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EMERGENCE AND SEEDLING GROWTH OF MIMOSA DIPLOTRICHA C. WRIGHT EX SAUVALLE AND ITS COMPETITION WITH GARDEN EGG IN RESPONSE TO SAWDUST AND PALM KERNEL SHELL MULCH

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SUMMARY

The influx and destructive characteristic of *Mimosa diplotricha* weed in most farming land in the humid tropical agroecosystems calls for sustainable control. A field experiment was conducted to evaluate the effects of different levels of sawdust and palm kernel shell mulch (1.5, 3.0, and 4.5 tonnes per hectare) and unmulched (control) on *M. diplotricha* weed emergence and seedling growth in a garden egg farm at the Imo State University, Botanical garden, in 2018 and 2019 cropping seasons. The effects of the two mulches and *M. diplotricha* on garden egg performance and yield were quantified. A randomized complete block design(RCBD) with three replicates in two growing seasons was developed. Results showed that palm kernel shell and sawdust mulch reduced *M. diplotricha* emergence, root and shoot lengths, and biomass in both experimental years compared to unmulched soil, while, on the other hand, increased the garden egg biomass, leaf area, and fruit yield. The performance of *M. diplotricha* and garden eggs was unaffected by either of the research years but was impacted by mulch volume. Therefore, *M. diplotricha* emergence in the garden egg farm can be suppressed by the application of a thick volume of rice husk and palm kernel shell mulch and may lead to a profitable garden egg production system, and a reduction in future weed infestation. In addition, these agro-waste mulch could be used as a non-chemical and sustainable weed management approach that could help to decrease the use of synthetic herbicides and manual labour.

Keywords: *Mimosa diplotricha*; agro-wastes, sawdust; palm kernel shell

***Mimosa** diplotricha* C. Wright ex Sauvalle belongs to the class, Mimosaceae (1). It is a problematic perennial weed, native to the Americas (2) It has invaded large parts of Asia and Africa (3). It impacts negatively on existing plant communities and poses a threat to biodiversity, agricultural productivity and delivery of ecosystem services (3). It is a scrambling climber, that smothers other vegetation and has sharp and curved thorns that cause painful wounds to livestock, and humans, preventing access to farmlands (1). Up to 10,000 seeds can be produced by a single plant in a single year (1), and some seeds may take several years to germinate in the soil. Some countries like Australia and some Pacific Islands have started many eradication or control methods for this weed (4), but the methods are not sustainable.

The garden egg (*Solanum macrocarpon* is a member of the Solanaceae family (5). It is distributed in temperate and tropical areas and is indigenous to sub-Saharan Africa (6). It is a herbaceous plant with some socioeconomic, cultural, high-demand, nutritious, and therapeutic values (6).

Mulch exerts a significant impact on plant health, crop productivity, weed suppression (8), and soil's physical, chemical, and biological properties (9, 10). In addition, dead organic mulch may release some phytotoxins that inhibit seed germination and early growth (11). Sawdust and palm kernel shell are abundant in the rainforest zone and decompose slowly.

Weeds are a prominent factor that hinders crop production, leading to substantial decreases in both plant yield and quality (12). Weeds engage in competition with agricultural plants for essential resources such as nutrients, water, light, and space, leading to a subsequent decrease in crop productivity (13). The cultivation of garden egg, similar to other crops, has a distinct critical period that necessitates the implementation of weed management measures in order to mitigate potential reductions in yield.

However, natural mulch such as palm kernel shell and sawdust are low cost, suitable for waste management, biodegradable, eco-friendly, and available throughout the year.

Enhancing crops' capacity to suppress weeds before or soon after crop establishment is a crucial component of the multifaceted approach to weed management.

Therefore, this study objectives were: To evaluate the effects of sawdust and palm kernel shell mulch on the emergence and early growth of *M. diplotricha*, as well as garden egg growth and yield.

MATERIALS AND METHOD

Study area.

The 2-year study was carried out during the 2017/2018 and 2018/2019 cropping seasons at the Imo State University Owerri, botanical garden located at 5°29'1"N 7°1'60"E located in the humid rainforest ecosystem of Nigeria (14). Owerri is noted for the high incidence of and spread of *M. diplotricha*, as a result of frequent transportation of animals, contaminated plants, or soil materials and machinery that trap the seeds from different localities to the state capital. Also, the choice of garden egg (*Solanum macrocarpon* is because of its socioeconomic, high demand, nutritious and therapeutic values (6). *M. diplotricha* spread in Abia, Anambra, Akwa-Ibom, Delta, Ebonyi, Edo, and Enugu states, which fall within the region were surveyed.

