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Research Article

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The Growth and Yield Performance of Sweet Melon as Affected by Years of Usage for Formulated Treated Soil in North Central Nigeria

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Abstract The study was carried out at the National Centre for Agricultural Mechanization Ilorin Kwara State, Nigeria to evaluate the performance of formulated/treated soil used over a period of three years for vegetable production in a greenhouse, using response to sweet melon (galia f1) as case study. The experiment was conducted using a completely randomized design with four replications. Data were collected on the growth and yield of sweet melon and analyzed using analysis of variance (ANOVA) at 5% level of significant difference and Duncan multiple range tests was used to separate the means. The result showed that the average values of fruit yield obtained from the freshly formulated/treated soil, formulated/treated used soil and untreated soil (the control) are 5.45kg; 4.70kg and 1.95kg respectively. It is therefore concluded that the formulated treated soil as described in this work can be used in greenhouse melon farming, sustainably with good productivity for minimum of three years.

Keywords Formulated soil, Greenhouse, Yield, Sweet melon

Introduction

A very significant event in the world history of Agriculture is the domestication of plants by mankind. Instead of depending on wild growth, it was realized that the planting of seeds or cuttings allowed the propagation of the type of plants desired. Another important breakthrough resulted from the need to protect the domesticated plants from a-biotic and biotic stress factors. Protected cultivation such greenhouse farming emerged as a way to protect crops from adverse weather conditions allowing year-round production and the application of an integrated crop production and protection management approach for better control over pests and diseases. Greenhouse crop production is now a growing reality throughout the world with an estimated 405,000 ha of greenhouses spread over all the continents [FAO, 2013]. The degree of sophistication and technology depends on local climatic conditions and the socio-economic environment.

The initial cost of setting up a greenhouse is usually very high; thus farmers often plant high value crop in order to break even. To maintain consistently high productivity, soil nutrient management is essential, and fertilization is an important way to supplying soil nutrients within a short period of time [Han *et al*., 2016]. A major method of safe and sustainable fertilization for green house production is the use of formulated/treated growing media. Greenhouse growing medium may contain harmful disease causing organisms, nematodes, insects and weed seeds, so it should be decontaminated by heat treatment or by treating with volatile chemicals like methyl bromide, chloropicrin etc, to eliminate or reduce pathogens load and other harmful constituents, especially in container farming practice [Wittwerand Castilla, 1995]. The practice of soil treatment by heat is preferred in organic farming but it is very expensive, laborious and time consuming, therefore there is the need for farmers to make effective use of such formulated/treated soil and be equipped with knowledge of how long it takes before a replacement of the soil is due for profitable and sustainable practice.

Sweet melon was adopted in the study because it's an important commercial crop in many countries including Nigeria where it is mostly grown in the Northern part of the country for its sweet pulp and the pleasant aroma [Villanueva et al, 2004 and Adeyeye, et al, 2017]. It is rich in bioactive compounds such as Phenolics, flavonoids and vitamins as well as carbohydrate and minerals especially potassium, also low in fat and calories with large amount of dietary fiber [Shafeek et al, 2015, and Tamer et al, 2010]. This work intends to predict the minimum time a formulated soil can be profitably and sustainably used for production of sweet melon in a greenhouse in north central Nigeria.

Materials and Methods

This study was carried out at the National Centre for Agricultural Mechanization (NCAM), Ilorin situated on longitude 4^o 35" East and Longitude 8^o 29" North, with an altitude of 370m above sea level. The annual rainfall varies from 1000mm -1500mm and the temperature ranges from 30^oC to 35^oC. It is a transitional zone between the climate of southern Nigeria and semi-arid Sudan savannah of Northern part of Nigeria. The project was carried out from October, 2021 to January 2022, on one of the nine greenhouses of NCAM, a free standing, Quonset type with dimension of 8m x 24 m operated by Land and Water Engineering (LWE) department.

