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Effect Of Soil Solarization And Colour Of Solarization Material On Weed Control In Cassava Variety (Manihot Esculetum Crantz) In Obudu, Nigeria

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Abstract
This research was conducted to study the effect of soil Solarization and colour of Solarization material on need management in cassava varieties. The experimental design was a Randomized Complete Block (CRB) with split plots, replicated 3 times. The entire experimental plot was one hectare. The plot was cleared and the trash packed. Ridges were constructed according to the design of the experiment. Soil Solarization was done to kill weed seeds. Solarization materials were; control (zero or no Solarization), black, white, and green polyethene materials. The Solarization was removed after six weeks in the field. Three varieties of cassava, TMS. 30555, TMS. 30572 and TMS. 50398 were cultivated in the field. The type of Solarization materials were the main plots while the cassava varieties were the subplots. Growth and yield data were taken at Weeks after Planting (WAP) and at maturity of the cassava. The data were subjected to analysis of variance using Genstat version 8.1 and the means compared Using Least Significant Difference (LSD) at $p<0.05$. The result showed a significance effect of Solarization and colour of Solarization material on weed control in cassava varieties. Black polyethene material was significantly better than other colours. Higher number of tubers per stand and higher yields in tonnes per hectare were recorded in TMS. 50393 and TMS. 30555 respectively, in black polyethene solarization. It was recommended that farmers should adopt the use of black plyethene solarization for weed control in cultivating TMS. 50395 and TMS. 30555 for higher yields in (t/ha).

Keywords: *Soil Solarization, Solarization material, Polyethene, experimental design, Significant effect, environmentally friendly*

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I. Introduction

The recent food shortages experienced globally due to Russian invasion of Ukraine, and the menace of climate change, call for adjustment in food production techniques in Nigeria and in Africa as whole. Various challenges engross food production in Nigeria, thereby contributing significantly to food shortages and food security problem. If these problems are not urgently addressed, there might be global famine by 2030, especially in developing countries. Improving crop production techniques through sustainable agricultural practices especially during this era of COVID 19 and climate change cannot be over emphasized. This will help to alleviate food insecurity arising from crop losses and decrease in yields (Grace Foundation, 2020).One way of tackling food insecurity is the deliberate increase in the production of valuable crops such as cassava.

Cassava is a very important tuber crop that is produced in all tropical areas of the world, especially by the resource poor farmers (Onwueme, 1999). It is a popular energy food in most of the tropics where its production and yields are prolific. It has replaced yam and cocoyam as the number one carbohydrate staple and is said to provide up to 40 % of all the calories consumed in Africa (Onwueme, 1999).Apart from being a major staple food in the tropics, cassava is a prime source of starch for both food and industrial purposes globally. Only recently, it has been introduced in the bakery industry in Nigeria as cassava flour for bread making. (Udoh *et al.*, 2005). Garri, one of the primary products of cassava is becoming an essential commodity, as the price goes up in geometric progression on weekly basis. Chips or pellets of cassava are becoming more important in world commerce as a relatively cheap energy feed for ruminants and other livestock such as pigs. The leaves are eaten as vegetables in some parts of Africa. The goats relish them most (Alves, 2002).

The world production of cassava tubers stood at 276.7 million tons in 2013. Currently Nigeria is the leading producer of the crop globally, although Thailand stands as the largest exporter of the crop in the world

(IITA, 2014). There is ongoing collaboration between the International Institute for Tropical Agriculture (IITA) and the United Nations Children's Emergency Fund (UNICEF) for the development and promotion of the crop, in view of its potential (IITA, 2021).

Cassava as a crop is susceptible to weed competition, despite its high adaptation to adverse environmental conditions (Udoh *et al.*, 2005). The impact of the weed competition is most adversely felt by the crop during its first 30 to 120 days of planting (IITA, 2014). In effect, it means that the field must be kept weed free during the early life of the crop (IITA, 2014). There are various techniques adopted in weed management, aimed at reducing the damaging effects weeds will have on crops, if allowed to grow side by side with the crops (Narayan, 2012).

