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RESPONSE OF GINGER RHIZOME SEED WEIGHT AND LEAF MULCH OF DIFFERENT MULTIPURPOSE TREES AND SHRUBS (MPTS) ON GINGER FLOWERING, GROWTH AND YIELD ATTRIBUTES, IN UMUDIKE, SOUTH EASTERN NIGERIA

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ABSTRACT

A two-year field study was initiated in 2018 and 2019 to determine the effect of different multipurpose trees and shrubs (MPTS) and rhizome seed size on ginger flowering, growth, and yield in Umudike, South-eastern Nigeria. Treatment consisted of 3 levels of mulch species at 0 t/ha (control), 5 t/ha Dactyladenia barteri, and 5 t/ha Dialum guineense mulch and 3 different seed rhizome sizes of 10, 20, and 30 g. The treatments were arranged in a Randomized Complete Block Design (RCBD) with 3 replications. The plot size was 2.5 m x 2.5 m at a planting distance of 0.2m x 0.2m. Data on plant height, flowering, tiller number, plant survival, and rhizome yield were collected, processed, and subjected to analysis of variance. Results show that the mulch effect of different MPTS was statistically similar (P>0.05) on plant height, tiller number, and ginger rhizome yield, but significantly higher than the no mulch control. Similarly, the different seed rhizome sizes followed the same trend as observed for mulch species above However, significant differences were observed for mulch species on ginger plant survival and flowering. Dialum guineense leaf mulch gave a higher percentage of survival (95%) and flowering (77%), compared to Dactyladenia barteri, 80% and 42.3% respectively for survival and flowering. The no mulch control gave the least result- 56% and 15.6% respectively for survival and flower initiation. The 20 and 30g seed rhizome sizes were similar in terms of ginger survival and flower initiation, buds were higher than the 10g seed ginger sett size. It is concluded that Dialum guineense mulch and 30g ginger set size increased ginger plant survival and flower production and rhizome yield and may open a new vista in ginger breeding.

Keywords: *Multipurpose trees, Shrubs, Ginger, Flowering, Mulch, Rhizome seed Size and yield.*

INTRODUCTION

Ginger is an important spice crop grown globally for its oleoresin and oil content. It is grown extensively for its medicinal and industrial uses (Nwogu, 2003). Little is known about environmental factors affecting ginger's flowering and rhizome swelling. Although factors affecting the yield of the crop such as nutrition, temperature, soil moisture, planting space, size of planting material, and harvesting time have been investigated, there is no documented report (known to the authors) on environmental factors in relation to flowering in ginger.

Schinichi. *et al.* (1999) reportedly obtained flowers in ginger by day-length variation, even with difficult-to-flower regions, and recommended further studies on other environmental factors such as temperature and soil moisture management and their effects on ginger flowering.

Mulching is an important agronomic practice in ginger production (Hussain *et al.,* 2022). Mulching helps to manage excessive temperature fluctuations and encourages soil moisture retention and management. It also slows the release of nutrients after mineralization and guarantees soil aggregate stability (Ekeledo *et al.,* 2023). *Dactyladenia barteri* (monkey fruit) and *Dialum guineense* velvet tamarind are indigenous multipurpose trees and shrubs species used extensively in agroforestry systems (Okeke and Omaliko, 2003). Their high lignin and carbon-nitrogen ratio ensures mineralization and longer ground cover when used as mulch (Choudhang, 2020). Asawalam *et al.* (2004) reported improvement in the growth and yield of maize treated with the pruning of *Dactyladenia barteri* and concluded that the mulching effect of *Dactyladenia barteri was* higher than the no mulch control.

Dialum guineense is an important fallow species for fertility restoration. The specie has a symbiotic relationship with certain soil bacteria. These bacteria form nodules in the roots zone and fix atmospheric nitrogen. The leaves are important mulch material used in agroforestry systems (Schmidt *et al.,* 2014).

Seed rhizome size is an important consideration in ginger production. The appropriate seed size will help minimize the wastage of planting material and cut down the cost of production and will ensure proper growth and yield of ginger (Ogbaji, 2002, Girma and Kindie, 2008).

Ginger rarely flowers, and flowering in plants is an important breeding consideration in the search for new varieties of crops. Girma and Kindie (2008), reported that an increase in seed ginger size significantly increased the major growth and yield components of ginger.

Mulching and seed rhizome size are known to influence the growth and yield of ginger, but there are no documented reports on the effect of MPTS mulch on flowering, growth, and yield of ginger. The aim of this study was to determine the effect of selected MPTS mulch species on the flowering, growth, and yield of ginger; and to determine which seed rhizome size influenced better flowering, growth, and yield of ginger.

MATERIALS AND METHODS

Study site, location, and description

The study was conducted at the experimental site of the College of Natural Resources and Environmental Management of Michael Okpara University of Agriculture, Umudike, Abia state, which lies between Latitude 5^0 28 and 5^o 30''N and between Longitude 7^0 31'E and 7o 33'E. The climate within the study location is in the humid tropical region with low land rainforest vegetation. The study site has low fertility status and is susceptible to soil erosion and drought stress (Enwuzor *et al.,* 1990).

