi of maize

		Mycelial Mean Growth (cm)				
		Concentration (%)				
Days	Treatment	0.0	0.1	0.5	1.0	1.5
Day 3	*Bipolaris maydis*	2.47±0.06^{a}	2.27±0.06^{a}	2.17±0.15^{b}	1.23±0.06^{b}	0.00±0.00^{c}
	Curvularia lunata	2.53±0.12^{a}	2.40±0.00^{a}	2.30±0.00^{a}	0.73±0.64^{b}	0.00±0.00^{c}
	Dreschlera sp	2.63±0.06^{a}	2.23±0.12^{b}	2.23±0.06^{b}	0.00±0.00^{c}	0.00±0.00^{c}
	Fusarium verticilloides	2.17±2.07^{a}	2.07±0.06^{b}	0.00±0.00^{c}	0.00±0.00^{c}	0.00±0.00^{c}
	Macrophomina phaseolina	2.67±0.06^{a}	2.40±0.00^{b}	1.70±0.00^{c}	1.47±0.06^{d}	0.00±0.00^{e}
	Fusarium equiseti	3.17±0.15^{a}	2.83±0.1^{b}	0.30±0.52^{c}	0.00±0.00^{c}	0.00±0.00^{c}
	Fusarium solani	2.80±2.47^{a}	2.47±0.25^{b}	2.20±0.10^{c}	2.03±0.06^{c}	1.00±0.10^{d}
	Fusarium oxysporum	2.83±0.0^{a}	2.53±0.06^{a}	2.30±0.20^{a}	0.77±0.67^{b}	0.00±0.00^{c}
	LSD	0.15	0.21	0.36	0.57	0.06
Day 6	*Bipolaris maydis*	5.03±0.06^{a}	3.77±0.15^{b}	3.43±0.06^{c}	2.23±0.12^{d}	0.00±0.00^{e}
	Curvularia lunata	5.17±0.15^{a}	4.50±0.00^{b}	4.40±0.00^{b}	2.77±0.68^{c}	1.37±0.06^{d}
	Dreschlera sp	5.43±0.06^{a}	4.87±0.06^{b}	4.57±0.12^{c}	0.00±0.00^{d}	0.00±0.00^{d}
	Fusarium verticilloides	4.67±0.15^{a}	4.40±0.10^{a}	2.27±0.21^{b}	1.50±0.87^{c}	0.00±0.00^{c}
	Macrophomina phaseolina	5.43±0.32^{a}	4.90±0.00^{b}	3.90±0.00^{c}	3.57±0.06^{d}	0.00±0.00^{e}
	Fusarium equiseti	5.83±0.32^{a}	5.37±0.15^{b}	1.63±0.32^{c}	0.00±0.00^{d}	0.00±0.00^{d}
	Fusarium solani	4.93±0.32^{a}	4.70±0.26^{a}	4.13±0.15^{b}	4.00±0.10^{b}	2.07±0.21^{c}
	Fusarium oxysporum	5.43±0.06^{a}	5.46±0.06^{a}	5.03±0.15^{a}	2.87±1.01^{b}	2.67±0.06^{b}
	LSD	0.34	0.22	0.28	0.92	0.14
Day 9	*Bipolaris maydis*	6.87±0.12^{a}	5.30±0.10^{b}	4.87±0.12^{c}	4.33±0.12^{d}	0.00±0.00^{e}
	Curvularia lunata	6.97±0.15^{a}	6.30±0.00^{b}	5.80±0.00^{c}	4.03±0.31^{d}	3.40±0.10^{e}
	Dreschlera sp	7.83±0.06^{a}	6.73±0.12^{b}	6.07±0.12^{c}	0.00±0.00^{d}	0.00±0.00^{d}
	Fusarium verticilloides	6.90±0.10^{a}	6.47±0.06^{a}	1.73±0.23^{b}	0.90±1.01^{b}	0.00±0.00^{c}
	Macrophomina phaseolina	7.10±0.10^{a}	6.50±0.00^{b}	5.43±0.06^{c}	4.37±0.12^{d}	0.00±0.00^{e}
	Fusarium equiseti	7.83±0.21^{a}	7.10±0.26^{b}	2.57±0.38^{c}	0.00±0.00^{d}	0.00±0.00^{d}
	Fusarium solani	7.00±0.10^{a}	6.20±0.26^{b}	5.73±0.21^{c}	5.47±0.12^{c}	2.93±0.35^{d}
	Fusarium oxysporum	7.10±0.10^{a}	6.80±0.10^{a}	6.30±0.20^{a}	4.30±0.95^{b}	4.33±0.12^{b}
	LSD	0.21	0.26	0.34	0.88	0.23

