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MANAGEMENT OF FUNGAL PATHOGENS ASSOCIATED WITH MANGO DISEASES USING ORGANIC MATERIALS

Muhammad Nasiru Abubakar[1], Ibrahim Alhaji Salau[2]* and Samaila Tambari[3]

[1]Department of Forestry & Environment, Usmanu Danfodiyo University, Sokoto Nigeria

*[2]Department of Biological Sciences, Federal University Gusau, Zamfara, Nigeria

[3]Department of Agricultural Extension and Rural Dev't. Usmanu Danfodiyo University, Sokoto

*Corresponding Email: amnafad597@yahoo.com ;Tel: +234(0) 8053569551

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ABSTRACT: *Mango (Mangifera indica) is one of the most economically important tropical fruits, but it is susceptible to various fungal pathogens that cause significant yield losses and reduce fruit quality. Traditional management strategies for these fungal diseases often involve the use of synthetic fungicides, which can have adverse effects on the environment and human health. Therefore, there is a growing need to explore sustainable and organic alternatives for managing these pathogens. This study aims to evaluate the efficacy of organic materials in controlling fungal pathogens associated with mango diseases. Various organic materials of different plant extracts were tested against common fungal pathogens. The results of the study demonstrated the potential of organic materials in managing mango fungal diseases. Plant extracts derived from neem (Azadirachta indica), garlic (Allium sativum), and ginger (Zingiber officinale) exhibited strong antifungal activity against the tested pathogens. Overall, the findings of this study suggest that organic materials can be effective tools for managing fungal pathogens associated with mango diseases. Incorporating these organic management strategies into mango production systems can contribute to sustainable agriculture practices, reduce chemical inputs, and promote the production of high-quality, disease-free mangoes.*

KEYWORDS: Mango, Diseases, Fungal pathogens, Organic materials, Plant extracts.

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INTRODUCTION

The economic importance of mango as food, source of income, foreign exchange earnings and employment opportunities could not be overemphasized; in fact mango orchard cultivation is a profitable activity that could bring huge returns to the growers (Nasiru & Idris, 2021). It is therefore of immense importance to broaden research on some of the common diseases affecting mango yield and productivity and where possible device measures of control (Rajmane & Korekar, 2016). Furthermore, despite the continuous decline of mango tree stands in the study area, recent studies conducted were mainly focused on the assessment of mango tree diseases (Nasiru *et al.*, 2015). However, the effectiveness of these organic materials in managing fungal pathogens associated with mango diseases may vary depending on various factors such as the type of disease, severity of the disease, environmental conditions, and application method. Therefore, it is good to conduct further research and field trials to determine the most effective application methods and concentrations of these organic materials for the management of mango diseases (Okibo, 2001).

Mango diseases caused by fungal pathogens can be managed using organic materials. Organic management practices are beneficial as they are eco-friendly, reduce the risk of chemical residues in the fruit, and are sustainable (Swart, 2010). Some organic materials that can be used to manage fungal pathogens associated with mango diseases include Neem oil which is derived from the neem tree and has antifungal properties (Senghor *et al.*, 2007). It can be applied as a foliar spray to control powdery mildew and anthracnose in mangoes. Copper-based fungicides are commonly used in organic farming to control fungal diseases. They are effective against anthracnose and other fungal diseases in mangoes. Garlic extract has antifungal properties and can be used to control anthracnose in mangoes. It can be applied as a foliar spray or added to the soil. Trichoderma is a beneficial fungus that can be used as a bio-control agent against fungal pathogens (Okereke *et al.*, 2010). It can be applied to the soil or as a foliar spray to control fungal diseases in mangoes.

Compost is a rich source of nutrients and beneficial microorganisms that can improve soil health and reduce the incidence of fungal diseases in mangoes. In addition to the above-mentioned organic materials, it is also important to practice good cultural practices to manage fungal diseases in mangoes. These include pruning infected plant parts, removing fallen leaves and fruit, and avoiding overhead irrigation. With proper management, fungal pathogens associated with mango diseases can be effectively controlled using organic materials (Prakash, 2004). The aim of this research is to determine the most effective management strategies of Mango plant diseases through organic amendments in Usmanu Danfodiyo University, Sokoto State.

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MATERIALS AND METHODS

The methodology of managing fungal pathogens associated with mango diseases using organic materials includes the following steps:

Identification of Fungal Pathogens

After laboratory analysis of the infected plant tissues, fungal pathogens identified include: *Alternaria alternata, Aspergillus flavus, A. fumigatus, A. niger, Colletotrichum gloeosporioides, Fusarium semitectum, Papulaspora sp., Penicillium sp., Pestalotiopsis guepinii* and *Rhizopus stolonifer* among others.