Several weeds interfere and compete strongly with cassava, thereby reducing the crop yield. Weeds cause a substantial reduction in yield of cassava in all the crop growing areas. Patel *et al* (2005) reported a 12.8 % reduction in the yield of the crop in a growing season. Weed control is a vital management practice necessary to ensure optimum tuber yield of cassava (Narayan, 2012). Hand weeding is the most common method of weed control in West Africa. The associated drudgery, high cost and the need for repeated weeding operations have made the method undesirable, especially in large scale production. Therefore, alternative management methods which are less costly and environmentally friendly are desirable. No one method has been able to completely eliminate weeds from crop farms. More researches are needed to unravel the best approach to weed management that is suitable for optimal crop yield (Khan *et al.*, 2002).

Weed management methods include; biological, chemical, mechanical, cultural and preventive, which include sowing of weed free seeds, farm sanitation, crop canopy management and solarization. The use of soil solarization is becoming increasingly popular and can be applied in cassava production in Nigeria (Yaduraju, 1993). According to Pokharel (2010) soil solarization is a hydrothermal process that occurs in moist soils, when the soil is covered with plastic film and heated by exposure to sunlight during warm months of the year. Pathel *et al* (2005) earlier reported that soil solarization is a novel technique of controlling soil borne pests including weeds. It is an effective and hazard free practice that can be an essential component of an integrated pest control approach (Morenco and Lustosa, 2000). Kumietti and Valentino (2006) described soil solarization as a process in which the solar radiation is trapped under a plastic soil mulch during periods of high ambient temperature causing an increase of temperature in the upper soil layers to levels lethal or sub-lethal to soil borne pathogens and weeds.

Soil depth is very important as far as soil solarization is concerned. Tucel *et al* (2007) observed that, the highest soil temperatures during solarization were achieved near the soil surface in the day time, whereas temperature decreased by increasing depth and at night time. Kashi *et al* (2007) also collaborated that under a clear plastic mulch, temperatures higher than 50^o C were recorded only in the top 5 cm soil. Other literatures reported temperatures of 40-50^o C and 36-40^o C down to 10-15 cm and 20-30 cm depth, respectively during summer solarization in warm areas. Kasha *et al* (2007) added that no lethal or sublethal thermal levels were generally found at deeper soil layers, where temperature increases only 3 - 4^o C.

Statement of the problem

Synthetic pesticides have been successfully used to control soil borne diseases, weeds and nematodes in most vegetables, tuber crops and fruit crops, over the past decades. However, the toxicity of these chemicals to animals and humans and their adverse effect on the environment, couple with their economic cost, calls for serious environmental and human safety concerns. This has led to the phase out of the most effective and largely used chemicals such as the methyl bromide and the increasing restrictions on the applications of available pesticides (WHO, 2017).The limited availability of chemicals resulted in an increased emphasis on reduced pesticides or non-pesticide control methods. And also a renewed interest in farmers on soil solarization as a simple, environmentally safe and effective non-chemical control method. Therefore, more research works are required on the phenomenon of soil solarization so as to make its principles well known and more dependable to farmers in Nigeria. By doing so, it can become a better alternative to the use of synthetic chemicals (Herbicides) in weed control and/or the manual weeding associated with drudgery.

Objective of the study

The overall objective of the study is to design a weed management method in cassava production that will be simple and cost effective, considering human and environmental safety in this era of climate change.

The specific objectives include to:

i. determine the efficacy of soil solarization in weed control in cassava varieties
ii. determine the effect of colour on the efficacy of solarization material to control weeds in cassava varieties
iii. determine the effect of soil solarization on the yield of cassava varieties

II. Materials And Methods

This research was conducted in Obudu Local Government Area of Cross River State of Nigeria. Obudu is in the northern part of the state, bounded to Obanliku Local Government Area in the east down to the south, Bekwarra in the West, and Vandeikya Local Government Area of Benue State in the north. Obudu experiences rainforest conditions in the remote areas and Guinea Savannah Climate in the areas lying along the boundary with Benue State. The Local Government Area has a bimodal annual rainfall distributed in the range of 2500 - 3000 mm with a mean annual temperature range of 27° C to 35° C, and a relative humidity of about 80 - 75% (Ministry of Agriculture: Weather report Obudu, 2024).