Land preparation and input collection

Dry leaf litter mulch of *Dactyladenia barteri* and *Dialum guineense* were collected at the National Root Crops Research Institute *Dactyladenia barteri* alley plantation site, while *Dialum guineense* dry leaf litter mulch was collected at the planted fallow site of the Department of Forestry, Michael Okpara University of Agriculture, Umudike. Ginger rhizomes (yellow ginger-Umu Gin 1) were sourced from ginger programs, National Root Crops Research Institute, Umudike. The experimental site was prepared mechanically using a tractor while the ridges were later converted to seed beds according to plot dimensions manually.

Experimental design and planting

3 levels of mulch: zero mulch, 5t/ha *Dactyladenia bacteria,* and 5 t/ha *Dialum guineense,* and 3 different seed rhizome sizes of 10, 20, and 30 g were laid in a Randomized Complete Block Design (RCBD) and replicated 3 times using a plot size of 2.5 x 2.5 m, and ginger rhizomes were planted using 0.2 m x 0.2 m spacing in April 2018 and repeated in 2019. Mulch was applied 2 days after planting while poultry manure was incorporated during land preparation to obtain maximum impact.

Data collection and analysis

Data on plant survival (%), plant height (cm) tiller number, and the number of flowers per plant were collected at 4, 8, and 12 weeks after planting, while data on yield were collected at harvest. Data obtained were processed and later subjected to Analysis of Variance (ANOVA) while treatment means were separated using the least significant differences at 0.05 level of probability.

Results

The mean soil physical and chemical properties of the experimental site are shown in Table 1. Results show that the particle size distribution varied but with sand dominating. The textural class was sandy loam. Soil pH was 4.8, while organic carbon and organic matter were low 0.89 and 1.53g/kg respectively. Total Nitrogen (g/kg) was also low (0.19). However, moderate available phosphorus was observed in the soil before experimentation (19.41mg/kg). Furthermore, exchangeable Ca^+ and Mg dominated the exchange complex of the soil with high base saturation (73.67%). This confirms the report of Enwezor *et al.* (1990) who stated that soil within the location of the study site is low in soil fertility and is susceptible to soil erosion

Table 1: Mean Physical and Chemical Properties of the Experimental Site of Michael Okpara University of Agriculture, Umudike.

Variables	Unit of measurement	Mean values
Physical characteristics		
Sand	%	48
Silt	%	20
Clay	%	32
Texture	Sandy loam	

Chemical characteristics		
pH (H_2O)	1:1 H_2O	4.82
Organic carbon (OC)	g/kg	0.89
Organic matter (Om)	g/kg	1.53
Exchangeable acidity (EA)	Cmol/kg	1.29
Total Nitrogen (N)	g/kg	0.19
Available phosphorus	g/kg	19.41
Exchangeable cations	Cmolkg	
Ca+		1.71
Mg		1.62
K+		0.19
Na+		0.09
Effective Cation Exchange Capacity (ECEC)		4.90
Base saturation (BS)	%	73.67

Results of data analysis on the study parameters showed that rhizome set size had no significant impact on ginger plant survival (%). Plant height (cm), tiller number but significantly influenced the mean rhizome yield of ginger – Tables 2 and 3 However, significant differences in means of some growth parameters of ginger were observed for the different mulch species studied. *The Dialum guineense* leaf litter mulch gave a higher mean percentage of ginger survival (94.91%), followed by *Dactyladenia barteri* mulch (81.44%). The least survival occurred in the control (zero mulch) with a value of 55.91% (Table 2). Again, the mulch effect on the mean tiller number was significant (p= 0.05). The two mulch species though statistically similar in their effect on tiller number, were significantly higher than the control (zero mulch). The mulch species influenced ginger tiller number in the orders of 6.63 >5.26 > 3.81 respectively for leaf mulch of *Dialum guineense, Dactyladenia barteri and* zero mulch (Table 3). The ability of mulch to increase the percentage sprout, ginger survival, and tillering is through the moderation of soil temperature and moisture conservation and this was similarly observed by Ohiri and Njoku (1987) and Thankamani., et al, (2016) and probably, accounted for the higher percentage sprout observed on mulched plots relative to the no mulch control.

Table 2: Effect of Mulch species and rhizome size on ginger plant count and survival (%).

Application of mulch species				
Rhizome size	**Zero mulch**	**Dactyladenia barteri**	**Dialum guineense**	**Mean**
10	**56.60**	**79.0**	**91.61**	**75.74**
20	**57.55**	**83.72**	**93.39**	**98.22**
30	**55.56**	**81.61**	**94.91**	**77.36**
Mean	**55.91**	**81.44**	**94.91**	
FLSD (0.05)				
Rhizome size	**NS**			
Mulch species	**3.46**			

Table 3: Effect of Mulch species and rhizome set size on Mean ginger tiller number

Mulch species Application				
Rhizome set size	**Zero mulch**	***Dactyladenia barteri***	***Dialum guineense***	**Mean**
10	**3.13**	**5.15**	**6.99**	**5.09**
20	**4.20**	**5.31**	**6.90**	**5.47**
30	**4.11**	**5.31**	**5.99**	**5.14**
Mean	**3.81**	**5.26**	**6.63**	
FLSD (0.05)				
Rhizome set size NS.				
Mulch species: 1.07				

Table 4 shows the plant height response of ginger with respect to rhizome size and different MPTS mulch. The 20 and 30 g set sizes were statistically similar but gave higher plant height than the 10 g rhizome set size. The mulch of different MPTS had no significant impact on ginger plant height.