Selection of Appropriate Organic Materials

Various organic materials such as neem extract, garlic extract, and ginger extract were used to manage fungal pathogens. The selection of appropriate organic materials depends on the type of fungal pathogens and the availability of organic materials in the locality or environment.

Preparation of Aqueous and Ethanolic Extracts

Aqueous and ethanolic extracts of neem (A. *indica*) seeds, *ginger* (Z. *officinale*) and garlic (A. *sativum*) bulbs were prepared at the laboratory prior to application. Neem seeds from tree sheds; ginger rhizomes and garlic bulbs bought at the local market in Sokoto were used. Crude extracts were obtained by sterilizing the plant organs in a solution of 10% sodium hypochlorite (NaOCl) for 1 min, rinsed five times in distilled water and then dried (Akinbode & Ikotun 2008). Dried seeds, rhizome or bulbs were ground using a mortar and pestle and sieved through a 40 mm sieve. The grounded powder (100 g) was weighed into a conical flask and 100 mL of the solvent was added (distilled water or ethanol) to obtain a ratio of 1:1 w/v (weight/volume). This was then corked with a rubber lid and shaken for 20 min to mix and allowed overnight at room temperature (25°C before filtering the content). To obtain a concentration of 10 and 20% for field application, the filtered content was diluted accordingly; to obtain a concentration of 10%, 100 mL of the filtered plant extract suspension was added to 900 mL of distilled water to make up to 1 l (Tunwari & Nahunnaro 2014).

Application of Organic Materials

Extracts treatments were first applied at the onset of disease 30 days after symptoms (DAS) as indicated by disease symptoms observed. Foliar applications were carried out at 60 DAS, 90 DAS, 120 DAS and 150 DAS. Applications were performed using a pressurized hand sprayer. Spraying was done in the evening to prevent solar heat from denaturing plant extracts. Precautions were also taken to avoid drift effects.

Monitoring and Evaluation

The progress of disease management was monitored regularly to evaluate the effectiveness of the organic materials. These involve visual inspection of the plants and laboratory analysis of the plant tissues.

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Data Analysis

Data collected on the growth and disease parameters were arranged in a spreadsheet using Microsoft Excels 2013. The spreadsheet was imported into SPSS version 20 (Statistical Package for Social Sciences), and analysis of variance was carried out with mean values separated using the Tukey test at a probability threshold of 5%

RESULTS AND DISCUSSION

The results of managing fungal pathogens associated with mango diseases using organic materials are dependent on various factors such as the type of fungal pathogens, the severity of the disease, and the effectiveness of the organic materials used. Some of the possible results of this management approach. The efficacy of aqueous and ethanolic plant extracts on management of mango diseases shows that treatment with various extracts is effective as more days are counted, at 150 days after spraying became more effective than 60DAS. The result is presented in Table 1.

Table 1: Efficacy of Aqueous and Ethanolic Plant Extracts on Management of Mango Diseases

Treatments	60 DAS	90 DAS	120 DAS	150 DAS
Control Fungus	18.1 ± 3.0[a]	27.2 ± 9.2[a]	32.1 ± 10.1[a]	45.1 ± 11.3[a]
Aqueous extract of neem seeds 10%	15.6 ± 6.2[a]	27.2 ± 9.2[a]	36.0 ± 10.1[a]	46.1 ± 11.1[a]
Aqueous extract of neem seeds 20%	18.6 ± 3.6[a]	29.5 ± 4.9[a]	37.3 ± 5.8[a]	38.3 ± 5.7[a]
Ethanolic extract of neem seeds 10%	18.8 ± 3.8[a]	26.8 ± 4.7[a]	35.6 ± 5.9[a]	37.6 ± 5.6[a]
Ethanolic extract of neem seeds 20%	19.1 ± 3.1[a]	29.8 ± 6.1[a]	29.6 ± 7.3[a]	38.6 ± 7.2[a]
Aqueous extract of garlic 10%	18.6 ± 4.5[a]	40.1 ± 6.3[a]	46.9 ± 7.5[a]	48.6 ± 7.4[a]
Aqueous extract of garlic 20%	18.6 ± 4.1[a]	28.0 ± 5.4[a]	37.9 ± 6.7[a]	37.1 ± 6.2[a]
Ethanolic extract of garlic 10%	17.7 ± 6.1[a]	28.5 ± 5.0[a]	28.3 ± 6.3[a]	37.3 ± 4.1[a]
Ethanolic extract of garlic 20%	18.0 ± 4.9[a]	27.0 ± 5.8[a]	36.9 ± 6.7[a]	35.6 ± 6.6[a]
Aqueous extract of ginger 10%	18.6 ± 4.1[a]	28.0 ± 5.4[a]	36.9 ± 6.2[a]	37.2 ± 6.6[a]
Aqueous extract of ginger 20%	17.7 ± 6.1[a]	28.5 ± 5.0[a]	37.3 ± 6.2[a]	37.1 ± 6.2[a]
Ethanolic extract of ginger 10%	18.0 ± 4.9[a]	27.0 ± 5.8[a]	36.9 ± 6.6[a]	38.0 ± 6.6[a]
Ethanolic extract of ginger 20%	19.1 ± 3.2[a]	28.2 ± 6.1[a]	36.0 ± 8.3[a]	28.2 ± 7.4[a]
Interactions				
Treatments × Location	NS	NS	NS	NS

