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Comparative Effect of Foliar Application of Cow Dung, Wood Ash and Benlate on the Disease Initiation and Development of Roselle (*Hibiscus sabdariffa* L.) Leaf Spot Disease Caused by *Coniella musaiensis* Var. *Hibisci*. in Makurdi, Central Nigeria

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Abstract

A study on the comparative effect of cow dung, wood ash and benlate for the control of leaf spot disease of Roselle (*Hibiscus sabdariffa* L.) was carried out following the preparation and foliar application of the materials on selected Roselle plants of the green and red accessions (Acc_1 & Acc_3) in the field. The cow dung was fermented for 14 days while sour milk was added to wood ash, dissolved and all filtered and labeled. The spraying commenced soon after the plants were thinned to one and was done weekly until after 50% of the plants had flowered. Results showed significant ($p = 0.05$) difference between benlate, the synthetic fungicide and the bio-fertilizers (cow dung and wood ash) for the two years of the study. Disease severity was significantly lower in the benlate than in the bio-fertilizers. There was no significant difference in yield between the treatments although higher yield was recorded in benlate. Though the bio-fertilizers could not suppress infection, they aided the growth of the plants by boosting luxuriant growth. The result showed that these bio-fertilizers cannot be used as substitute to the synthetic fungicide for the control of this leaf spot disease caused by *Coniella musaiensis* var. *hibisci.* However, since they give equally good yield the bio-fertilizers can still be used to minimize the reliance upon use of chemical fungicides.

Keywords

Foliar Application, Cow Dung, Wood Ash, Benlate, Disease Initiation, *Hibiscus sabdariffa* L.,

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Accession, Leaf Spot, *Coniella musaiensis* Var. *Hibisci*

1. Introduction

Several diseases affecting the Roselle plant have been identified and shown to limit the production of Roselle worldwide. Apart from having the same disease situation as *kenaf* [1], it serves as an alternative host for most diseases of *kenaf* [2]. Several of the fungal pathogens have been reported on Roselle in States of Nigeria, where the plant is cultivated, causing varied diseases. Amusa [3] reports a foliar blight caused by *Phyllosticta hibisci* in tropical forest region of southwestern Nigeria. Vascular Wilt of the plant caused by *Fusarium oxysporium* was also reported in the South-Western Nigeria by Amusa; Adegbite and Oladapo [4]. Apart from these diseases, Roselle plant suffers from a leaf spot disease which happens to be the most dangerous disease around Makurdi, Nigeria. This leaf spot disease of Roselle is caused by *Coniella musaiensis* var. *hibisci*. The pathogen was first reported in Nigeria as being a causal agent of leaf spot on *Kenaf* [5].

According to Alegbejo [6], this leaf spot disease, caused by *Coniella musaiensis* var. *hibisci*, though not noticed in Nigeria for long, remains the most important disease of Roselle plant in the country. It has an overwhelming destructive ability on the plant. The first sign of this leaf spot disease appears as water soaked spot (**Plate 1**). These spots are usually small, irregular and light brown in color [7]. These increase in size, covering the whole leaf surface and bleaching it (**Plate 2**). Infected leaves eventually darken, becoming necrotic and distorted (**Plate 3**). Affected leaves have the dead tissues covered with tiny black pycnidia on both the upper and lower epidermis of the leaves.

Diseased leaves drop off the stem when attack reaches this stage. According to Persad and Fortune [7], severe infection usually results in complete defoliation. Symptoms on stems include girdling of stem and stem canker. Severe stem infection results in the death of the plant. Attack on pods and flowers was also reported by Persad and Fortune [7], where that of the pods led to premature dehiscent of the pods.