The experiment was designed in a Randomized Complete Block (RCB) with split plots and replicated three times. Plot size for the cassava production was measuring 100 x 100m (one hectare). It was cleared on the 10th to 15th of March 2024, the trash were packed and the ridges constructed according to the design of the experiment. Soil solarization was done on the 15th of March 2024, with three colours of polyethene solarization materials (white, black and green) to suppress weed seeds and to kill soil nematodes for six weeks. The unsolarized plots in each block were kept as control. The type of solarization materials were the main plots, while the cassava varieties were the subplot. Each main plot measured 9 m x 4 m while the subplot size was 3 m x 2 m. One meter path separated one subplot from the other, while the main plots and replicates were separated from each other by 2 metre path.

The solarization materials were removed on the 30th of April 2024, before the planting of cassava was done on the 3rd to 7th of May 2024. Three varieties of improved cassava stems were planted (TMS. 30555, TMS. 300572 and TMS. 50395). NPK (10:10:20) fertilizer was applied six weeks after planting at the rate of 300 – 400 kg/ha.

Growth parameters considered at 4 weeks after planting included; plant height (cm), stem girth (cm) and leaf area index (cm^2). While the yield parameters assessed during harvesting at maturity were; number of tubers per stand, tuber weight in kg per hectare (kg/ha) and tuber yield in tons per hectare (t/ha). Weed density was also considered by placing a 0.5 m x 0.5 m quadrat at random on each sub-plot and the total number of weeds counted.

All data generated were subjected to analysis of variance using Genstat version 8.1, and the means compared using Least Significant Difference (LSD) at $p<0.05$ according to Wahua (1999).

Table 1: Effect of soil solarization and colour of material on the growth of cassava varieties

Treatments	Plant Height (cm) 6 WAP			Stem Girth (cm) 6 WAP		Leaf area index 6 WAP			
Colour	**Var_1**	**Var_2**	**Var_3**	**Var_1**	**Var_2**	**Var_3**	**Var_1**	**Var_2**	**Var_3**
Control	114.60	120.40	136.28	2.10	2.22	2.16	11.31	11.10	12.22
Black	131.80	130.22	141.28	4.21	3.81	3.80	16.21	15.27	16.34
Green	138.21	129.32	135.31	3.10	2.81	2.88	12.62	13.28	11.22
White	146,22	144,21	145.31	3.66	3.61	3.82	14.31	14.82	13.63
SED±	9.22	9.66	9.56	8.66	6.84	7.81	6.86	6.84	6.82
LSD	NS	NS	NS	0.81	0.95	0.93	4.30	2.90	4.10

Key: Var = Variety; Var_1 = TMS. 30555, Var_2 = TMS. 30572, Var_3 = TMS. 50395
NS = Not Significant.

Table 1 above shows that, solarization and colour of solarization material did not significantly ($p>0.05$) affect the plant height of the cassava varieties, at six weeks after planting (6 WAP). There was however, a significant effect ($p<0.05$) in the stem girth and leaf area index of the cassava varieties.

Table 2: Effect of soil solarization and colour of solarization material on the yield of cassava varieties

Treatments	**No. of tubers per stands**			**Weight of tubers per stand**			**Tuber yield in tons per hectare**		
Colour	**Var_1**	**Var_2**	**Var_3**	**Var_1**	**Var_2**	**Var_3**	**Var_1**	**Var_2**	**Var_3**
Control	15.2	15.60	16.26	5.20	4.61	5.01	14.3	13.10	12.22
Black	16.60	16.62	17.24	7.55	5.85	6.72	16.62	15.83	15.84
Green	15.62	16.24	13.61	5.43	4.62	4.52	12.56	14.10	13.63
White	16.20	16.10	16.64	6.52	5.66	6.23	15.68	15.63	14.28
SED±	7.46	7.66	8.25	6.81	5.82	6.80	12.22	13.21	13.32
LSD	NS	NS	NS	1.58	2.61	2.48	1.86	2.18	1.89

