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Influence of Mulching Materials on the Agronomic and Yield Parameters of Pineapple (*Anana comosus* L. Merr. Var. Sugar Loaf) in Owode -Yewa Southwest Nigeria

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Abstract

A field research trial was conducted to assess the influence of mulching materials on the growth and yield of sugar loaf pineapple variety (*Anana comosus* L. Merr.). Slips of the pineapple were collected and nursed. At 9 months after nursing, 108 nursed pineapple plants measuring between 97-100cm were purposively selected and transplanted at 12 plants per experimental plot on beds covered with Trt1 (black polyethene sheet), Trt2 (organic matter) and Trt3 no application of mulch which served as (Control) and the whole arrangement was laid down using a Randomized Complete Block experimental Design (RCBD) replicated three times. Fifty percent (50%) of pineapple plants used per experimental plot was randomly selected for data collection. The number of leaves was counted, plant heights were measured and number of weeds growth were uprooted and counted at two (2) months interval for 14 months. At the end of the trial, the length and weight of the fruits were measured and recorded in centimetre (cm) and kilogram (kg). Both the number of days to flower initiation and fruit harvest maturity from day of transplanting were counted and recorded. Data collected were first tested for normality of distribution using Shapiro-wilk test at 0.05 level of significant. After ascertaining the normality of the data distribution, the data were then subjected to General Linear Model (GLM) Univariate Two Ways Analysis of Variance (ANOVA) using IBM Statistical Package for Social Sciences (SPSS) software package version 21. The significant means were separated using Duncans' Multiple Range Test (DMRT) at 0.05 level of significant. The result showed that significant different ($P<0.05$) existed in the influence of the mulching materials on the number of leaves and weed growth as well as length and weight of harvested fruits with black polyethene sheet showing the greatest influence. There was no significant different ($P>0.05$) in plant height, number of days to flower initiation and fruit harvesting from day of transplanting. It was concluded that black polyethene sheet (BPSH) positively influenced the growth and yield of sugar loaf pineapple variety. It is thus recommended that awareness through demonstration be created on the efficacy of plastic mulch for improved yield and reduction in risk of injury from the plant.

Keywords: Sugar loaf pineapple; Mulching materials; Nursery; Slips; Harvest maturity.

1. Introduction

Pineapple [*Ananas comosus* (L.) Merr.var. sugar loaf] belong to Bromeliaceae family. It is cultivated extensively in different parts of the continent around both tropical and subtropical region for different purpose.

Most commonly, sugar loaf pineapple is consumed freshly and utilised as a good source of essential mineral elements, nutrients and vitamins needed for better functioning of the body system. The pineapple variety is a candidate crop that can help in boosting the economic status of many fruit and vegetable farmers as well as marketers especially women as it is commonly hawked around the street as a means of livelihood and poverty alleviation in both the rural and urban centres.

Unfortunately, sugar loaf pineapple is not usually cultivated in Nigeria probably due to farmers erroneous believe that the crop yield performance is low which has resulted into legal or illegal importation through our borders into the country. However, few farmers that may be engaging in the cultivation face difficulties of weed

invasion, insufficient planting materials and inability to cope with the various agronomic practices on the farm because of the peculiar nature of the crop therefore making commercial cultivation a mirage.

It is worthy to note that every crop plant has its inherent defence mechanism. Unlike smooth cayenne, sugar loaf pineapple variety has a very dense defence mechanism in form of spines all over the leave margin which is obviously making it very difficult to handle and work with on plantation most especially during planting and post planting activities.

Advantageously, for more planting materials, sugar loaf pineapple has the inherent genetic potential of producing between 5-10 slip suckers (Figure 1) which invariably has provided little succour to farmers in terms of sourcing for planting materials if well harnessed.

Figure-1. Showing slips of sugarloaf pineapple used for the research trial

But aside from this, attempt to generate more planting materials and reduce difficulties in this respect has been carried out through various empirical studies by researchers. Absolutely, on smooth cayenne pineapple variety, the report of Usman, *et al.* [1] had confirmed that 5µM of Benzylaminopurine (BA) and 3µM of Naphthalene acetic acid (NAA) could be used as an effective protocol for mass multiplication of plantlets through micro propagation protocol. Similarly, Ogunkunle [2] had asserted that matured fowl dung (MFD) could also be used to induce more sprouting of plantlets on smooth cayenne pineapple crown for mass generation of the planting materials.