Data are presented as means for three replicates, followed by standard deviation within replicates. Values followed by the same letters in rows are not significantly different at P = 0.05. LSD = Least Significant Difference

Table 3. Combined effect of bamboo and wood extract on pathogenic fungi of maize

		Mycelial Mean Growth (cm)				
		Concentration (%)				
Days	Treatment	0.0	0.1	0.5	1.0	1.5
Day 3	*Bipolaris maydis*	2.60±0.10^{a}	2.56±0.15^{a}	1.90±0.10^{a}	1.43±0.12^{b}	1.73±0.12^{c}
	Curvularia lunata	2.43±0.12^{a}	2.27±0.12^{a}	1.50±0.17^{b}	1.33±0.15^{b}	1.36±0.06^{b}
	Dreschlera sp	3.47±0.12^{a}	3.20±0.20^{a}	2.37±0.06^{b}	2.20±0.10^{bc}	2.07±0.21^{c}
	Fusarium verticilloides	3.73±0.12^{a}	3.60±0.10^{a}	2.33±0.21^{b}	1.90±0.00^{c}	1.17±0.12^{d}
	Macrophomina phaseolina	2.30±0.10^{a}	2.20±0.00^{a}	2.80±0.20^{b}	2.67±0.25^{b}	1.77±0.06^{c}
	Fusarium equiseti	2.80±0.10^{a}	2.50±0.10^{b}	2.40±0.10^{b}	2.40±0.00^{b}	1.43±0.06^{c}
	Fusarium solani	2.60±0.10^{a}	2.47±0.15^{a}	2.10±0.10^{b}	2.00±0.10^{b}	1.73±0.12^{c}
	Fusarium oxysporum	2.73±0.21^{a}	2.57±0.12^{a}	3.17±1.42^{a}	3.20±1.48^{a}	1.93±0.06^{b}
	LSD	0.21	0.22	0.89	0.93	0.19
Day 6	*Bipolaris maydis*	4.70±0.10^{a}	4.63±0.46^{a}	3.90±0.30^{b}	3.73±0.12^{b}	2.90±0.20^{c}
	Curvularia lunata	4.93±0.12^{a}	3.73±0.01^{a}	3.70±0.17^{b}	3.33±0.15^{b}	3.67±0.06^{b}
	Dreschlera sp	5.90±0.00^{a}	5.87±0.90^{b}	5.23±0.12^{c}	5.07±0.15^{c}	4.13±0.25^{cd}
	Fusarium verticilloides	5.53±0.12^{a}	4.57±1.01^{a}	4.90±0.26^{a}	4.33±0.15^{ab}	3.03±0.15^{c}
	Macrophomina phaseolina	5.53±0.06^{a}	5.37±0.15^{a}	5.17±0.21^{a}	4.50±0.30^{b}	3.80±0.44^{c}
	Fusarium equiseti	5.70±0.10^{a}	5.45±0.25^{a}	5.37±0.06^{a}	5.37±0.06^{a}	3.20±0.26^{b}
	Fusarium solani	5.27±0.06^{a}	5.23±0.06^{a}	4.90±0.26^{ab}	4.73±0.23^{bc}	4.47±0.25^{c}
	Fusarium oxysporum	5.77±0.15^{a}	5.67±0.83^{a}	5.13±0.85^{a}	5.48±0.96^{a}	4.47±0.25^{a}
	LSD	0.17	1.20	0.62	0.66	0.44
Day 9	*Bipolaris maydis*	6.90±0.10^{a}	6.93±0.12^{a}	5.87±0.31^{b}	5.53±0.31^{c}	5.43±0.15^{c}
	Curvularia lunata	7.30±0.17^{a}	5.63±0.15^{b}	5.47±0.12^{b}	5.13±0.15^{c}	3.40±0.10^{e}
	Dreschlera sp	7.90±0.00^{a}	6.57±0.25^{b}	6.23±0.12^{d}	6.90±0.36^{b}	6.00±0.10^{d}
	Fusarium verticilloides	5.57±0.06^{c}	6.67±0.12^{a}	6.27±0.23^{b}	5.90±0.17^{d}	4.97±0.15^{e}
	Macrophomina phaseolina	7.23±0.12^{a}	7.23±0.21^{a}	7.03±0.15^{ab}	6.43±0.15^{b}	4.93±0.67^{c}
	Fusarium equiseti	7.43±0.12^{a}	7.33±0.12^{a}	6.97±0.40^{a}	7.10±0.10^{a}	4.37±0.40^{b}
	Fusarium solani	7.00±0.10^{a}	6.97±0.06^{a}	6.27±0.23^{b}	6.00±0.02^{b}	6.07±025^{b}
	Fusarium oxysporum	7.40±0.10^{a}	6.63±1.03^{a}	6.37±0.95^{a}	7.03±0.68^{a}	6.03±0.38^{a}
	LSD	0.18	0.68	0.70	0.48	0.57