Key: Var: = Variety; Var_1 = TMS. 30555, Var_2 = TMS. 30572, Var_3 = TMS. 50395
NS= Not Significant

The result of the analysis in Table 2 above shows that solarization and colour of solarization material had significant effect ($p<0.05$) on both the tuber weight per stand and tuber yield in tonnes per hectare. There was however, no significant effect ($p>0.05$) on the varieties of cassava cultivated and the number of tubers per stand.

Table 3: Effect of solarization and colour of solarization material on weed density in cassava varieties

	Var_1	**Var_2**	**Var_3**
Control	41.56	59.90	86.54
Black	20.06	18.21	18.65
Green	40.22	45.24	50.36
White	21.23	22.43	22.35
SED±	6.12	9.08	8.64
LSD	NS	NS	NS

Key: Var = Variety; Var_1 = TMS. 30555, Var_2 = TMS. 30572, Var_3 = TMS. 50395
NS= Not Significant

Analysis of the result in Table 3 above shows that the colour of solarization material had a significant effect ($p<0.05$) on the weed density in the cassava field. There was however no significant effect ($p>0.05$) amongst the varieties of the cassava cultivated here.

III. Discussion

Analysis of the data in Table 1 shows that there was no significant effect ($p>0.05$) of solarization and colour of solarization material on plant height of the cassava varieties cultivated here. However, solarization and colour of solarization material had significant effect ($p<0.05$) on the stem girth of the cassava varieties. Cassava varieties cultivated on plots treated with black solarization material produced larger stem girth, Var_1 (TMS. 30555) = 4.21 cm, Var_2 (TMS. 30572) = 3.81 cm Var_3 (TMS. 50395) = 3.80 cm. Var_1 (TMS. 30555) recorded a stem girth of 4.21 cm higher than other varieties (Table 1). Cassava varieties cultivated in plots treated with white polyethene materials recorded stem girths only next to stem girths in black polyethene material. The stem girths in white polyethene material were V_1 = 30.66cm, Var_2 = 3.61cm, Var_3 = 3.82 cm respectively. Although green polyethene solarized plots recorded the lowest stem girth of cassava (Var_1 = 3.10, Var_2 = 2.81, and Var_3 = 2.88) cm respectively, the stem girths here were greater than the stem girths in cassava stands in unsolarized (control) plots. (Table 1). The biggest stem girth recorded by variety 1 (TMS. 30555) in black polyethene solarized plots confirms the observation of Stapleton (2008) that black polyethene is better for soil solarization than other colours.

On leaf Area Index (LA1), solarization and colour of solariation material had significant effect ($p<0.05$) on the cassava varieties. Cassava stands in black polyethene solarized plots recorded higher leaf Area Index (LAI), with Var_1 (TMS. 30555) = 16.21 cm, Var_2 (TMS. 30572) = 15.27 cm and Var_2 (TMS. 50395) = 16.34 cm. Variety 3 (TMS. 50395) recorded the highest Leaf Area Index (LAI) of 16.34 cm. Cassava stands in plots solarized with white polyethene material recorded values of Leaf Area Index (LAI) only next to cassava stands in black polyethene solarized plots (Table 1). Nimje and Agrawel (2008) earlier reported that early weed suppression by solarization can increase the growth and yield of crops.

Effect of soil solarization and colour of solarization material on the yield of cassava varieties

Both solarization and the colour of solarization material had significant effect ($p<0.05$) on the tuber weight per stand and tuber yield in tonnes per hectare (Table 2). Black polyethene was significantly better ($p<0.05$) than other colousr in terms of tuber weight per stand and tuber yield in tons per hectare (t/ha). Cassava stands in black solarized plots produced tuber weights of 7.55, 5.86, and 6.72 kg/ha respectively. While tuber yield in tons per hectare were 16.62, 15.82, and 15.84 t/ha respectively. There was however, no significant effect in the number of tubers per stand in all the varieties (Table 2).