Crop farming had always been an interesting endeavour to all because of high expectation on bumper harvest at reduced efforts. But one of the factors that inhibit the behavioural tendency towards crop farming by all folks is the difficulties 'drudgeries' experience at different facets of farming operation. Drudgeries emanate from inability of farmers to cope with and manipulate agronomic practices such as weeding to allow crop plants utilise the scarce environmental resources such as water, light and soil fertility in order to achieve better growth and yield.

Mulching is an agronomic practice done on cultivated crop plants to reduce the growth of weeds, soil erosion, water loss, leaching of soil fertility and provide conducive environment for effective functioning of soil floras and faunas towards better crop yield.

Different mulching materials which ranges from organic to inorganic had been confirmed to be effective in providing a better environment for the growth of agricultural crops. Natural mulch has been recommended for garlic cultivation as reported by Mohsen, *et al.* [3]. In the same vein, the use of rice husk had proved effective according to Nwokwu and Aniekwe [4], due to its effectiveness, environmental friendly as well as alternative to expensive mulching materials for the production of Watermelon (*Citrullus lanatus*). Furthermore, black polyethylene had been confirmed to be the most widely used due to its excellent properties such as; low cost and high capacity to improve the soil physico-chemical properties thereby boost nutrient availability in the soil for use by crop plants [5, 6].

Generally, Tapani, *et al.* [7] asserted that different mulching materials has been used in different ecological zone for different crop plants with either positive and negative impact for instance, black polyethene may be an effective mulching material but may also not be affordable and has been constituting a serious threat to the environment due to low degradability within a short time constituting a persistence organic pollutant (POP) while organic materials decay to improve soil property, readily available at no cost but not durable most especially for biennial crop like pineapple.

In this respect, as opined by Greer and Dole [8], to make generalisation of the influence of these mulching materials on some crops and in different ecological zone may be very difficult. Meanwhile, there is a death of

information on the response of this variety of pineapple 'sugar loaf' to these different mulching materials. It is on this background that this research was conceptualised and conducted to ascertain the influence of these mulching materials on the agronomic and yield parameters of sugar loaf pineapple in Owode Yewa South Western, Nigeria.

2. Materials and Method

2.1. Description of Site and Duration of the Experiment

The study was carried out at the research farm of Bioresouces Development Centre, (BIOCEC) Owode-Yewa South, Ogun State Nigeria between February 2017 to September, 2019. BIODEC is an outreach centre of National biotechnology Development Agency Nigeria. The centre has a geospatial coordinate of N 06^0 43.712^1 E 002^0 59.531^1 obtained from field survey via the use of hand-held GPS receiver, (Model Etrex, Legend H, Germin). Geographically, Owode–Yewa is a town located between latitude 6^0 48^1 N, 2^0 57^1 E and longitude 6.8^0 N 2.95^1 E [9]. Agro-ecologically, the study area is classified as rain forest zone with bi-modal raining seasons that usually start and stretch from February to July, interrupted in August and continue from September to November.

2.2. Source and Preparation of Planting Materials

Equal sized Sugar loaf pineapple slips were collected from pineapple farm in the centre (Figure 1). The slips were prepared by removing the lower leaves to expose the roots for easy establishment in the soil. Prior to field experimentation, the prepared slips were planted in nursery bags filled with soil arranged and managed in the acclimatization platform of the nursery shed for nine (9) months.

2.3. Land Preparation and Field Lay Out

The site was cleared, debris were packed manually, stumps were removed with hand tools. The prepared site was mapped out into nine (9) experimental plots and flat beds were made manually. Each of the beds measured (2.5m x 2m x 0.4m) length, breath and height with buffer zone of 1m between each plots making a net plot of $45.0m^2$ and a gross plot of $76.0m^2$.

2.4. Application of Treatments and Experimental Design

After a heavy rainfall at approximately 9 months after nursing, the different treatments Trt_1 black polyethene sheet (BPSH), Trt_2 organic material (OM) predominantly the remains of spear grass (*Imperata cylindrica*) were used to cover the entire beds while Trt_3 (control) were left uncovered. Twelve (12) pineapple plants measuring between 97-100cm were purposively selected from the nursery, prepared by removing the lower leaves again and then planted on the marked portions of the beds at a distance of 0.5m x 0.5m between and within rows to make a plant population of 40.000 plants ha^{-1}. The whole experimental plots were laid out in a Randomised Complete Block Design (RCBD) and replicated three times.