Though there is no available documentation on the economic importance of the disease in the country, it is no doubt a potential stumbling block to the production of Roselle which is gradually being accepted as an economic crop in Nigeria. No definite control measure has been reported, but synthetic fungicides have been reported to be very effective in the control of many fungal diseases. However, chemical fungicides are very hazardous to the environment causing air pollution and change in soil properties, hence there needs to try environmental

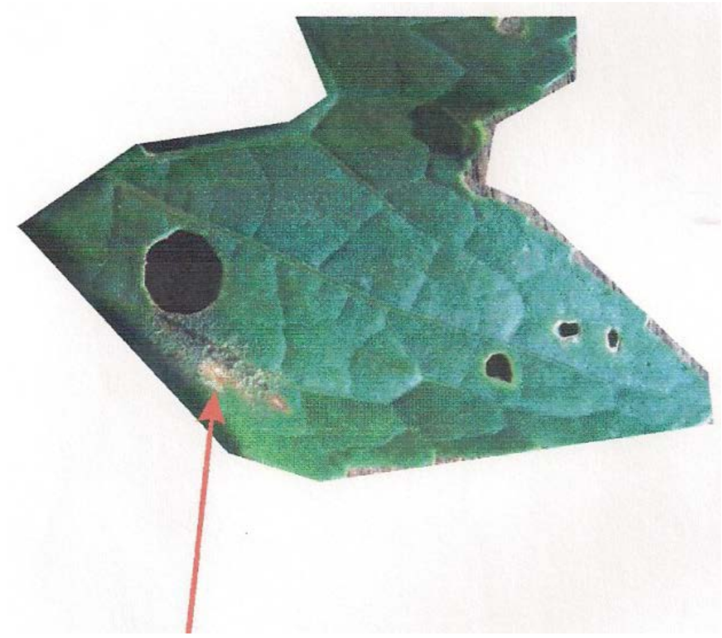

Plate 1. Water-soaked spot on cut section of a Roselle leaf.

Plate 2. Advanced level of disease development on Roselle leaf showing bleached surface area.

Plate 3. Severely infected Roselle leaf showing necrosis and distortion.

friendly measures. The use of cow dung as bio-fertilizer and bio-control has been on for quite some time [8]. The choice of these bio-fertilizers was based on the findings of Basak, Lee and Lee [9] who reported cow dung as being very effective in controlling *Fusarium* Wilt of cucumber. Also Basak, Lee and Lee [10] reported a 75% inhibition of mycelia growth of *Screrotinia sclerotiorum*, a fungal pathogen causing *Sclerotinia* rots of many vegetable crops including cucumber. The control noticed is as a result of the antagonistic action of the microbes that are contained in the cow dung [11]. Swan and Ray [12] reported that *Bacillus substlis* strains from cow dung inhibited the *in vitro* growth of *Fusarium oxysporium* and *Botryodiplodia theobromae*, the causal agents of rots in yam tuber.

2. Materials and Methods

A comparative analysis was done using one synthetic fungicide (benlate) and two bio-fertilizers (cow dung and wood ash) on two accessions of Roselle, the green (Acc_1) and the red (Acc_3). The cow dung was collected from the livestock farm of the University of Agriculture, Makurdi while wood ash was collected from burnt firewood.

2.1. Preparation of Cow Dung

Fermented cow dung was prepared following the method described by Stoll [13]. Dried patches of the cow dung (5 kg) which were collected were mixed with 20 litres of sterile distilled water and maintained in closed plastic buckets and kept under shade [13]. This was stirred daily for 14 days. A handful of clay was added to reduce the unpleasant smell. After the 14 days of fermentation, the mixture was diluted 3 times with sterile distilled water and filtered using cheesecloth. This was labeled C_1 and used for spraying.

2.2. Preparation of Wood Ash

The preparation of wood ash was done following the method described by Stoll [13]. A heaped tablespoon of wood ash representing 5 g was stirred in a litre of water. This was left to stand overnight. It was strained and mixed with a cup of sour milk (Yoghurt). The mixture was diluted 3 times and filtered using cheesecloth before spraying. It was labeled C_2.

2.3. Preparation of Benlate (Benomyl)

The chemical name of this systemic fungicide is Metyl1-[(butylamino) carbonyl]-H-benzimidazol-2-yl carbamate [14]. The fungicide was applied at the rate of 5 kg/ha. This quantity was dissolved in 1000 litres of ordinary water, filtered using cheesecloth and labeled C_3 and was used for spraying.