Data are presented as means for three replicates, followed by standard deviation within replicates. Values followed by the same letters in rows are not significantly different at P = 0.05. LSD = Least Significant Difference

Table 4. Combined effect of rice husk, bamboo and wood extract on pathogenic fungi of maize

		Mycelial Mean Growth (cm)				
		Concentration (%)				
Days	Treatment	0.0	0.1	0.5	1.0	1.5
Day 3	*Bipolaris maydis*	2.47±0.06^{a}	2.33±0.06^{b}	2.03±0.12^{c}	1.53±0.06^{d}	0.00±0.00^{e}
	Curvularia lunata	2.60±0.10^{a}	2.20±0.00^{b}	1.57±0.06^{c}	0.00±0.00^{d}	0.00±0.00^{d}
	Dreschlera sp	2.53±0.12^{a}	2.13±0.12^{b}	1.90±0.10^{b}	0.17±2.25^{c}	0.00±0.00^{d}
	Fusarium verticilloides	2.33±0.06^{a}	2.06±0.12^{a}	1.73±0.31^{a}	0.83±0.76^{b}	0.00±0.00^{c}
	Macrophomina phaseolina	2.07±0.31^{a}	1.80±0.20^{a}	1.47±0.12^{b}	0.00±0.00^{c}	0.00±0.00^{c}
	Fusarium equiseti	2.93±0.12^{a}	2.67±0.12^{a}	1.70±0.20^{b}	0.83±0.72^{c}	0.00±0.00^{d}
	Fusarium solani	2.47±0.06^{a}	2.07±0.06^{b}	1.83±0.06^{c}	0.00±0.00^{d}	0.00±0.00^{d}
	Fusarium oxysporum	2.57±0.15^{a}	2.57±0.15^{a}	2.17±0.12^{b}	0.00±0.00^{c}	0.00±0.00^{c}
	LSD	0.25	0.19	0.27	0.66	0.00
Day 6	*Bipolaris maydis*	4.73±0.21^{a}	4.37±0.21^{b}	3.80±0.26^{c}	2.70±0.17^{d}	0.00±0.00^{e}
	Curvularia lunata	5.47±0.12^{a}	4.90±0.00^{b}	3.73±0.12^{c}	0.30±0.52^{d}	0.00±0.00^{d}
	Dreschlera sp	5.10±0.17^{a}	4.67±0.12^{b}	3.90±0.10^{c}	3.30±0.36^{d}	0.00±0.00^{e}
	Fusarium verticilloides	3.53±0.06^{a}	3.27±0.15^{a}	2.97±0.15^{b}	2.03±0.25^{c}	0.00±0.00^{d}
	Macrophomina phaseolina	4.10±0.26^{a}	3.70±0.20^{a}	3.93±0.15^{a}	0.27±0.46^{b}	0.00±0.00^{b}
	Fusarium equiseti	4.60±0.10^{a}	4.23±0.15^{a}	2.63±0.60^{b}	1.87±0.06^{c}	0.00±0.00^{d}