2.5. Management Practices

The black polyethene sheets were secured to cover the whole flat beds by begging while the organic material were added on routine bases after appreciable decay has been observed. After fruit set, the slips developed from the fruit peduncles (Figure 2) were removed before harvesting to improve the yield which correlates with the report [10]. Harvesting was done by cutting the fruits peduncle 5 cm below the fruits to facilitate ease of handling.

Figure-2. Showing slips removed from fruit peduncle before harvesting

2.6. Data Collection and Statistical Analysis

Fifty percent (50%) of the total number of pineapple plants used per experimental plot was randomly selected for data collection. The numbers of leaves were counted with the last count marked with conspicuous strings for ease of continuous counting, plant heights were measured from the base to the apex of the longest leaves using string and meter rule while the number of weeds growth were uprooted and counted at two (2) months interval for 14 months.

Furthermore, length of fruits were measured and recorded in centimetre (cm) with the use of meter rule. At the end of the experiment, the weight of harvested pineapple fruits were measured using digital sensitive balance (CAMRY, Model EK 5055) in kilogram (kg), number of days to flower initiation as well as fruits harvest maturity from day of transplanting were counted and recorded.

Data collected most especially on count and percentage were first tested for normality of distribution using Shapiro-wilk test following the procedure of Kent [11] with the postulation of null hypotheses that the data are normally distributed at 0.05 level of significant. After ascertaining the normality of the data distribution, the data were then subjected to General Linear Model (GLM) Univariate two ways Analysis of Variance (ANOVA) using IBM SPSS software statistical package version 21. The significant means were separated by employing Duncan Multiple Range Test (DMRT) at 0.05 level of significant.

3. Results and Discussions

3.1. Number of Leave Growth

The result on (Table 1) showed the mean bi-monthly number of leaves growth of sugar loaf pineapple plant (*Anana comosus* L. Merr. Var. sugar loaf) as influenced by different mulching materials. Generally, Trt_1 (BPSH) influenced the highest number of leave growth with a mean count of 44.23, followed by Trt_2 (OM) 42.27 and the least Trt_3 (control) 37.86.

Table-1. Mean number of leaves growth as influenced by different mulching materials

Months after Transplanting (MAT)								
Treatments	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**Mean**
Trt_1(BPSH)	27.9^a	32.7^a	37.4^a	42.7^a	49.1^a	56.1^a	63.7^a	44.23
Trt_2 (OM)	27.3^a	31.2^a	34.5^a	38.3^{ab}	42.2^b	47.2^b	53.2^b	42.27
Trt_3 (control)	26.6^a	29.9^a	32.8^a	36.3^a	41.0^b	46.5^b	51.9^b	37.86
Mean	27.26	31.26	34.93	39.08	44.08	50.12	56.26	
SEM	9.587	8.653	6.941	3.788	5.040	4.769	6.841	
(F-value)	0.140	0.670	2.371	8.490	11.49	20.22	18.23	
(P- value)	0.874	0.561	0.209	0.036	0.022	0.008	0.010	
CV(%)	11.36	9.41	7.54	4.98	5.05	4.36	4.65	
Shapiro-wilk test remark	N.D	N.D	N.D	N.D	N.D	N.D	N.D	

Mean with the same letter within the same column are not significantly difference at 0.05 level of significance using Duncan Multiple Range Test (DMRT), SEM - Standard error of the Mean, N.D- Normally Distributed from Shapiro-wilk test)

Specifically, at 2^{nd}, 4^{th} and 6^{th} months after transplanting, the results showed that there was no significant ($P>0.05$) different in the influence of mulching materials on the number of leave growth of sugar loaf pineapple. In this respect sugar loaf pineapple treated with Trt_1 (BPSH) had the highest number of leave growth with mean counts of 27.9, 32.7 and 37.4 while those with no mulch (control) had the least number of leaves growth with values of 26.6, 29.9 and 32.8 progressively.

Conversely, there was a significant difference ($P<0.05$) in the number of leave growth at 8^{th}, 10^{th},12^{th},and 14^{th} months after transplanting with Trt_1 (BPSH) having the highest values of 42.7, 49.1, 56.1 and 63.7while the least values of 36.3, 41.0, 46.5 and 51.9 was counted on Trt_3 (control).