Experimental Design and Treatments

The experiment was laid out in a Completely Randomized Design. The treatments composed of three soil media: freshly formulated/treated soil (media A), formulated/treated soil used for 3 years (media B) and untreated soil (media C) used as control. The soil media were transferred into a soil grow bag. These soil bags were then laid on top of bed in completely randomized design and arranged at 60cm spacing inside the green house. Seeds were planted and plants allowed to grow and developed during which measurements were taken weekly the on the growth and yield parameters from first week after sprouting to the last harvest covering a total of ten weeks.

Soil Sampling and Laboratory Analysis

Soil samples were collected from the freshly formulated/treated soil (media A), formulated/treated soil used for 3 years (media B), and untreated soil (media C) and taken for laboratory analysis to determine the physical and chemical properties of the soil using suitable laboratory analytical procedures. The result is presented in table 1.

Planting and Management Practices

Land and planting media preparation

Six beds of one metre width and 10metre high were prepared, shaped and a tipper lorry load of loamy soil and three tons of cured poultry manure were procured, both were sieved to remove sticks, stones, and other large materials. Then Frying pan of dimension 3m x 1m was mounted over burning log and a mixture of the soil and the manure at ratio 3:1 was poured in and heated at temperature ranges of 100 ºC to 120 ºC for 25 – 30 minutes, turning soil every 5 minutes to prevent burning. The treated soil was allowed to cool down and afterwards transferred to soil bags, which were then arranged on the beds earlier prepared inside the greenhouse at a spacing of 60cm between bags.

Irrigating the plants

Drip lines, connected to an overhead tank beside the greenhouse, were drawn over the soil bag with the water emitters positioned at the middle of the bags. The water valves were opened and water from the emitters dripped onto the soil for about two hours until the soil were very moist. After planting, irrigation was done twice daily for about 30minutes each.

Fumigation

The entire inside of the greenhouse was well fumigated with a fumigant (D.D. force) and closed for 24hours to decontaminate the greenhouse.

Planting

The sweet melon seeds were planted in the bags, and thinned to one plant per stand after germination. There were six rows and each had 40 soil bags giving a total of 240 plant population inside the greenhouse. Weeding was done starting from two weeks after planting by handpicking while pest was controlled using *cypermethrin* chemical at the rate of 2ml per 1liter of water starting from two weeks after planting and subsequently as when necessary.

Data Collection and Analysis

Data were collected on the growth and yield of the plant from a week after sprouting to harvesting.The measurements taken were: stem height, number of leaves, number of branches, number of fruits, and weight of the fruits. Data collected were analyzed using analysis of variance (ANOVA) at 0.05% level of significance. Further analysis was carried out using Duncan multiple range tests.

Results and Discussion

Results

Table 1: Soil Nutrients Analysis

Sample Codes	N (%)	P (%)	K (ppm)	Ca (ppm)	Zn (ppm)	Mg (ppm)
A	1.412	0.513	15.800	21.300	0.810	8.145
	1.418	0.509	15.800	21.100	0.804	8.160
B	1.150	0.492	15.200	18.600	0.760	7.905
	1.140	0.487	15.500	18.400	0.753	7.910
C	1.106	0.435	14.900	18.900	0.660	7.820
	1.102	0.430	14.600	19.200	0.639	7.816

A- Freshly formulated/treated soil; B- formulated/treated soil used for 3 years continuously for vegetable production in green house; C- untreated soil (control)

