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Assessment of Ultimax Plus 72 W.P. for the Control of Black Pod Disease of Cocoa in Nigeria

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ABSTRACT

Ultimax Plus 72 W.P was screened for its efficiency and safety in-vitro and on field. The composition of the test fungicide was analysed in the laboratory. The in-vitro screening examined the radial mycelial growth of the *Phytophthora megakarya* on different fungicides treated PDA Plates. Field experimental design was carried out with F_3 Amazon cocoa varieties plantation in a Randomized Complete Block Design (RCBD). The chemical analysis showed that Ultimax Plus 72 W.P. contained 62.0% copper oxide and 12% Metalaxyl. The *in vitro* assay revealed that Ultimax Plus 72 W.P. had 79.8% growth inhibition on *P. megakarya* . The total black pod incidence depicts that there was no significant difference between Ultimax Plus 72 W.P. and Ridomil Gold 66 W.P. treated plots, but statistically different from the control. A comparative significant increase in pod production on the plot treated with Ultimax Plus 72 W.P. was observed. The residue analysis of Metalaxyl in cocoa beans showed that the LoD was 0.01 mg/kg. With respect to percentage suppression of *P. megakarya*, LoD level in cocoa bean and the increase in pod production observed, Ultimax Plus 72 W.P is recommended for farmers' use on cocoa plantation.

KEY WORDS: Cocoa, fungicide, pesticide residue, *P. megakarya,* Ultrimax Plus.

INTRODUCTION

Cacao, a tree native to the upper Amazon region of South America, suffers from severe losses due to pests and diseases everywhere it is cultivated [1, 2]. Since the beginning of *cacao* cultivation, the fungal disease has remained the major limiting factor of production both quantitatively and qualitatively [3]. Black-Pod Rot (BPR), caused by several species of the straminipile (formerly oomycete) genus *Phytophthora*, is the main disease affecting the cacao crop (*Theobroma cacao* L.) worldwide [4, 5]. It probably causes more production losses globally than any other disease of cocoa [6] with annual losses of up to 90% of pod production, depending on the environmental conditions [7, 1].

In Central and West African countries, cacao is one of the most important cash crops. More than two million farmers grow cacao on smallholdings in these regions resulting in approximately 70% of the world's cocoa [8]. However, black pod disease is a major constraint to the cocoa production [9]. Among the *Phytophthora* species causing black pod, *P. megakarya* is the most aggressive causal agent of black pod in Central and West Africa causing total loss of pods [10]. It is endemic to Equatorial Guinea, Gabon, Cameroon, Togo, Nigeria, Ghana, and is still in an invasive phase in Côte d'Ivoire [11]. In Nigeria, there has been consistent downward trend in cocoa production and position in the world market [12], most importantly due to pest and disease outbreaks among other factors [13]. Reports have, however, shown that in Nigeria losses up to 100% have been observed with some virulent strains of *Phytophthora megakarya* [13, 14].

To combat black pod disease of cocoa, copper and metalaxyl-based fungicides are applied [15]. The use of chemical which are copper and metalaxyl-based fungicides has undoubtedly resulted in increased crop production, hence it has been popular among farmers because of its quick and relatively effective action. Notwithstanding, heavy reliance on chemical in existing control regimens may lead to resistance of the pathogen to fungicides [16]; while runoff from heavy rainfall, common in cacao growing regions of West Africa, may lead to soil and water pollution. The quantity and frequency of metalaxyl application have escalated with the advent of metalaxyl-tolerant crops and is likely to remain so with regard to projections of higher cocoa production rates in future in the main farming regions in Africa. Sequel to the aforementioned challenges associated with the use of fungicides and the growing movement to reduce the amount of chemicals being released into the environment, the need to establish the efficacy and safety of pesticides cannot be overemphasized, hence the need to screen the fungicides in usage.

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Cocoa Research Institute of Nigeria (CRIN) is the only Government agency in Nigeria saddled with the responsibility of fungicide screening for black pod disease, in order to achieve economically and environmental friendly control of this disease. Thus, the objective of this work therefore, is to screening Ultimax Plus 72 W.P. fungicide for its effectiveness and safety use on cocoa farms.

METHODOLOGY

Plot Location

The plots for the field trials were located in Ibadan (Oyo State), Owena (Ondo State) and Ajassor (Cross-River State), all in Nigeria. These are forest and humid regions, with history of high black pod disease infestation.

Sample Collection

The fungicides used was obtained from chemical company and retailing stores in Ibadan, Oyo State.