The highest number of leave counts from Trt_1 (BPSH) may be as a result of the ability of the treatment to conserve soil water which will resultantly be used by the plant to dissolve soil nutrients for easy absorption by the roots or ability of the treatment to suppress weed growth that will consequently compete with plant nutrient and inhibit growth. This is in line with Tapani, *et al.* [7] who reported that mulch significantly reduces the growth of weeds in the soil.

3.2. Plant Height

The overall result on plant height as shown in (Table 2) revealed that there was an increase in the pineapple plant height across the experimental period with the highest plant heights of 79.13cm, 73.73cm and 70.90cm for Trt_1, Trt_2 and Ttr_3 progressively. At the 2^{nd} 4^{rd} ,6^{th}, 8^{th}, 10^{th} 12^{th} and 14^{th} month after transplanting, the table revealed that Trt_1 has the highest plant height as influenced by different mulching materials with values of 53.4cm, 57.4cm, 67.2cm , 73.6cm, 86.5cm 102.3cm and 113.5cm. This may be as a result of the availability of plant nutrient in which the loss was reduced by the polyethene sheet. Similarly, the least plant height of 48.4cm, 54.6, 60.0, 64.8cm, 79.7cm, 88.8cm and 100.0cm was recorded for Trt_3 (Control) which may have resulted from the negative influence of weed growth on the plant. However, there was no statistical significant different ($P>0.05$) in the plant height with the influence of different mulching materials across the period of the experiment.

Table-2. Mean Plant height (cm) as influenced by different mulching materials

Months after Transplanting (MAT)								
Treatments	**2**	**4**	**6**	**8**	**10**	**12**	**14**	**Mean**
Trt_1(BPSH)	53.4^a	57.4^a	67.2^a	73.6^a	86.5^a	102.3^a	113.5^a	79.13
Trt_2 (OM)	48.6^a	52.6^a	58.8^a	69.7^a	87.0^a	95.0^a	104.4^a	73.73
Trt_3 (control)	48.4^a	54.6^a	60.0^a	64.8^a	79.7^a	88.8^a	100.0^a	70.90
Mean	50.12	54.88	61.86	69.39	84.40	95.34	106.0	
SEM	36.10	59.96	103.1	97.35	166.0	183.5	182.6	
(F-value)	0.659	0.292	0.627	0.598	0.228	0.756	0.784	
(P- value)	0.566	0.761	0.580	0.592	0.758	0.527	0.516	
CV (%)	12.00	14.11	16.41	14.22	15.22	14.21	12.75	
Shapiro-wilk test remarks	N.D	N.D	N.D	N.D	N.D	N.D	N.D	

Mean with the same letter within the same column are not significantly difference at 0.05 level of significance using Duncan Multiple Range Test (DMRT), SEM - Standard error of the Mean, N.D- Normally Distributed from Shapiro-wilk test)

3.3. Number of Weed Growth

Table 3 showed the influence of mulching materials on the number of weed growth on the beds. It was revealed that the highest number of weed growth occurred on Trt_3 (control) with mean of 147.7, Trt_2 115.7 and Trt_3 9.81 across the experimental period. Specifically, there was significant different ($P<0.05$) in the number of weeds emergence with the influence of treatment 3 having the highest while treatment 1 recorded the lowest across the experimental period. The highest weed count on treatment 3 may be attributed to the exposure of the beds to direct rainfall and solar energy which is instrumental to weed seed activation for germination and emergence from the seed bank in the soil without any disturb. This tally with the report of Campiglia, *et al.* [12] that mulching materials suppresses weed growth and facilitate improvement in the yield of agricultural crop.

Table-3. Mean number of weeds growth as influenced by different mulching materials

Months after Transplanting (MAT)								
Treatments	2	4	6	8	10	12	14	Mean
Trt_1(BPSH)	15.0^b	12.3^b	6.0^b	8.67^b	14.67^c	7.00^a	5.00^a	9.81
Trt_2 (OM)	55.7^b	197.3^a	59.7^a	230.0^a	210.0^b	27.3^a	29.7^a	115.7
Trt_3 (control)	258^a	210^a	41.0^{ab}	203.3^a	253.3^a	33.0^a	35.0^a	147.7
Mean	109.6	139.9	35.56	147.3	159.3	22.44	23.22	
SEM	2213.3	177.9	340.3	2119.3	1136.7	413.28	212.9	
(F-value)	22.96	206.4	6.544	20.67	42.67	1.357	3.608	
(P- value)	0.006	0.000	0.055	0.008	0.000	0.355	0.127	
CV (%)	43	10.0	52	31.2	4.1	90.6	63.0	
Shapiro-wilk test remarks	N.D	N.D	N.D	N.D	N.D	N.D	N.D	