Soil analysis

The top 0- 3cm soil profile of the study area, at the start of the experiment, was processed and analyzed for some physical and chemical properties following standard procedures (14,15).

Sand	Silt	Clay	^{P}H	Organic matter	Organic carbon	Nitrate	Phosphate	Sulphate	$Ca^{2}+$	$Mg^{2}+$	K2+	$Na^{2}+$	CEC
830 kg–1	330 kg –1	90g kg–1	6.01	20 g kg–1	0.96 g kg–1	12.6 mg/kg	4.21 mg/kg	121.73 mg/kg	7.62 mg/kg	7.41 mg/kg	6.69 mg /kg	1.59 mg/kg	23.32 Ca/mg

Seed collection and treatments

Matured (senesce) *Mimosa diplotricha* pods from more than 20 plants were randomly collected from several places in Imo State University, Owerri, Nigeria in November 2017 and 2018 for the 2018 and 2019 experiments, respectively. The seeds were scarified by cutting the outer layer with a scalpel to break dormancy (17).

Treatments and experimental design

The field study was carried out at the Imo State University, Owerri botanical garden, between the years 2018 and 2019. The experiment consisted of two distinct phases, designed in a randomized block design with three replicates, three treatments, and two growing seasons. The treatments included different levels of rice husk and palm kernel shell mulch (0, 1.5, 3.0, and 4.5 tonnes per hectare) leaving decomposed mulch on top of the soil and unmulched soil that served as a control.

Effects of the two mulches on *M. diplotricha* emergence.

In the emergence experiment, a total of 50 mature scarified *M. diplotricha* seeds were planted in perforated plastic boxes. These boxes were then placed in the soil between two rows of garden egg field. Subsequently, rice husk and palm kernel shell mulch were administered, followed by regular irrigation of the field post-planting and on a weekly basis thereafter.

The emerged seedlings that successfully penetrated through the mulch cover were marked every two-day interval in all treatments till 30 days after planting, using plastic labels with treatment names and emergence dates. Then the percentage of cumulative seed emergence was calculated.

Measurement of *M. diplotricha* root and shoot growth

The main root and shoot length were uprooted with a knife, washed with distilled water to remove soil particles, and then measured with a ruler.

In the competition experimental study, scarified *M. diplotricha* seeds were planted in the spaces between garden egg rows. Additionally, varying quantities of rice husk and palm kernel shell mulch were applied to the soil surface.

The plots were subjected to flood irrigation immediately after the planting process and then received weekly irrigation throughout the duration of the study. During the course of the cultivation periods, manual removal was employed to eliminate various weed species.

***M. diplotricha* biomass**

M. diplotricha seedlings were randomly harvested, oven-dried for 72 h at 30°C, and the dry weight (biomass) was measured with Gram EH precision scale until a constant weight was obtained.

Garden egg biomass

The garden eggs were randomly harvested by hand at physiological maturity, oven dried for 72 h at 30°C and the dry weight (biomass) was measured with Gram EH precision scale until a constant weight was obtained.

Garden egg leaf area

Measurements of the garden egg leaf area were recorded at flowering (65 days after germination) using a ruler. The leaf area was measured by multiplying the leaf length and width of the terminal leaflet.

Garden egg fruit yield

The impact of *M. diplotricha* and the two mulches on garden egg yield was evaluated by harvesting ten matured garden egg plants at the centre of each plot. They were pre-labelled and the number of fruits in each plant per square meter was counted. The total number of fruits were converted to grams per square meter.

Data analysis:

All data collected were subjected to

statistical analysis of variance (ANOVA) using the (MINITAB 19 software). The significance of differences between means was evaluated using Tukey's HSD test ($p < 0.05$).

RESULTS

Mimosa diplotricha percentage emergence

A one-way ANOVA comparison of sawdust, palm kernel shell (Pks), and untreated control on *M. diplotricha*,s seedling percentage emergence revealed a significant difference during the experimental years, control (91.20 %), sawdust (32.89) and Pks (20) in 2018, and control (90), sawdust (35.11) and Pks (23) in 2019 (Table 1). The Pks mulch was more effective than sawdust at stifling *M. diplotricha*,s seedling emergence. Increasing levels of mulch treatments impeded the emergence of *M. diplotricha.* However, there were no significant effects of experimental years on the weed emergence (Table 3).

Mimosa diplotricha root and shoot growth.

