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RESEARCH ARTICLE

BIOCONTROL EFFICACY OF FUSARIUM OXYSPORIUM AGAINST MIMOSA DIPLOTRICHA WEED

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ABSTRACT

Weed is a terrible pest that has a negative impact on biodiversity and agricultural production, and the application of natural mycoherbicides represents one of the most innovative and promising strategies to suppress invasive weeds and improve crop productivity. During the 2020–2021 growing seasons, the efficacy of a Fusariumoxysporummycoherbicide against Mimosa diplotricha weed was examined in the field. The mycoherbicide application significantly (p 0.05) reduced Mimosa diplotricha percentage emergence, and infection rate, and increased garden egg yield. These results encourage the need to search for new mycoherbicides that replace synthetic herbicides and pesticides.

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INTRODUCTION

Mimosa diplotricha, C. Wright ex Sauvalle (Syn. *Mimosa invisa* Mart.) belongs to the family, Fabaceae) **(**Holm *et al.* (1977). It is one of the 76 worst invasive species in the world. It was classified as a weed in 18 countries and 13 different commodities (Gibson and Waring, 1994; (Alabi *et al*., 2001). The weed has a substantial negative influence on economically important crops, cattle, and forest flora in Nigeria. It is a concern in many parts of the world, including India, Borneo, Fiji, Malaysia, Melanesia, New Guinea, West Polynesia, Philippines, Taiwan, Australia, Indonesia, Pacific islands, South-East Asia, Mauritius, and Nigeria (Holm *et al.* (1977). Garden egg *Solanummacrocarpon*(BBS 119), is a member of the Solanaceae family. It is indigenous to sub-Saharan Africa and inhabits both temperate and tropical climates (Lock *et al*., 2004). It is a herbaceous plant of socioeconomic, cultural, nutritional, and medicinal importance (Omotesho *et al.*2017). One of the factors limiting the production of garden eggs and other vegetables is weed pressure ((6)Ike *et al*. 2014). Yield loss may occur if weeds heavily infest the garden egg (Ike *et al*. 2014, Sunday and Winifred 2020). It has been established that *Fusariumoxysporum* has the potential to be used as a biocontrol agent to manage a variety of pests (Marley *et al*.,1999; Kurose *et al*., 2023). This study's primary objectives were to assess the effects of *M. diplotricha* weed on local garden egg yield and to test the effectiveness of three indigenous strains of *Fusariumoxysporum* f. sp. diplotricha (FoOW, FoEN, and FoPH) against *M. diplotricha* emergence and infection rate on local garden egg cultivars that were susceptible at three sites in the humid tropical region of Nigeria.

MATERIALS AND METHODS

Experimental sites: In Owerri, Port Harcourt, and Enugu, all of which are situated in the humid tropical region of Nigeria, between longitude 3°E and 12°E and latitude 4°N and 9°N, within the Guinea Coast zone of West Africa (Ogungbenro and Morakinyo, 2014; Akinsanola *et al., 2016*), this study was carried out at three farmer's fields with a history of *Mimosa diplotricha* infestation. The extensive range of *M. diplotricha* in Nigeria is known to occur in the humid rainforest, derived savannah, and southern Guinea savanna agroecological zones (Alabi *et al*., 2001; Ogbe and Bamidele, 2006). However, the climate, the properties of the soil, and the crop and soil management are the same throughout the entire region (Dania *et al*., 2019). It is also touched by the West African monsoon is localised convection and unpredictability, which contributes to the beginning of precipitation in May and its end in October (Sanogo *et al*., 2015). The selection of the places is based on their importance in the *M. diplotricha* invasion. The garden egg (*Solanummacrocarpon*) was also chosen because of its socioeconomic, high demand, nutritional, and therapeutic advantages (Bertoia *et al*., 2015; Omotesho *et al*., 2017), as well as the fact that it is a green and fruit vegetable native to temperate and sub-Saharan Africa (Lock *et al*., 2004).

Experimental design: Before planting, *M. diplotricha* was inoculated with *Fusariumoxysporum* f. sp.*diplotrica* strains from three different ecological areas (Owerri municipal, Enugu city, and Portharcourt city).At each site, three blocks were arranged using a completely randomized block design, in three replications.

Each plot measures 28 by 25 metres, and a block contains six plots. A control was also kept in a place where seeds were planted without an inoculant during the 2021 and 2022 cropping seasons.

Isolation of the fungi: *M.diplotrica* plants displaying indications of necrosis and wilting were removed from farms in the cities of Owerri, Enugu, and Port Harcourt. Before being brought to the laboratory of the Department of Plant Science and Biotechnology at Imo State University, Owerri, they were placed in paper bags. One-centimetre-long portions of diseased *M. diplotrica* samples were cut into pieces and sterilised in a 1% sodium hypochlorite solution for five minutes. The tissues were sterilized by thoroughly rinsed three times with distilled water. Then Chloramphenicol antibiotic was added to potato dextrose agar (PDA), to inhibit the growth of bacteria, The set-up was incubated at 25°C for 18 to 24 hours and checked for the development of pinkish/purple mycelia. Serial dilutions were made to produce pure cultures on PDA-sterile media. Observations were made using a compound microscope.