Percentage Composition of the Test Fungicide (Ultimax Plus 72 W.P)

Chemical analysis to determine percentages of active ingredients and impurities were done at Rotas Soilab Limited, Ibadan, Oyo State, Nigeria

In-vitro screening

The *in-vitro* screening was done using Potato Dextrose Agar (PDA). The PDA was prepared according to the manufacturer's instruction. The Ultimax Plus 72 W.P. was screened in-vitro with comparism to Ridomil Gold 66 W.P., an earlier approved fungicide on cocoa in Nigeria. A preparation of 2.8 and 3.3g/litre of each were made. Two milliliters of each treatment, was introduced separately into plates of molten PDA at 45^{o}C. Distilled water was used as control. The plates were swirled for the agar to mix thoroughly with the fungicide. Two milliliters disc of 7 day old *Phytophthora megakarya* was thereafter inoculated into each plate and incubated for 10 days. Radial mycelial growth of the fungus was measured daily till the fungus covered the entire plate. The experiment was done in replicates. Percentage inhibition was determined thus:

$$I = \frac{C - T}{C} \times 100$$

Where I – Percentage Inhibition

C – Growth in Control

T – Growth in Treatment

Field Trials

The field trials of Ultimax Plus 72 W.P. with 60% Copper-1-oxide + 12% Metalaxyl active ingredients were carried out at Ibadan (Oyo State), Ajassor (Cross River State) and Owena (Ondo State). The sites used for these studies contained F_3 Amazon cocoa varieties planted in rows at the spacing of 3.1m x 3.1m. The experimental design was a Randomized Complete Block Design (RCBD) with three blocks. The treatment plots contained nine trees each separated by three rows of trees. Each treatment had three replicates.

Treatments

The Ultimax Plus 72 W.P. was evaluated at 33g compared with Ridomil Gold 66 W.P. at the same rate. Each treatment was applied in 10 litres of water for its effectiveness against *Phytophthora* pod rot of cocoa using CP-15 knapsack sprayer. A treatment with water only served as the control. Pods on the trunks were sprayed to run-off and as much as possible up to the canopy. Unsprayed guard trees were located between plots. There were six applications at tri-weekly intervals. Data were collected on disease and healthy pods at tri-weekly interval. Analyses of variance (ANOVA) and multiple comparison tests were carried out on the data using GENSTAT package version 8 (VSN International Ltd., Lawes Agricultural Trust, Hempstead, U.K.).

Residue Analysis

Mature and ripened cocoa pod were harvested separately from the test plots. The pods were broken, beans extracted, fermented and sun dried. The beans from each test plot were kept separately in sealed thick brown envelopes and stored. The coded cocoa bean samples were forwarded to a standard analytical laboratory in United Kingdom to determine the magnitude of residue of the Metalaxyl (as contained in Ultimax Plus 72 W.P.) in cocoa beans samples harvested.

RESULTS

The chemical analysis showed that Ultimax Plus 72 W.P. contained 62.0% copper-1-oxide and 12% Metalaxyl as active ingredients (Table 1). The *in vitro* assay revealed that Ultimax Plus 72 W.P. had 79.8% growth inhibition on *Phytophthora megakarya* . The radial growths of the pathogen were 1.12cm and 1.43cm against Ultimax Plus 72 W.P. and Ridomil Gold 66 W.P., respectively at 3.3g/litre. However, these were significantly different from the radial growth observed with the control ($p \leq 0.05$) (Table 2).

Ultimax Plus 72 W.P. compared favourably with Ridomil Gold 66 W.P., another CRIN recommended fungicide (Tables 3-8). The total black pod incidence depicts that there was no significant difference between Ultimax Plus 72 W.P. and Ridomil Gold 66 W.P. treated plots (Table 3), although it was statistically different from the control ($p \leq 0.05$). There was a significant increase in pod initiation on the plot treated with Ultimax Plus 72 W.P. at all locations as compared with other treatments (Table 4). This was followed by Ridomil Gold 66 W.P. in contrast with the control.

The residue analysis of Metalaxyl in cocoa beans as carried out in a standard laboratory in United Kingdom did not detect any residues of Metalaxyl present at or above the Limit of Determination (LoD). The LoD in the sample was 0.01 mg/kg, which was an order of magnitude (x10) less than the MRL set for Metalaxyl on cocoa imports into the EU.

Table 1: Laboratory analysis of Ultimax Plus 72 W.P.

Analysis / Observation	Result
Color of the chemical	Light brown
Type / Form	Powder
Toxicity	Toxic to fungi
% Copper -1-Oxide	60%
Metalaxyl	12%
% Impurities	0.09%

Table 2: *In-vitro* screening of Ultimax Plus 72 W.P. in comparison with Ridomil Gold

Fungicide	Concentration (g/litre)	Radial growth (cm)	Growth inhibition (%)
Ultimax Plus	3.3	1.12b	79.8
	2.8	1.33b	76.0
Ridomil Gold	3.3	1.43b	74.0
	2.8	1.77b	68.0
Control	-	5.53a	-

Each value is the mean of 3 replicates.