Table 2: The performance of the different soils on the growth parameters

Parameters	Types of soil	Mean values	Maximum	Minimum
Plant height (cm)	formulated/treated soil	98.890275	84.0111	113.4667
	formulated/treated Used soil	96.844450	74.7556	123.1222
	Control soil	47.111125	42.6667	52.6667
No. of leaves	formulated/treated soil	43.6563	29.50	54.88
	formulated/treated Used soil	46.6875	40.13	60.00
	Control soil	17.5013	15.25	20.88
No. of branches	formulated/treated soil	6.8125	4.38	8.13
	formulated/treated Used soil	8.6563	6.88	12.25
	Control soil	3.0863	2.65	3.63
No. fruits	formulated/treated soil	5.0000	4.00	6.00
	formulated/treated Used soil	4.0000	3.00	5.00
	Control soil	2.0000	1.00	3.00
Weight of fruits (kg)	formulated/treated soil	5.4500	4.80	6.00
	formulated/treated Used soil	4.7000	3.80	5.20
	Control soil	1.9500	1.00	3.50

Table 3: Analysis of Variance of the growth parameters

ANOVA						
		Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**
Plant height (cm)	Treatments (kinds of Soil)	6878.226	2	3439.113	14.244	0.00
	Error	2172.956	9	241.440		
	Total	9051.182	11			
Numbers of leaves	Treatments (kinds of Soil)	2060.146	2	1030.073	13.115	0.00
	Error	706.849	9	78.539		
	Total	2766.996	11			
Numbers of branches	Treatments (kinds of Soil)	64.412	2	32.206	10.426	0.01
	Error	27.801	9	3.089		
	Total	92.213	11			
Harvested fruit	Treatments (kinds of Soil)	18.667	2	9.333	14.000	0.00
	Error	6.000	9	.667		
	Total	24.667	11			
Weight harvested (kg)	Treatments (kinds of Soil)	27.167	2	13.583	21.078	0.00
	Error	5.800	9	.644		
	Total	32.967	11			

Table 4: Duncan multiple range test for plant height (cm)

Plant height (cm)			
Duncan			
Kind of soil	N	Subset for alpha = 0.05	
		1	2
Control soil	4	47.111125a	
Formulated/treated Used soil	4		96.844450b
Formulated/treated soil	4		98.890275b

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 4.000.

Table 5: Duncan multiple range test for numbers of leaves

Numbers of leaves			
Duncan			
Kind of soil	N	Subset for alpha = 0.05	
		1	2
Control soil	4	17.5013a	
Formulated/treated soil	4		43.6563b
Formulated/treated Used soil	4		46.6875b

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 4.000.

Table 6: Duncan multiple range test for numbers of branches

Numbers of branches			
Duncan			
Kind of soil	N	Subset for alpha = 0.05	
		1	2
Control soil	4	3.0863a	
Formulated/treated soil	4		6.8125b
Formulated/treated Used soil	4		8.6563b

Means for groups in homogeneous subsets are displayed.
a. Uses Harmonic Mean Sample Size = 4.000.

Table 7: Duncan multiple range test for numbers of harvested fruits

Harvested fruit			
Duncan			
Kind of soil	N	Subset for alpha = 0.05	
		1	2
Control soil	4	2.0000a	
Formulated/treated Used soil	4		4.0000b
Formulated/treated soil	4		5.0000b
Means for groups in homogeneous subsets are displayed.			
a. Uses Harmonic Mean Sample Size = 4.000.			

Table 8: Duncan multiple range test for weight of harvested fruits (kg)

Weight harvested (kg)			
Duncan			
KIND OF SOIL	N	Subset for alpha = 0.05	
		1	2
Control soil	4	1.9500a	
Formulated/treated Used soil	4		4.7000b
Formulated/treated soil	4		5.4500b
Means for groups in homogeneous subsets are displayed.			
a. Uses Harmonic Mean Sample Size = 4.000.			