Field management: Mature (senesce) *Mimosa diplotricha* pods were collected in November 2020 and November 2021 for the studies in 2021 and 2022 cropping seasons, respectively from three farms in Owerri municipal, Enugu city, and Portharcourt city,(in the humid tropical agroecological zones of Nigeria) that were highly infected with *M. diplotricha.*The outer covering of the seeds was cut using a scalpel to break their dormancy (Silveira and Fernandes, 2006). Until they were used, the seeds were kept at room temperature (25°C) in a plastic container. Before planting, *M. diplotricha* was inoculated with *Fusariumoxysporium* f. sp.*diplotrica* strains from three different ecological areas (Owerri municipal, Enugu city, and Portharcourt city). *M. diplotrica* seeds that had been sun-dried were primed for 10 hours and dressed with 40 g of *F. oxysporum*for every 600 seeds, untreated dried seeds served as control (Woomer*et al.* 2004). We purchased garden egg seedlings from the Imo State Agricultural Development Programme. In each site, the garden egg seeds were planted in ridges with a 70 cm between-rows and 30 cm within-rows spacing.There were nine rows with eight plants each, giving each plot a total plant population of 72. One teaspoon of fertiliser (N.P.K. granules) was poured into each planting hole. Two weeks after germination, the seedlings were decreased to one per hole. All weeds, with the exception of *M.diplotrica* were manually removed every two weeks, to prevent interference with the growth of garden egg.

***M. diplotricha* emergence:** In order to reduce border effects, the percentage number of emerged seedlings, within a 15 cm circle surrounding each garden egg was counted from the three inner rows. The emergence was calculated as described by (Zhang *et al*., 2020).
Seed germination rate (%)= Number of germinated seeds/Total number of seeds ×100

***M. diplotricha* infection rates:** For the purpose of calculating percentage infection rates, the fraction of *M. diplotrica* plants displaying wilt symptoms was employed. Infection rate was calculated as described by (Zhang *et al*., 2020).

Seed infection rate (%)= Number of seeds infected by fungi/Total number of seeds ×100;

Garden egg yield: The number of garden eggs per sampled plant per plot was counted at maturation. The garden egg fruit production was calculated by pre-labelling and counting the number of fruits on each plant per square metre. The number of fruits was converted to grammes per square metre. The moisture content of the garden eggs could be ascertained by randomly choosing three of them in each plot, and placing them in a moisture meter. It was carried out three times. The fruit weight per plot and the moisture content (MC) were used to determine the yields in tonnes per hectare.

Data and statistical evaluation: All the collected data were subjected to an analysis of variance (ANOVA) using MINITAB 19 software package and significant differences between themeans are obtained using the LSD test ($p < 0.05$).

RESULTS

Emergence of *M.diplotricha:* The proportion of *M.diplotricha* emergence in all treatments with *Fusariumoxysporium* strains showed a high significant difference (p .05) in the ANOVA findings. Control (untreated) weed had the highest rate of emergence, followed by FoOW, and FoPH had the lowest rate of emergence,except for Enugu, there was no discernible difference in the emergence of*M.diplotricha* in Owerri and Port Harcourt in 2021. In contrast, there was no discernible difference in the emergence of *M.diplotricha* throughout the zones in 2022 (Table1).

Rate of infection: The *M. diplotricha* infection rate varied significantly across all treatments over the experimental years of 2021 and 2022, according to the ANOVA results. FoPH-treated weed had the highest infection rate, whereas untreated (control) weed had the lowest infection rate. However, there was no discernible difference in the infection rate between the two experimental years. (Table 2).

Garden egg yield: During the experimental years, garden egg yields varied significantly across all treatments. Untreated (control) showed the maximum yield, while FoPH showed the lowest yield. Although there was no significant difference in yield across the zones during the experimental year of 2021, but in 2022 Owerri scored the highest yield while Enugu had the lowest. (Table 3)

DISCUSSION

The result of the study showed that *F. oxysporium* is a suitable biocontrol agent for the invasive plant due to its effectiveness in decreasing *M.diplotricha* emergence and increasing its infection rate.

Emergence of *M.diplotricha*: Different factors may have affected *F. oxysporium* strain treatments' ability to effectively reduce *M. diplotricha* weed emergence. The decrease in emergence observed in the current result is consistent with earlier findings that application of *Fusariumpallidoroseum*, fsp mimosa strain, reduced Mimosa seedlings (APFISN, 2008), and also reduced some weed population (Atera*et al*.,2013,Avedi *et al*.,2014,Shayanowako*et al*.,2020). However, according to various studies (Kanampiu*et al*., 2003, Yonli*et al*., 2005), variations in soil moisture content, rainfall, and high temperatures have an impact on plant seed emergence. Additionally, similar evolutionary groups of *F. oxysporium* may not exert equivalent control over weeds, (Atera*et al*., 2013).