Mean values with the same letter within the column are not significantly different at $p < 0.05$; ±: standard error; NS: not significant; DAS: days after spraying.

Table 2 shows that extract treatments had no significant effect on the growth (plant height and number of branches) of the studied mango. However, the three extracts demonstrated different growth habits. However, neem seed extract produced significantly lower number of branches than that of ginger and garlic treatment at 90 and 150 DAS; this confirms that the ethanolic extraction treatment is more branching than aqueous extraction in conformity of their growth habit.

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Table 2: Efficacy of Aqueous and Ethanolic Plant Extracts on Height (cm) Mango before and after Spraying

Treatment	0 DAS	90 DAS	150 DAS
Control Fungucides	8.8 ± 4.6[a]	18.1 ± 3.0[a]	27.2 ± 9.2[a]
Aqueous extract of neem seeds 10%	6.9 ± 2.5[a]	15.6 ± 6.2[a]	27.2 ± 9.2[a]
Aqueous extract of neem seeds 20%	7.7 ± 2.6[a]	18.6 ± 3.6[a]	29.5 ± 4.9[a]
Ethanolic extract of neem seeds 10%	8.0 ± 3.0[a]	18.8 ± 3.8[a]	26.8 ± 4.7[a]
Ethanolic extract of neem seeds 20%	7.5 ± 3.6[a]	19.1 ± 3.1[a]	29.8 ± 6.1[a]
Aqueous extract of garlic 10%	8.3 ± 2.7[a]	18.6 ± 4.5[a]	40.1 ± 6.3[a]
Aqueous extract of garlic 20%	7.3 ± 3.0[a]	18.6 ± 4.1[a]	28.0 ± 5.4[a]
Ethanolic extract of garlic 10%	7.4 ± 2.1[a]	17.7 ± 6.1[a]	28.5 ± 5.0[a]
Ethanolic extract of garlic 20%	8.1 ± 3.3[a]	18.0 ± 4.9[a]	27.0 ± 5.8[a]
Aqueous extract of ginger 10%	7.3 ± 3.0[a]	18.6 ± 4.1[a]	28.0 ± 5.4[a]
Aqueous extract of ginger 20%	7.4 ± 2.1[a]	17.7 ± 6.1[a]	28.5 ± 5.0[a]
Ethanolic extract of ginger 10%	8.1 ± 3.3[a]	18.0 ± 4.9[a]	27.0 ± 5.8[a]
Ethanolic extract of ginger 20%	7.8 ± 2.7[a]	19.1 ± 3.2[a]	28.2 ± 6.1[a]
Interactions			
Treatments × varieties	NS	NS	NS

Mean values with the same letter within the column are not significantly different at $p < 0.05$; ±: standard error; NS: not significant; DAS: days after spraying.

At 65 DAS, plants treated with phyto-extracts showed no significant difference in the incidence of disease (Table 3). Generally, the disease incidence was lower in plants treated with aqueous and ethanolic extracts compared to the control. This is similar to previous work by Ambang *et al.* (2010). Disease incidence among all treatments ranged between 66.67% (lowest) and 88.89% (highest) at 0 DAS (before application) for 10% ethanolic extract of garlic and 20% aqueous extract of garlic, respectively. This shows that 10% ethanolic extract offered the best control measure and reduced disease incidence by 11.11%. This corroborates the results obtained by Kantwa *et al.* (2014), who observed that phyto-extracts of garlic and neem were effective in inhibiting the mycelial growth and sporulation of a pathogenic fungus *Alternaria alternata* Keissler isolated from the infected plant. However, at 90 DAS, the disease incidence was 100% for all the phyto-extract treatments irrespective of the concentrations suggesting that the frequency of application was low.