	Fusarium solani	5.53±0.15^{a}	4.07±0.15^{b}	3.33±0.06^{c}	0.00±0.00^{d}	0.00±0.00^{d}
	Fusarium oxysporum	4.67±0.15^{a}	3.60±0.44^{b}	3.30±0.43^{b}	1.73±0.23^{c}	0.00±0.00^{d}
	LSD	0.28	0.37	0.51	0.53	0.00
Day 9	*Bipolaris maydis*	7.10±0.26^{a}	6.87±0.12^{a}	5.80±0.30^{d}	4.13±0.15^{c}	0.00±0.00^{d}
	Curvularia lunata	7.20±0.17^{a}	6.97±0.06^{a}	5.60±0.00^{b}	1.40±0.70^{c}	0.00±0.00^{d}
	Dreschlera sp	7.20±0.17^{a}	6.17±0.12^{b}	5.93±0.12^{b}	5.00±0.36^{c}	0.00±0.00^{d}
	Fusarium verticilloides	6.00±0.10^{a}	5.77±0.15^{a}	5.40±0.20^{b}	2.97±0.31^{c}	0.00±0.00^{d}
	Macrophomina phaseolina	7.10±0.20^{a}	6.47±0.15^{a}	5.77±0.21^{a}	1.03±1.79^{b}	0.00±0.00^{b}
	Fusarium equiseti	6..73±0.15^{a}	6.40±0.20^{a}	4.03±0.90^{b}	2.83±0.12^{c}	0.00±0.00^{d}
	Fusarium solani	6.33±0.12^{a}	5.80±0.17^{b}	5.50±0.10^{c}	1.63±0.15^{d}	0.00±0.00^{e}
	Fusarium oxysporum	7.10±0.10^{a}	6.57±0.25^{b}	5.90±0.10^{c}	2.47±0.38^{d}	0.00±0.00^{e}
	LSD	0.29	0.28	0.62	1.24	0.00

Data are presented as means for three replicates, followed by standard deviation within replicates. Values followed by the same letters in rows are not significantly different at P = 0.05. LSD = Least Significant Difference

Table 5.: Mean percentage growth inhibition of fungal pathogens at day 9 at 1.5% concentration

	Mycelia Mean Inhibition (%)			
Pathogenic fungi	**RHE *x* BE**	**RHE *x* WE**	**BE *x* WE**	**RHE *x* BE *x* WE**
Bipolaris maydis	77.73	100.0	21.26	100.0
Curvularia lunata	100.0	51.99	55.42	100.0
Dreschlera sp.	64.84	100.0	24.05	100.0
Fusarium verticilloides	100.0	100.0	10.78	100.0
Macrophomina phaseolina	39.49	100.0	31.80	100.0
Fusarium equiseti	100.0	100.0	41.25	100.0
Fusarium solani	43.04	58.10	14.29	100.0
Fusarium oxysporum	100.0	38.97	18.47	100.0