Table 4: Effect of Mulch species and rhizome set size on Mean ginger Plant height (cm)

Mulch species Application				
Rhizome set size	**Zero mulch**	***Dactyladenia barteri***	***Dialum guineense***	**Mean**
10	**36.03**	**39.80**	**38.15**	**38.00**
20	**38.55**	**42.43**	**38.86**	**39.95**
30	**41.05**	**43.71**	**42.58**	**42.45**
Mean	**38,00**	**5.26**	**6.63**	
FLSD (0.05)				
Rhizome set size	**3.0.**			
Mulch species:	**NS**			

Significant differences were observed for mulch species and rhizome size in the number of flowers produced per ginger stand, (Table 5). Results revealed that an increase in rhizome size significantly increased flower production in ginger stands. Rhizome size influenced flower initiation in ginger in the other 30 > 20 > 30 g. This confirms the observations of Giema and Kindie. (2008) and Islam, *et al*, (2017) who reported that an increase in seed rhizome size significantly increased the major growth and yield component of ginger. Again, *Dialum guineense* leaf litter mulch gave a higher number of flowers per ginger plant (over 77%) relative to *Dactyladenia barteri and no mulch control which had* 42.3 and 15.6 % flowers per plot respectively. The moderation of soil temperature by mulch and the inherent protection it offered the soil against the direct impact of rainfall may have influenced ginger growth and flower production in the mulched plots. Again, mulch of some MPTS is known to have high lignin and carbon nitrogen ratio (Okekeke and Omaliko, 2002). This guarantees longer ground cover, slow decay to mineralize, and adds more nutrients to the soil (Chukwu et al, 2014; Chukwu and Madu, 2020). This phenomenon most likely accounted for the higher improvement in fertility and productivity of soils mulched with MPTS relative to un mulched plots. The results confirmed that the application of mulch is an important agronomic strategy to recapitalize soils as reported by Chukwu and Madu (2020).

Table 5: Effect of Mulch species and rhizome set size on a number of ginger flowers

Mulch species Application				
Rhizome set size	**Zero mulch**	***Dactyladenia barteri***	***Dialum guineense***	**Mean**
10	**1.41**	**3.91**	**7.00**	**4.72**
20	**1.11**	**4.33**	**7.89**	**4.52**
30	**2.11**	**4,44**	**8.78**	**4.44**
Mean	**1.56**	**4.23**	**7.78**	
FLSD (0.05)				
Rhizome set size	**2.46**			
Mulch species:	**1.32**			

Again, the application of different MPTS mulch significantly improved ginger rhizome yield relative to the no mulch control. (Table.6). The *Dialum guineense* leaf mulch tended to increase yield compared to *Dactyladenia barteri* mulch. This confirms the report of Okeke and Omaliko, (2002) who reported that different mulch materials have different impacts on crop growth and productivity. It further shows that mulch is a necessary agronomic requirement in ginger production and enhances soil fertilizer use efficiency. Subrahmaniyan *et. al (2018),* reported that improvement in soil organic matter improves the fertilizer use efficiency of the soil. Chukwu (2003) also reported that organic matter management is an important means of conserving and improving soil fertility status for ginger production. Again, Chukwu and Emehute (2001), and Ahaiwe *et a*l, (2016) reported that ginger performance is influenced by moderate to high level of soil fertility and productivity is enhanced with the presence of mulch. Furthermore, Jones *et al.* (2007) and Kumara and De- Silva (2019) reported that application of mulch minimizes the use or demand for nitrogen fertilizer in ginger production.

Table 6: Effect of Mulch species and rhizome set size on ginger rhizome yield (t /ha)

Mulch species Application				
Rhizome set size	**Zero mulch**	***Dactyladenia barteri***	***Dialum guineense***	**Mean**
10	**2.33**	**4.31**	**5.02**	**3.87**
20	**3.08**	**4.43**	**5.89**	**4.46**
30	**3.31**	**4,94**	**6.08**	**4.78**
Mean	**2.91**	**4.56**	**5.67**	
FLSD (0.05)				
Rhizome set size	**NS**			
Mulch species:	**1.26**			

CONCLUSION

This study showed that different mulch materials have a different impact on ginger growth and yield, and it's therefore concluded that *Dialum guineense* mulch applied at 5t/ha using a seed rhizome size of 30g influenced ginger survival, flowering, and some growth attributes of ginger. The study revealed positive improvements in the growth attributes of ginger in plots mulched with

MPTS of *Dialium guineense* and *Dactyladenia barteri* leaf mulch. It is an indication that multipurpose trees and shrubs mulch have inherent characteristics that ensure longer grand cover and stimulate slow but steady mineralization of nutrients for the benefit of crops.

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