2.4. Preparation of Field and Planting

The experimental field measured 172.8 m^2 (7.2 m × 24 m). The field was cleared and ridged manually. Each treatment was done on a plot of 2.4 × 3 m with four (4) rows of 1m apart. Seeds of green (Acc_1) and red (Acc_3) Roselle accessions were planted on ridges at a spacing of 60 cm in June 2004 and May 2006. The plants were thinned to one per stand after four weeks of growth. Cow dung c_1, wood ash c_2, benlate c_3 and the control c_4 served as the four treatments applied on plants Acc_1 and Acc_2 and this was replicated three times in a randomized complete block design.

2.5. Application of the Fungicide and Bio-Fertilizers

The application of the materials commenced in July 2004 and June 2006 respectively, soon after the plants were thinned to one per stand, using a knapsack sprayer. This was done weekly until 50% of the plants had flowered.

2.6. Data Collection

Five parameters were used. The parameters were:

1) Disease severity at 50% flowering,
2) Number of branches at harvest,
3) Number of fruits at harvest,
4) Plant height (cm) at harvest,
5) Calyx yield kg/plot.

2.6.1. Disease Severity

Disease severity was taken after 50% of the plants had flowered using 1 - 5 rating scale adapted from Mohanan; Kaveriappa and Nambiar [15]. This depended on the percentage of the infected leaves. This was done by unaided eyes as described in **Table 1**.

Each of the plots had 20 plants each of green and red out of which 6 plants each from the two middle lines were selected and visually rated as stated above for infection.

2.6.2. Number of Branches at Harvest

The branches of each of the 6 selected plants were counted and recorded separately at harvest period.

Table 1. Table of disease descriptive scale.

Disease Score	% of leaves with symptoms	Remarks
1	0	No infection
2	1 - 20	Slight infection
3	21 - 50	Moderate infection
4	51 - 70	Severe infection
5	71 - 100	Very severe infection

2.6.3. Number of Fruits per Plant at Harvest

The number of fruits from the selected plants were counted and recorded at harvest.

2.6.4. Plant Height at Harvest

The height of the selected plants was measured in centimeters and recorded.

2.6.5. Calyx Yield g/ha

Calyces from the fruits of the selected plants were removed using sharp knives. They were dried to stable weights and weighed. The weights were recorded as dry weight of calyces. The area covered by the selected plants was 1.2 m^2. This was used in converting the data to kilograms per hectare.

2.6.6. Analysis of Variance

This was performed for the five traits studied. All statistical analyses were performed using GenStat 5 version 3.2, 1995 (Laws Agricultural Trust: Rothamsted Experimental Station, UK).

3. Result

Analysis of variance for the year 2004 of the treatments showed significant differences between benlate and the bio-fertilizers for disease severity (**Table 2**). Bio-fertilizers had significantly ($p = 0.05$) greater disease severity than benlate. Benlate had the least disease severity score of 1.19 indicating absolute control of the disease. The difference between the bio-fertilizers (wood ash and cow dung) and the control was not significant indicating also lack of control of the disease. Plants treated with cow dung were taller significantly ($p = 0.05$) than those treated with wood ash and the control. There was however no such difference between benlate and cow dung and between control and wood ash. Number of branches, number of fruits and calyx yield were not significantly different in the treatments. Accession showed significant difference in number of branches and number of fruits only. The green accession (Acc_1) had significantly greater number of both branches and fruits than the red accession (Acc_3). In this result plants treated with benlate had the best yield as indicated by the scores. Yield in control was even better than in the bio-fertilizers.

The parameters tested responded differently to treatments as indicated in **Table 3** in the preceding year being 2006. Benlate had the least disease severity score of 1.08 making it significantly ($p = 0.05$) different from the bio-fertilizers and control. Wood ash and cow dung which were the bio-fertilizers and the control, had higher scores which shows lack of control of the disease. The rest of the parameters showed no such difference at significant level. However, cow dung gave the largest yield which was not significant at 5% significant level.