Mean with the same letter within the same column are not significantly difference at 0.05 level of significance using Duncan Multiple Range Test (DMRT), SEM - Standard error of the Mean, N.D- Normally Distributed from Shapiro-wilk test)

3.4. Length and Weight of Harvested Fruits

The results on (Table 4) showed that the mean influence of black polyethene sheet (28.3cm) on the length of harvested pineapple was higher and differ significantly from that of organic matter (25.8cm) and that of control (23.6cm).

Table-4. Mean weight and length of harvested fruits

Treatments	**Length of harvested fruit (cm)**	**Weight of harvested fruit (kg)**
Trt_1(BPSH)	28.3^a	2.17^a
Trt_2 (OM)	25.8^b	1.90^a
Trt_3 (control)	23.6^c	1.43^b
Mean	25.9	1.834
SEM	0.655	0.019
(F-value)	26.11	21.96
(P- value)	0.005	0.007
CV (%)	3.12	8.0
Shapiro-wilk test remarks	N.D	N.D

Mean with the same letter within the same column are not significantly difference at 0.05 level of significance using Duncan Multiple Range Test (DMRT), SEM - Standard error of the Mean, N.D- Normally Distributed from Shapiro-wilk test)

Similarly, the mean weight of harvested pineapple fruits (Figure 3) was (2.17kg) as influenced by the mulching material is higher on treatment 1 and differs significantly from that of treatment 2 organic matter and treatment 3 (control). This findings correlates with the report of Coolong [13] that plastic mulch improves the yield of agricultural crops.

Figure-3. Showing example of harvested sugarloaf pineapple fruit at the end of the research trial

3.5. Number of Days to Flower Initiation and Fruit Harvesting from Day of Transplanting

Table 5 showed that the mean number of days to flower initiation was highest for treatment 3 (454.4) followed by treatment 2 (430.3) and the least from treatment 1(416.5). There was no significant difference (P>0.05) in the number of days to flower initiation from the day of transplanting as influenced by the mulching material throughout the experimental period.

Table-5. Mean number of days to flower initiation and fruit harvesting from days of transplanting

Treatments	Number of days to flower initiation from day of transplanting	Number of days to fruit harvesting from day of transplanting
Trt_1(BPSH)	416.5[a]	506.5[a]
Trt_2 (OM)	430.3[a]	523.3[a]
Trt_3 (control)	454.4[a]	522.7[a]
Mean	433.7	517.5
SEM	402.3	1191
(F-value)	2.747	0.229
(P value)	0.178	0.805
CV (%)	4.62	6.67
Shapiro-wilk test remarks	N.D	N.D

Similarly, the highest number of days to fruit harvest maturity was highest for treatment 2 (523.3) followed by treatment 3 and the least 506.5 days was recorded for treatment 1. There was no significant difference (P>0.05) in the number of days to fruit harvesting from day of transplanting throughout the experimental period.

4. Conclusion and Recommendations

The study revealed that black polyethene sheet (BPSH) influenced the highest number of leave, greatest plant height, least number of weed emergence, highest length and weight of harvested pineapple fruit as the plant progresses in growth. In the same vein, it also influenced the least number of days to flower initiation and days to fruit harvest maturity compared to organic matter and the control. It could be concluded that black polyethene sheet has positive influence on both the agronomic and yield parameters of sugarloaf pineapple variety and therefore liable of providing succour to farmers in effectively coping with the cultivation of the crop and make it a viable bioenterprise despite the presence of dense network of spine on the leave margin that usually make it difficult to work with it on the field. It is recommended that;

i. Change agents in the agro-ecological zone should initiate awareness creation to farmers through demonstration on the efficacy of the mulching material.
ii. Plastic mulch should be made available to the farmers at low cost to boost their interest and productivity on sugarloaf pineapple cultivation.
iii. Farmers need to be stimulated to harness the inherent genetic potential in sugar loaf pineapple for poverty alleviation in the rural and peri-rural areas in and around the study area.

Conflict of Interest

The authors declare that there is no conflict of interest regarding development and publication of this article.

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