Variety 1 (TMS 30555) produced the highest tuber weight per stand of 7.55 kg/ha and the highest tuber yield in tonnes per hectare of 16.62 kg/ha in black polyethene solarized plots. This was followed by the same variety 1 (TMS 30555) with tuber weight of 6.52 kg/ha and tuber yield of 15.68 t/ha in white polyethene solarized plots. The higher tuber weight in (kg/ha) and tuber yield in (t/ha) recorded in black polyethene solarized plots, justifies the better performance of black polyethene over others in controlling weeds in crops (IITA, 2014). The good performance of black polyethene over other colours here may not be unconnected with the fact that, black absorbed heat from sun rays and retained it for a longer time thereby killing weed seeds and soil nematodes (Nimje and Agrawel, 2008). There was a weed free and nematodes free environment, maintained almost all through the growing season of the cassava plants in the black polyethene salarized plots. This contributed immensely to the higher yields recorded in such plots. This was in support of Amador-Ramirez *et al* (2005) who reported that crop yield is higher under conditions of weed free crop growth.

Effect of soil solarization and colour of solarization material on weed density in cassava varieties

There was a significant effect of solarization and colour of solarization material on the weed density in cassava varieties during the sampling period (Table 3). Colour black was significantly better than other colours (White and Green) and recorded the least weed density per 0.25 m^2 compared to White and Green. The significantly better performance of black polyethene here over others, is in line with the report of Amador-Ramirez *et al*. (2005) that black polyethene material was better than other colours for soil solarization.

However, Green polyethene material recorded higher weed density but was lower than the weed density in control plots. (Table 3). There was no significant difference ($p>0.05$) amongst the varieties of cassava. The result shows that soil solarization obliterates early weed infestation, as evident in the low weed density in all the varieties of cassava. This was also in line with the observation of Nimje and Agrawel (2008) that soil solarization impedes early weed emergence. Decrease in weed density due to soil solarization was also reported by Chittapur and Hosmani (2000). Crop yields are generally higher under conditions of low weed densities than that of high weed densities, and vice versa. Soil solarization is significant in weed control and hence crop yield. This is evident in the significant weed population reduction by the different treatments as shown in tables above. Solarization also resulted in differential growth responses of the cassava plants in the various plots, with plants in plots of lower weed densities doing significantly better than those in plots with higher weed densities. This was in line with IITA (2020) that reported that weeds reduces crops access to growth factors.

IV. Conclusion

Improving crop production through sustainable agricultural practices can alleviate food shortages associated with crop losses and decrease in yield. Food production can be improved by tackling the various challenges that engross crop production. One of such drawbacks in crop production is weed competition with crops, for nutrients and space. Various techniques have been adopted in managing weeds, all of them aimed at reducing the damaging effects of the weeds on crops.

However, an alternative management method such as soil solarization, which is not only cost effective but also environmentally friendly is most suitable. No one method has been able to completely eliminate weeds from crop farms. More researches are therefore necessary to unravel the best approach to weed management that is most suitable for optimal crop yield.

V. Recommendations

1. Farmers should adopt the method of soil solarization in controlling weeds in crop farms. The method is cost effective and environmentally friendly,
2. Black polyethene material is a better material for soil solarization than other colours,
3. In terms of number of tubers per stand of cassava, variety TMS. 50395 is a better variety than others in using solarization for weed control,
4. In terms of tuber yield in tonnes per hectare (t/ha), the variety TMS 30555 is a better option for cultivation when using black polyethene for soil solarization.
5. Government should assist farmers to procure sophisticated and durable black polyethene materials for soil solarization, and should post extension agents to the rural areas to assist farmers in practizing soil solarization in weed control.

References

[1] Alves, A.C. (2002). Cassava Botany And Physiology. In Hillock, R.J., Thresh, J.M., Bellotti, A (Eds). Cassava: Biology, Production And Utilization, CABI, Wallingford, UK, 67-90 Cited 9th May, 2022.