The case of differences in the accessions for the parameters was noticed but none was significant ($p = 0.05$). In the use of synthetic fungicide and the bio-fertilizers, benlate significantly ($p = 0.05$) reduced disease severity and also increased yield. Cow dung and wood ash rather increased severity of the disease even. The control of the disease by use of synthetic fungicide (benlate) was highly good. On the other hand the bio-fertilizers rather increased the severity of the disease well above even the untreated. This goes to confirm the moisture loving nature of this pathogen as the application of these bio fertilizers was accompanied with much water.

4. Discussion

Between the synthetic fungicide (benlate) and the bio-fertilizers, control was near absolute in benlate and absent

Table 2. Effect of synthetic fungicide and other bio-fertilizers on disease severity and other agronomic characteristics of two Roselle (*Hibiscus sabdariffa*) accessions, green (Acc_1) and red (Acc_3), in Makurdi, Nigeria during the 2004 cropping season.

	Disease severity	Plant height (cm)	No. of branches	No. of fruits	Calyx yield (g/plot)
Treatment (2004)					
Benlate	1.19	13.85	24.70	67.60	22.0
Cowdung	4.44	14.68	31.10	57.50	16.80
Woodash	4.99	11.30	24.00	49.00	12.20
Control	4.10	11.80	27.50	51.50	18.50
Accession					
1	3.75	12.70	29.20	83.20	16.80
3	3.61	13.12	24.50	29.50	17.90
LSD (5%)-Treat.	1.30^{*}	2.23^{*}	6.32^{ns}	19.42^{ns}	9.77^{ns}
LSD (5%)-Acc.	0.97^{ns}	1.58^{ns}	4.47^{*}	13.73^{*}	6.91^{ns}

LSD = least significant difference. ns = indicates not significant at 5%. * = Significant at 5%.

Table 3. Effect of synthetic fungicide and other bio-fertilizers on disease severity and other agronomic characteristics of two Roselle (*Hibiscus sabdariffa*) accessions, green (Acc_1) and red (Acc_3), in Makurdi, Nigeria during the 2006 cropping season.

	Disease severity	Plant height (cm)	No. of branches	No. of fruits	Calyx yield (g/plot)
Treatment (2006)					
Benlate	1.08	72.90	21.36	76.30	19.60
Cowdung	4.66	69.30	20.52	68.60	21.80
Woodash	4.50	80.60	22.51	76.80	19.00
Control	4.61	79.10	22.80	75.10	21.50
Accession					
1	3.70	74.20	21.37	81.60	20.30
3	3.73	76.80	22.23	66.80	20.70
LSD (5%)-Treat.	0.29^{*}	14.26^{ns}	4.64^{ns}	23.29^{ns}	6.88^{ns}
LSD (5%)-Acc.	0.21^{ns}	10.09^{ns}	3.28^{ns}	16.47^{ns}	4.86^{ns}

LSD = least significant difference. ns = indicates not significant at 5%. * =Significant at 5%.

in the bio-fertilizers in both the two years (**Table 1** and **Table 2**). A similar result was obtained in the case of yield where benlate treated plants had the highest scores in both the two years (**Table 1** and **Table 2**). The result of the treatments showed that these bio-fertilizers cannot be substitute to the synthetic fungicides. Though there had been an induced resistance in rice against *Xanthomonas oryzae* pv. *oryzae* by foliar application of cow dung water extract [16] [17]. In this case cow dung and wood ash rather increased severity of the disease rather than reducing it. The result confirms the love for moisture by this pathogen as reported by Persad and Fortune [7]. Though the bio-fertilizers could not suppress infection, they aided the growth of the plants by boosting luxuriant growth.

5. Conclusion

The control of the disease by use of synthetic fungicide (benlate) was highly effective. On the other hand, the bio-fertilizers rather increased the severity of the disease on the treated plants well above the even untreated plants. This goes to confirm the moisture loving nature of this pathogen as the application of these bio-fertilizers was accompanied with much water. It means that any control measure against this pathogen that requires excessive use of water or moisture should be avoided.

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