In both experimental years, the root growth of *M. diplotricha* was significantly different between sawdust (5.34 cm), Pks (3.67cm), and the untreated control (control (7.33 cm), in 2018, and control (7.99), sawdust (5.40 cm), and Pks (3.56 cm) in 2019; Table 1).

The effect of the experimental years on the root growth of *M. diplotricha* were not significant, 2018 (5.63 cm), and 2019 (5.63 cm) (Table 3).

In addition, result revealed that there was no significant difference between sawdust and the control on shoot growth, whereas there was a significant difference between palm kernel shell and sawdust on shoot growth in both experimental years (Tables 1 and 2).

However, the effects of experimental years on the shoot growth were insignificant (Table 3). In this study, the effect of varying amounts of sawdust and Pks on the shoot growth was significant (Tables 2).

Table 1: Effects of sawdust and palm kernel shell mulch and control, on *M. diplotricha* emergence and growth during 2018 and 2019 cropping seasons.

Treatments(t/ha)	% Emergence	Root length (cm) (cm)	Shoot length (cm)	Seedlingbiomass (g plant^{-}1)
The year 2018				
Control	91.20(2.11)a	7.33(0.42)a	17.50(0.66)a	3.06(0.38)a
Sawdust:	32.89(5.10)b	5.34(0.61)b	16.19(0.83)a	1.71(0.65)b
Palm kernel shell	20.00(2.73)c	3.67(0.80)c	14.23(0.44)b	1.23(0.16)b
The year 2019				
Control	90.00(4.00)a	8.00(0.46)a	18.20(0.85)a	2.70(0.29)a
Sawdust:	35.11(5.17)b	5.397(0.51)b	17.41(0.92)a	1.81(0.44)b
Palm kernel shell	23.00(2.65)c	3.60(0.86)c	15.25(0.49)b	1.11(0.36)b

Means that do not share a letter within a column in a treatment are significantly different (Turkey's HSD test ($p < 0.05$).Numbers in brackets are ± standard deviation.

Table 2 Effects of different quantities of sawdust and palm kernel shell mulch on *M. diplotricha* emergence and growth during the 2018 and 2019 cropping seasons.

Treatments(t/ha)	% Emergence	Root length(cm)	Shoot length (cm)	Seedling biomass (g plant-1)
The year 2018				
Sawdust:				
1.5	38.67 (7.77)a	5.83(0.493) a	17.567 (0.38)a	2.79(0.44)a
3.0	31.00(3.61)ab	5.50(1.25)a	16.433 (0.91ab	2.66(0.32) ab
4.5	29.00(4.58)abc	5.43(0.36) a	15.567(0.59)bc	1.81(0.54) ab
Palm kernel shell				
1.5	23.000(1.000)bc	4.60(0.36)ab	14.567(0.74) bc	1.54(0.51) ab
3.0	19.33(6.03)bc	3.933 (0.50)ab	14.400(0.66) c	1.21(0.39) b
4.5	17.67(2.08c	2.80(0.66) b	13.73(0.80) c	1.27(0.89) b
The year 2019				
Sawdust:				
1.5	41.00(7.94) a	6.13(0.42)a	19.33(1.70) a	2.28(0.40) a
3.0	33.00(3.61) ab	5.89(0.55) a	17.20 (0.56)ab	1.98(0.38)ab
4.5	31.33(4.75) b	5.60(0.44) ab	15.93(0.50) b	1.60(0.77) abc
Palm kernel shell				
1.5	26.00(1.00) bc	4.1000(0.1000)bc	15.73(0.61) b	1.51(0.23) abc
3.0	22.00(5.57) c	4.000(0.624) bc	15.27(2.00) b	1.020(0.11) bc
4.5	21.00(2.00) c	2.57(1.06) c	14.80(0.89) b	0.81(0.22) c

Means that do not share a letter within a column in a treatement are significantly different (Turkey's HSD test ($p < 0.05$). Numbers in brackets are ± standard deviation.

Table 3 Effects of experimental years on M. diplotricha emergence and growth

Experimental year	% Emergence	Root length(cm)	Shoot length (cm)	Seedling biomass (g plant-1)
The year 2018	48.0 a	5.63 a	13.42 a	2.27 a
The year 2019	49.4 a	5.63 a	14.66 a	1.919 a

Means that do not share a letter within a column in a treatment are significantly different (Turkey 's HSD test ($p < 0.05$). Numbers in brackets are ± standard deviation.
Garden egg and *M.diplotricha* are in competition.