[2] Amador-Ramirez, M.D., Velasquez-Valle, R., Brovolozano, A.G., And Gutierrez-Luna, R. (2005). Interference Of Weeds On Growth And Yield Of Transplanted Dry Chilli Pepper. Revista Chapingo Serie Horticultura 11 (1): 73-81.

[3] Chittapur, B.M. And Hosmani, M.M. (2000). The Effect Of The Period Of Soil Solarization And Weed Control Measures On Weed Growth In Soybean (Glycine Max L.). Proceedings Of International Conference On Managing Natural Resources, 1121-1123.

[4] Grace Communication Foundation (2020). Food Security And Food Access. Grace Communication Foundation 215 Lexington Avenue, NY 10016 United States.

[5] IITA (International Institute Of Tropical Agriculture) (2014). Root And Tuber Improvement Programme. Archival Report (2011-2014) Part 7, Ibadan, Nigeria.

[6] IITA (International Institute Of Tropical Agriculture) (2021). Root And Tuber Improvement Programme. Archival Report (2018-2021). Part 8, Ibadan Nigeria.

[7] Kasha, K., Babbitt, S., Barreva, V., Zumelzu, G. (2007). Effect Of Soil Solarization And Biocontrol Agents On Plant Stand And Yield On Table Beet In Cordoba (Argentina) Crop Protection 27:337-342.

[8] Khan, M.A., Mawat, K.B., Hasan, G., And Khan, N. (2002). Impact Of Weed Management On Maize (Zea Mays) Planted At Night: Pakistan Journal Of Weed Science Research, 8 (1-2): 57-61.

[9] Kumietti, G. And Valentino, D. (2006). Soil Solarization As An Ecological Method For The Control Of Fusarium Wilt Of Melon In Italy. Crop Protection 25:389-397.

[10] Marenco, R.A. And Lustossa, D.C. (2012). Soil Solarization For Weed Control In Carrot. Agricultural Species Brasilia, Valume 35, Number 10, P. 2025-2032.

[11] Narayan, Khatri (2012). Weed Management In Maize. M.Sc. Agronomy, Department Of Agronomy, Institute Of Agriculture And Animal Science, Tribhuwan University, Nepal.

[12] Nimje, P.M. And Agrawal, V. (2002). Effect Of Soil Solarization On Weed Earliness In Nursery Raising Of Vegetables. Indian Journal Of Weed Science 38:324-326.

[13] Onwueme, I.C. And Sinha, T.D. (1999). Field Crop Production In Tropical Africa. The Netherland: Publication Of Technical Centre For Agricultural And Rural Co-Operation.
[14] Pathel, R.H., Shroff, J., Duta, S. And Meisheri, T.G. (2005). Weed Dynamics As Influenced By Solarization. Journal Of Agriculture. Review 26 (4): 295-300.
[15] Pokharel, R. And Hammon, R. (2010). Increased Efficacy Of Biofumigation By Soil Solarization And Integrating With Brassica Meal Cake And Poultry Manure To Manage Soil Borne Problems In Onion. Report Submitted To EPA, PESP Program. P 23.
[16] Udoh, D.J., Ndon, B.A., Asuquo, P.E. And Ndaeyo, N.U (2005). Crop Production Techniques For The Tropics. Lagos: Concept Publishers.
[17] WHO (2017). Public Health Impact Of Pesticide Use In Agriculture. World Health Organization, Geneva.
[18] Yaduraju, N.T. (1993). The Role Of Soil Solarization In Weed Management. In Integrated Weed Management For Sustainable Agriculture. Proceedings Of International Symposium Indian Society Of Weed Science, 1:343-349.
[19] Yucel S., Ozarslandan, A., Colak, K., Ayi, T. And Can, C. (2007). Effect Of Solarization And Fumigant Applications On Soil Borne Pathogens And Root Knot Nematodes In Green Houses-Grown Tomato In Turkey. Phytoparasitica, 35:450-456.