Rate of infection: Our field tests showed that *F. oxysporum*is effective against*M.diplotricha* starting with ungerminated seeds, and symptoms persist all the way to maturity. The irregular and erratic rainfall as well as the high temperatures associated with humid tropical agroecological zones may be the cause of the high infection rates in the local *F. oxysporum* isolated from different zones. However,Ciotola *et al*., 2000 observation thatfusarium-based mycoherbicides sprayed before sowing minimised*S. hermonthica*infestation in field and controlled environment, is consistent with our findings. The significant infection rate seen in this study is nevertheless similar to the report that*Corynesporacassiicola*, a stem-spot fungus unique to *M. diplotricha*, induced dieback and defoliation as well as decreased blooming and seed production (DAF, 2016). However, *Fusariumoxysporum* isolates have been demonstrated to reduce Witch Weed in fields (DYonli*et al,* 2005), and *Fusariumoxysporum* forma specialisperniciosum was reported to colonize and clog the vascular tissue as well as obstruct the movement of Mimosa (*Albiziajulibrissin*sap) (Miller, 2008).

Garden egg yield: The increased yield may be attributable to the combined effects of the fungal isolates that improve soil physical properties and nutrient addition (Avedi*et al*., 2014), and the inorganic fertilizer used at sowing. Furthermore, the application of*F. Oxysporum* strains is hoped to lessen the *M.diplotricha*seed bank and its threat to crop yield.

Table 1. Effects of different *F.oxysporium* strains on *M.diplotricha* percentage emergence rate during the growing zones and seasons

	2021			2022		
Treatments						
	Sites			Sites		
	Owerri	Enugu	Port Harcourt	Owerri	Enugu	Port Harcourt
Control	88.53(±0.757)a	88.63(±0.321)a	89.53(0.643)a	90.03(0.351)a	89.0(1.200)a	89.6(0.40a
Fo OW	27.26(±0.25)b	26.70(26.70)b	27.0(0.513)b	27.0(0.400)b	25.8(1.012)b	26.73(0.513)b
FoEN	25.4(±0.25)c	25.0(0.252)b	24.9(0.10)c	26.10(0.300)c	22.07(0.252)c	25.07(0.252)c
FoPH	20.4(±0.1528)d	19.8(0.1528)c	20.3(0.306)d	18.70(0.436)d	19.63(0.709)d	18.97(0.1528)d

Means that do not share a letter are significantly different. Values in brackets are the standard deviations of the treatments

Table 2: Effects of different *F.oxysporium* strainson *M. diplotricha* percentage infection rate during the growing zones and seasons (Table 2)

	2021			2022		
Treatments						
	Sites			Sites		
	Owerri	Enugu	Port Harcourt	Owerri	Enugu	Port Harcourt
Control	0.4(0.125)d	0.65(0.05)d	0.32(0.020)d	1.20(0.185)d	1.21(0.185)d	0.34(0.1250)d
FoOW	36.0(0.404)c	36.03(0.473)c	35.53(0.153)c	35.73(0.252)c	35.73(0.252)c	36.63(0.404)c
FoEN	43.50(0.100)b	43.63(0.321)b	42.76(0.306)b	41.47(0.252)b	41.47(0.252)b	43.50(0.100)b
FoPH	54.80(0.252)a	54.30(0.252)a	55.23(0.400)a	55.23(0.306)a	56.60(0.300)a	54.76(0.25)a

Means that do not share a letter are significantly different. Values in brackets are the standard deviations of the treatments

Table 3. Effects of different *F.oxysporium* strains on Garden egg yield (t/ha) during the growing zones and seasons

	2021			2022		
Treatments						
	Sites			Sites		
	Owerri	Enugu	Port Harcourt	Owerri	Enugu	Port Harcourt
Control	3.267(0.252)a	3.000(0.300)a	3.233(0.404)a	3.2000(0.100)a	3.5000(0.1000)a	3.3000(0.1000)a
Fo OW	2.300(0.300)b	2.3700(0.231)b	2.4700(0.152)b	2.467(0.306)b	2.6000(0.1000)b	2.5333(0.1528)b
FoEN	2.333(0.306)b	2.367(0.231)b	2.460(0.306)b	2.233(0.208)b	2.1667(0.15)c	2.3333(0.1155)b
FoPH	1.080(0.197)c	1.0100(0.1015)c	1.037(0.228)c	0.823(0.264)c	1.2233(0.0751)d	1.3333(0.065)c
F- value	36.34	32.86	30.39	54.85	219.41	154.62
P-value	0.000	0.000	0.000	0.000	0.000	0.000

Means that do not share a letter are significantly different Values in brackets are the standard deviations of the treatments

CONCLUSION

Our results clearly show the potential of mycoherbicide controlling *M.diplotricha* weed. However, an integrated approach to manage this invasive weed such as cultural practices, and host plant resistance should be encouraged. The *Fusariumoxysporium*m ycoherbicide should be formulated into granules of seed treatment, for effective results. Future studies should include*F.oxysporum* isolated from soil.

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