Means followed by the same letter in the same column are not significantly different according to LSD (5%)

Table 3: Comparative screening of Ultimax Plus 72 W.P. with Ridomil Gold at different locations.

Treatment	% Disease pods at different fungicide application (three weekly interval)						
	1	2	3	4	5	6	Total (%)
	OWENA Location						
Ridomil Gold	40.70b	14.39b	13.38b	5.33b	0.00b	0.00b	**8.58b**
Ultimax Plus	28.57c	15.13b	9.53c	0.00c	0.00b	0.00b	**7.69b**
Control	72.70a	79.22a	82.92a	91.47a	93.22a	94.89a	**88.35a**
	AJASSOR Location						
Ridomil Gold	40.03b	14.29b	13.33b	5.00b	0.00b	0.00b	**8.57b**
Ultimax Plus	28.57c	15.03b	9.52c	0.00c	0.00b	0.00b	**7.69b**
Control	70.03a	78.57a	81.25a	89.47a	89.47a	94.44a	**85.42a**
Treatment	IBADAN Location						
Ridomil Gold	40.13b	14.29b	13.33b	5.00b	0.00b	0.00b	**8.57b**
Ultimax Plus	28.60c	15.03b	9.52c	0.00c	0.00b	0.00b	**7.69b**
Control	66.03a	78.57a	81.25a	89.47a	89.47a	94.44a	**85.42a**

Each value is the mean of 3 replicates.

Means followed by the same letter in the same column are not significantly different according to LSD (5%)

Table 4: Total number of pods at each spraying application at different locations.

Treatment	Spraying Application 1	2	3	4	5	6	Total
				OWENA Location			
Ridomil Gold	8a	12a	14b	18b	22a	21a	**95b**
Ultimax Plus	9a	14a	18a	20a	21a	22a	**104a**
Control	8a	10b	12c	13c	16b	18b	**77c**
				AJASSOR Location			
Ridomil Gold	10b	14b	15b	20a	23a	23a	**105b**
Ultimax Plus	14a	20a	21a	20a	21a	21a	**117a**
Control	10b	14b	16c	19a	19b	18b	**96c**
				IBADAN Location			
Ridomil Gold	9a	12a	15b	20b	22a	22a	**100b**
Ultimax Plus	9a	14a	19a	22a	22a	23a	**109a**
Control	9a	10b	13c	13c	16b	18b	**79c**

Each value is the mean of 3 replicates.

Means followed by the same letter in the same column are not significantly different according to LSD (5%)

DISCUSSION

Cocoa farmers have a wide range of pesticides to limit losses from pests and diseases in cocoa agriculture. However, most effective and widely use pesticides are those copper and metalaxyl-based fungicides. Hence, the favourable comparism between Ridomil Gold 66 W.P. and Ultimax Plus 72 W.P obtained in this study is well deserved as Ultimax Plus 72 W.P active ingredients include metalaxyl and copper-1-oxide specified by Alderelm Limited, United Kingdom. The significant increase in pod production due to treatment with Ultimax Plus 72 W.P. at all locations could be as a result of the effective disease control and protection it offered on field since it is a broad spectrum fungicide and bactericide. Similar findings have been reported by Khan *et al*., [17]), where seed yield increased with an increase in insecticide levels. Norgrove {18] also reported that cocoa yields were 2.5 times greater in the high spray treatment than in the low spray treatment.

The residue analysis of Metalaxyl in cocoa beans did not detect any residues of Metalaxyl present at or above the Limit of Determination (LoD). The LoD was 0.01 mg/kg in this study, which did not exceed the Maximum Residue Limit in cocoa beans which is 0.1 mg/kg. Based on the results of the current concentrations of Ultimax Plus 72 W.P. residue in the cocoa bean analyzed, it is safe to state that Ultimax Plus 72 W.P does not pose a serious threat to the cocoa industry and that Ultimax Plus 72 W.P contamination should not be a limiting factor for cocoa bean uses in cocoa products and derivates such as chocolate, cocoa powder, cocoa creams and others.

CONCLUSION

From the results of *in-vitro*, field trials and residue analysis, Ultimax Plus 72 W.P. is an effective fungicide for the control of *Phytophthora* pod rot of cocoa. Therefore, Ultimax Plus 72 W.P. is worthy of recommendation for the control of *Phytophthora* pod rot of cocoa.

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