M. diplotricha biomass.
In both experimental years, there was no significant difference in *M. dilotricha* seedling biomass between sawdust and palm kernel shell treatments, but there was a high significant difference between mulch treatments and untreated controls. The effect of different quantities of sawdust and palm kernel shell mulch on the biomass was statistically significant (Tables 1 and 2).
The effects of experimental years on *M. diplotricha* biomass were not statistically significant,2018 (2.28 g) and 2019 (1.92 g). (Table 3)
The results indicate that the biomass production of *M. diplotricha* is inversely proportional to mulch quantity, which varied between sawdust and pks, but was unaffected by experimental years.

Garden egg leaf area

In 2018, there was a significant difference between the mulch treatments and the untreated control in the garden egg leaf area. In 2019, there were statistically significant differences between treatments and controls (Table 4). In this investigation, sawdust and palm kernel shell mulch had a significant effect on enhancing the leaf area of garden egg. (Table 5). However, the effects of experimental years on the leaf area of garden embryos were not significant. (Table 6).

Table 4 Effects of Sawdust and Palm kernel shell mulch on Garden egg leaf area during th 2018 and 2019 cropping years.

Treatments (t/ha)	Leaf area(cm^2)	Biomass (g plant^{-}1)	Yield(g-m^2)
The year 2018			
Control	34.900(1.706)a	9.357(0.575)a	9.357(0.575)a
Sawdust:	39.60(3.57)b	12.867(0.416)b	12.867(0.416)b
Palm kernel shell	45.110(1.273)b	14.420(0.507)c	14.420(0.507)c
The year 2019			
Control	34.27(1.81)a	9.170(0.244)a	9.170(0.244)a
Sawdust:	40.53(2.04)b	13.167(1.041)b	13.167(1.041)b
Palm kernel shell	44.900(1.473)c	14.643(0.573)c	14.643(0.573)c

Means that do not share a letter within a column in a treatement are significantly different (Turkey's HSD test ($p < 0.05$). Numbers in brackets are ± standard deviation.

Table 5 Effects of different quantities of Sawdust and Palm kernel shell mulch on Garden egg leaf area during the 2018 and 2019 cropping years.

Treatments (t/ha)	Leaf area(cm^2)	Biomass (g plant^{-}1)	Yield(g-m^2)
The year 2018			
Sawdust:			
1.5	39.33(2.08) b	12.133(0.416)b	12.400(0.954)c
3.0	40.37(4.14) ab	13.000(0.458)bc	12.367(0.493)c
4.5	43.833(1.258)ab	13.900(0.557)b	13.367(0.666)bc
Palm kernel shell			
1.5	43.67(2.97)ab	14.067(0.723)b	13.800(0.400)abc
3.0	44.833(0.737)ab	14.567(0.603)ab	14.633(0.603ab
4.5	46.50(2.11)a	15.767(0.802)a	15.067(0.252)a
The year 2019			
Sawdust:			
1.5	41.000(1.000)b	11.833(0.208)b	12.233(0.473)d
3.0	44.000(1.000)ab	13.133(0.473)ab	13.033(0.321)cd
4.5	45.33(2.31)ab	13.900(0.361)ab	13.767(0.208)bc
Palm kernel shell			
1.5	44.00(2.00)ab	14.000(0.500)	13.633(0.586)bc
3.0	44.667(1.528)ab	15.067(1.102)a	14.667(0.306)ab
4.5	47.33(2.52)a	14.83(2.20)a	15.533(0.416)a

Means that do not share a letter**within a column in a treatement**are significantly different (Turkeys HSD test ($p < 0.05$). Numbers in brackets are ± standard deviation.

Table 6 Effects of experimental years on Garden egg yield and yield components during 2018 and 2019 cropping seasons

Experimental year	Leaf area(cm^2)	Biomass (g plant^{-}1)	Yield(g-m^2)
The year 2018	40.36 a	2.28 a	2.27 a
The year 2019	41.01	1.91 a	1.91a

Means that do not share a letter within a column in a treatment are significantly different (Turkey's HSD test ($p < 0.05$). Numbers in brackets are ± standard deviation.

Garden egg Biomass

In both experimental years, there was a significant difference between mulch treatments and controls in garden egg biomass. (Table 4).

In the present investigation, the effect of various quantities of sawdust and palm kernel shell mulch on garden egg biomass was significant (Table 5).

The effects of experimental years on garden biomass were not significant. (Table 6).

Garden egg Yield.

A one-way ANOVA comparison of sawdust and palm kernel shell (Pks) mulch and untreated control on garden egg yield revealed significant differences during the experimental years, control (l 9.357), sawdust (12.867), and Pks (14.420) in 2018, and control (9.170), sawdust (13.167), and Pks(14.642) in 2019 (Table 4).