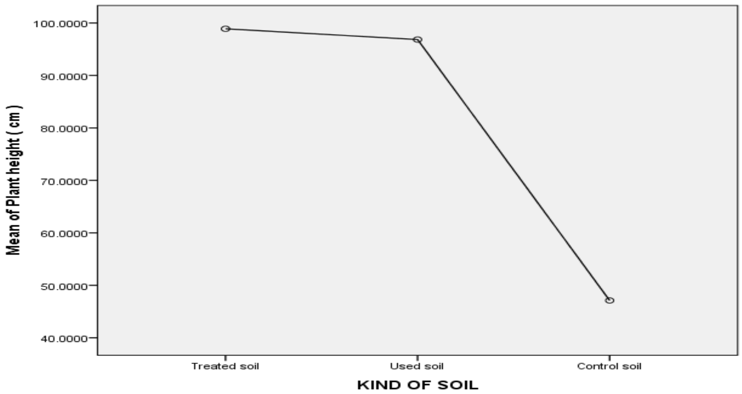

Figure 1: Graph showing mean of plant height for the different soils

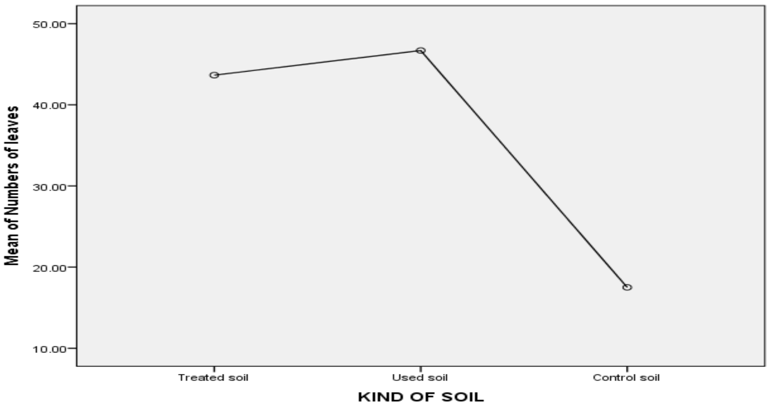

Figure 2: Graph showing mean of numbers of leaves for the different soils

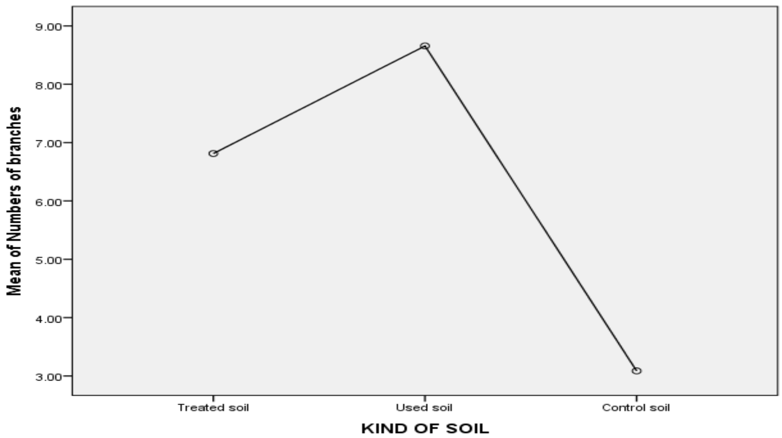

Figure 3: Graph showing mean of numbers of branches for the different soils

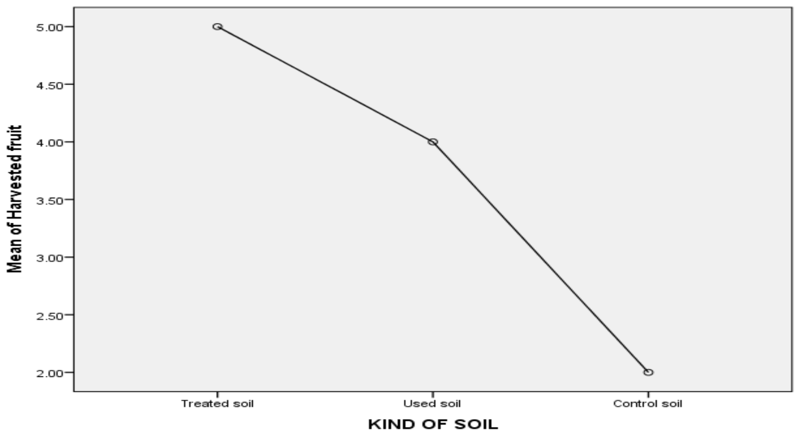

Figure 4: Graph showing mean of number of fruits for the different soils

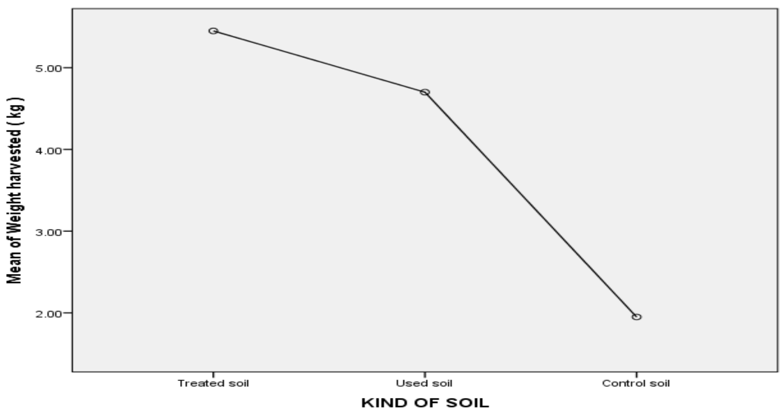

Figure 5: Graph showing mean of weight of fruits for the different soils

Discussion

Soil chemical properties

The freshly formulated/treated soil has nitrogen content of 27.7%, the available phosphorus 17% and potassium concentration 6.04% higher than the control, while a similarly formulated/treated soil, after a continuous usage for vegetable production for three years, has nitrogen 3.97%, available phosphorous 13.1% and potassium 2.01% higher than control. For the micronutrients of calcium, zinc and manganese, (for freshly formulated/treated soil) the percentage was 12.7%, 22.72%, and 4.12% higher than the control while those of formulated/treated used soil were 1.6%, 15.15% and 1.09% higher than control respectively.

The results of this study were in agreement with the results of several studies that have shown the organic matter of manure allows plants to use the nutrients for a long time, due to its slow decomposition, and reduces the loss of what is not utilized by the plants (Bhandari *et al*., 2002 and Han *et al*., 2016). In the present study, Major cations, including potassium, and nitrogen and phosphorus were higher in the formulated soil due to their high content in organic manure added during soil formulation process.

Growth and Nutrient Responses