Disease severity of diseases was significantly ($p < 0.05$) different among extract treatments (Table 3). At 0 DAS, after the application plants treated with extracts showed disease severity comparable to the chemical treatment (16% for fungusep) but significantly lower than the negative control (19%). In other words, at 65 DAP, neem seeds and garlic bulb extracts significantly reduced the severity of disease compared to the negative control. The lowest disease severity was observed on plants following the application of 20% ethanolic extracts of neem (14.74%) seeds and garlic bulb (14.99%) at 90 DAS (Table 3). This result is similar to that obtained from previous studies confirming 20% extracts as the most effective in food poison technique (Ahmad *et al.,* 2016). At 90 DAS, 20% ethanolic extract of neem seeds showed the least disease severity that was significantly different from the other treatments (Table 3). This demonstrates that the extracts of garlic bulbs and neem seeds were effective in

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controlling the disease of Mango with extracts of garlic bulbs reacting faster than extracts of neem seeds. Similar results were obtained by Kantwa *et al.* (2014) when they observed in vitro phyto-extract (garlic and neem) inhibition of mycelial growth of the fungus Alternaria alternata. This confirms previous suggestion by Ambang *et al.* (2008) that host resistance combined with phyto-extract treatment application considerably inhibits the progress of diseases of mango and that the two methods could be used in an integrated management scheme to improve mango production.

Table 3: Incidence and Severity of Mango Disease before and after Application of Extract

Treatments	Disease incidence (%)		Disease severity (%)	
	0 DAS	90 DAS	0 DAS	90 DAS
Control fungucides	77.78 ± 26.35^{a}	100.00 ± 0^{a}	19.14 ± 1.68^{a}	22.58 ± 3.49^{ab}
Aqueous extract of neem seeds 10%	80.56 ± 32.54^{a}	100.00 ± 0^{a}	16.00 ± 1.22^{bc}	19.83 ± 2.58^{ab}
Aqueous extract of neem seeds 20%	80.56 ± 20.83^{a}	100.00 ± 0^{a}	17.19 ± 2.38^{b}	20.99 ± 4.35^{ab}
Ethanolic extract of neem seeds 10%	72.22 ± 34.10^{a}	100.00 ± 0^{a}	17.21 ± 2.09^{b}	21.09 ± 3.24^{ab}
Ethanolic extract of neem seeds 20%	77.78 ± 29.16^{a}	100.00 ± 0^{a}	16.74 ± 1.97^{b}	21.20 ± 2.86^{ab}
Aqueous extract of garlic 10%	72.22 ± 31.73^{a}	100.00 ± 0^{a}	14.74 ± 0.26^{c}	18.47 ± 1.97^{b}
Aqueous extract of garlic 20%	83.33 ± 21.65^{a}	100.00 ± 0^{a}	16.73 ± 1.77^{b}	18.69 ± 2.34^{ab}
Ethanolic extract of garlic 10%	88.89 ± 25.34^{a}	100.00 ± 0^{a}	17.15 ± 2.22^{b}	22.99 ± 5.99^{a}
Ethanolic extract of garlic 20%	66.67 ± 35.35^{a}	100.00 ± 0^{a}	16.93 ± 2.45^{b}	18.69 ± 2.91^{ab}
Aqueous extract of ginger 10%	86.11 ± 28.26^{a}	100.00 ± 0^{a}	14.87 ± 0.47^{c}	18.62 ± 2.20^{ab}
Aqueous extract of ginger 20%	83.33 ± 21.65^{a}	100.00 ± 0^{a}	16.73 ± 1.77^{b}	18.69 ± 2.34^{ab}
Ethanolic extract of ginger 10%	88.89 ± 25.34^{a}	100.00 ± 0^{a}	17.15 ± 2.22^{b}	22.99 ± 5.99^{a}
Ethanolic extract of ginger 20%	86.11 ± 28.26a	100.00 ± 0^{a}	16.93 ± 2.45^{b}	18.69 ± 2.91^{ab}
Interaction				
Treatments × varieties	NS	—	Significant	NS

Mean values with the same letter within the column are not significantly different at $p < 0.05$; ±: standard error; NS: not significant; DAS: days after spraying.

CONCLUSION

In conclusion, the management of fungal pathogens associated with mango diseases using organic materials is a promising and effective strategy. The use of organic materials such as neem oil, garlic, mulch, compost, and biocontrol agents can help control fungal diseases while being safe for the environment. However, the selection of the appropriate organic material and its application should be based on the specific disease and the severity of the infestation. Regular monitoring of mango trees is crucial to detect early signs of disease and implement appropriate management strategies. Overall, the use of organic materials as a management strategy for fungal pathogens associated with mango diseases can contribute to sustainable and eco-friendly mango production. Farmers and mango growers can effectively manage fungal pathogens associated with mango diseases while reducing the environmental impact of agricultural practices. The use of chemical pesticides should be minimized, and organic materials should be used as the first line of defense against fungal pathogens

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associated with mango diseases. Government and non-governmental organizations should support and promote the use of organic materials in mango production to ensure sustainable and eco-friendly agriculture practices.

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Conflict of Interest

The authors have declared that no competing interests exist.

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