As mulch quantities increased, garden egg production increased. The effect of varying quantities of rice husk and palm kernel shell litter on garden egg production was significant (Table 5).

The effects of the experimental years on the yield of garden eggs were not statistically significant. (Table 6).

Pks was more effective than sawdust at increasing the fruit yield, and the degree of increase increased in both years as the quantity of mulch increased. (Tables 5 and 6).

DISCUSSIONS

The results obtained from *M.diplotricha* seed emergence and seedling growth indicate the herbicidal potentials of palm kernel shell and sawdust mulch for the control of the noxious *M. diplotricha* weed. Decreased *M. diplotricha* seed emergence in mulched plots suggests that it will encounter intense competition from garden egg, and with those crops that exhibit rapid growth and canopy development. A decrease in the seed emergence of *M. diplotricha* would lead to a reduction in seed production, which would then decrease the soil seed bank for future years.

Similarities in the year effect suggest that meteorological conditions did not influence all the measured parameters. The effectiveness of sawdust mulch in smothering weeds is corroborated by (18) who reported the effectiveness of sawdust mulch on the germination and growth of Barnyard grass, Bittercrest, and Woodsorrel.

Decreased weed biomass collaborates with (19) who reported decreased weed biomass, density, and fresh weight by wheat straw, pine needle, and black plastic mulch treatments, and (20) who reported decreased biomass in *Bidens pilosa* by Sorghum aqueous extract and ascribed it to

Inhibition of root growth was greater than that of shoot growth, in both experimental years.

Insufficient water and nutrient assimilation may have stunted the root and shoot growth of seedlings, resulting in a decrease in biomass accumulation observed in the present study.

This result is consistent with previous findings regarding the reduced shoot and root length of rice exposed to wheat straw litter (21).

The observed reduction in *M. diplotricha* biomass accumulation in the present study could potentially be attributed to diminished growth of both root and shoot seedlings, which may have been a consequence of inadequate absorption of water and nutrients.

The reduced weed biomass concurs with (19) who reported reduced weed biomass, density, and fresh weight by wheat straw, and pine needle mulch treatments.

The results of increased garden egg leaf area on mulch application can be attributed to the garden egg's ability to access more water resulting from moisture conservation by mulches and the availability of more nutrients from the decomposing mulch. The garden egg develops leaf area, accumulates dry matter gradually, and competes strongly with slow-emerged *M. diplotricha* weed.

Our findings on increased garden egg leaf area concur with (22) in muskmelon plants, (23), in garlic (*Allium sativum* L.), and (24) in maize (*Zea mays* L.).

However, the increased garden egg biomass in mulched plots may be a result of increased leaf area, which increases the amount of captured photosynthetic assimilate, and root development, which facilitates the absorption of nutrients and water. Our current findings are consistent with increased biomass in *Z. mays* (23) and *T. aestivum* (24).

Increase in garden egg yield might be linked to the presence of suboptimal *M.diplotricha* weed competition. Garden egg exhibits a steady increase in leaf area and dry matter accumulation, resulting in heightened competition with *M. diplotricha* weeds that emerge later. If weeds are not well managed before reaching the reproductive growth stages, there will be a decline in fruit yield.

The results of this study indicate that the competitive ability of *M.diplotricha* against garden egg plants was shown to decline as the mulch level increased.

Increased garden egg fruit yield is likely attributable to increased leaf area, which enhanced the absorption of photosynthetically active radiation, improved plant establishment and performance, and decreased weed pressure.

The increased fruit yield correlates with (26) who reported that sawdust improved the growth and yield of tomato plants. Nonetheless, there are available reports on the maximal crop yield resulting from mulch treatments (27; 28).

CONCLUSION

This research is the first trial we used agronomic techniques to evaluate the effect of mulch on *M. diplotricha* weed suppression and improvement of garden egg growth and yield.

Mulch, especially palm kernel shells up to 4.5 tons per hectare for both experimental years caused a significant decrease in the weed seed germination and seedling growth but was not enough to inhibit the germination completely and, at the same time, enhanced garden egg biomass, leaf area, and yield. For more suppression of weed seed emergence and performance, increased rice husk and palm kernel shell mulch greater than 4.5 tons per hectare is imperative for sustainable and eco-friendly management of *M. diplotricha* weed.

To prevent further spread of and invasion by the *M. diplotricha* weed, governments and institutions in Nigeria and other affected nations should work together on its management. The impacts of the mulch on the physical, biological, and biochemical processes of *M. diplotricha*, as well as the soil, need more study.

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