The growth and development of sweet melon was affected by the percentage of the nutrient available in the soil. The plants height, number of fruits and weight of the fruits were highest for the freshly formulated/treated soil which had the highest percentage of macro and micro nutrients. These parameters were also high for the formulated/treated used soil, which also had the high percentage of the nutrients while the control with lowest nutrients performed the least. This is in line with the study of Zulkarami *et al*., (2010) in Morpho-physiological growth, yield and fruit quality of rock melon as affected by growing media and electrical conductivity. The significant difference in response of the plant parameters to the three different forms of soil, as shown by ANOVA necessitated further statistical analysis using Duncan multiple range tests to determine the level of the significance. The difference in performance between the crops yield and growth by freshly formulated/treated and formulated/treated used soil is not wide as shown by Duncan multiple range test analysis, compared to the difference in performance of the control.

Conclusion

The formulated/treated soil produced the best yield and had better plant development. However, the result showed that the performance of the formulated/treated used soil was also favourable. Therefore, formulated/treated soil, as described in this work, can be sustainably used for production of sweet melon for a minimum of three years. The capability for good performance beyond one season will further endear the usage of formulated/treated soils considering the labour requirement for its production. The gains of undergoing an initial labour intensive formulation/treatment process cannot be compared to the lower yield obtained in untreated soils in spite of additional management practices such as weeding and constant application of pesticides needed to obtain a meaningful result.

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