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Combined Rice Mill and Poultry Wastes Affect Some Soil Chemical Properties and Water Melon (*Citriluslanatus)* Yield In A Derived Savanna Of Obubra, Southern Nigeria

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Abstract:
***Background**: Organic nutrient sources are promising resources for sustainable crop production. The variability in nutrients content of organic materials and their time and rate of release to crops pose a challenge. The C:N ratio is a major determinant in the choice of organic materials for crop nutrition and soil amendment. The higher the C:N ratio the slower the process of mineralization and the delay in nutrients release. Poultry droppings is known for its lower C:N ratio compared to rice mill waste. Combination of these organic wastes may improve the nutrients efficacy and release efficiency of rice mill wastes noted for its high ratio.The study evaluated the effect of combination of Rice mill waste (RMW) with Poultry droppings (PD) on some soil chemical properties and yield of Water melon.*
***Materials and Methods**:Six treatments consisting of Control (no manure), RMW 10t ha^{-1}, RMW 10t ha^{-1} + PD1t ha^{-1}, RMW 10t ha^{-1}+PD 2t ha^{-1}, RMW 10 t ha^{-1} + PD 3 t ha^{-1} and RMW 10 t ha^{-1}+PD 4t ha^{-1} were laid out in Randomized complete block design (RCBD) in three replicates. Each experimental plot unit measured 5m x 4m and a gross experimental plot of 27m x 22m (594m^2) or 0.059ha. Results obtained indicated that there were significant differences (P<0.05) among the combined manures and the sole and control.*
***Results**: All RMW 10 t ha^{-1} + PD 1, 2, 3and 4 t ha^{-1} produced higher number of fruits per plant in both years (10.10, 10.02, 11.03 and10.82 respectively for 2017 and 8.20, 10.8, 10.30 and 11.1 fruits per plant respectively in 2018). RMW 10 t ha^{-1} + PD 3 t ha^{-1} and RMW 10 t ha^{-1}+PD 4t ha^{-1} produced heaviest fruits (4.2kg and 4.4kg mean weight of each fruit respectively in 2017 and 4.3kg and 4.8kg respectively in 2018). Fruit yield per unit area was also highest in these same treatments with yields of 46.8 t ha^{-1} and 47.2 t ha^{-1} respectively in 2017 and 48.1 t ha^{-1} 49.4 t ha^{-1} respectively in 2018 while the least yield was obtained in the control and the sole RMW. SOC, total N, Avail. P and exch. Ca were increased by all combined manures over the control and the sole RMW that produced lower values.*
***Conclusion**: Combined application of RMW 10t ha^{-1} + PD 3 t ha^{-1} and RMW 10 t ha^{-1} + PD 4 t ha^{-1} are suitable for optimum yield of Water melon and improvement of soil fertility in this location.*
Key Words: *Ricemill waste, poultry waste, watermelon, soil properties, derived savannah, Nigeria*

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I. Introducton

Water melon (*Citriluslanatus* (Thunb) MatsumNakai) is a plant in the family Cucurbitaceae. The crop's origin has been traced to Africa and regions of the Kalahari and Sahara Deserts [1] and Sahelianzone of West Africa [2]. It is one of the world's most important and cherished vegetable as it is grown for both its fruit and vegetative parts [3]. The fruit vegetable is so nourishing with high water content and significant amount of sugar, Vitamins A,B,C[2]. In southern Nigeria there is no information on its production to meet the vegetable demand of this crop. At commercial production, watermelon cultivation is confined to the drier savannah region of Nigeria [4] where the crop is thought to do best possibly due to the prevailing climate of the region. There are divergent views on the crop's soil nutrients needs.[5]stated that water melon can be grown with little or no fertilizer in soil. In other findings, [6];[3] reported that the crop is a heavy feeder and high demander for N. The source of the nutrient has posedsome challenges on the quality and yield of crop as well as soil reaction. [7] reported that inorganic fertilizers has depressing effect on yield of water melon as it causes reduction in number of fruits, delays and reduces fruit setting which subsequently delays ripening. The practice of inorganic fertilizers in Nigeria has been implicated in negative impacts on soil and farmers economy. [8]reported physical and chemical deterioration of our fragile soil; prolong use deteriorates surface soil characteristics and affects nutrients availability and uptake by plants [9]. The cost and scarcity of inorganic fertilizer due to removal of all subsidies by government [10]makes fertilizers unaffordable to resource-poor farmers.

Organic manures has been reported to enhance soil productivity through improvement of soil physical andchemical properties and ultimately crops yields. Improvement of physical properties of bulk density, porosity, infiltration and aggregate stability were reported by [11], [12]Kekong ,[13]. Increase in soil N,P,Mg,Ca, CEC as well as reduction in exchangeable acidity with use of organics was reported by [14], [15],[16]. On increased crop yields using organic manures,[17], [18] reported on soybean, [19] reported on maize, [20]on leaf nutrients and yield of Amaranthus and [21] on Garden egg fruit yield.

The delay in decomposition in organic materials and consequent delay in mineralization to meet crop immediate demand vary with the type of the material. This variation depends on the C/N ratio of the organic material. The higher the ratio the slower the process and the delay in nutrients release. It is on this premise that this study was designed to combine Rice mill wastes (with higher C/N ratio) with poultry droppings with higher N content and lower C/Nratio for possible fast release of nutrient to meet nutrients demand of water melon and improve soil properties.

II. Materials And Methods

Location: The study was carried out at the Teaching and Research Farm of the Cross River University of Technology, Obubra Campus during the 2017 and 2018 cropping season on latitude 6^0 06' N and 8^0 18' E in the rainforest belt of Nigeria. Obubra is characterized by a mean annual rainfall density of 2250 mm-2500mm with an annual temperature range of 25^0C – 28^0C.

Experimental Design and Treatments

The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated three times. The treatments consisted of control and five manure rates of Rice mill waste (RMW) and Poultry droppings (PD) viz: T_1 – No manure, T_2 – RMW 10 t ha^{-1}, T_3 – RMW 10 t ha-1 + PD 1 t ha-1, T_4 – RMW 10 t ha-1 + PD 2 t ha^{-1}, T_5 - RMW 10 t ha^{-1} + PD 3 t ha^{-1} and T_6 – RMW 10 t ha^{-1} + PD 4 t ha^{-1}. Each experimental plot measured 5m x 4m and a gross experimental plot of 27m x 22m (594m^2).

Experimental Material and Agronomic Practices

The variety of the water melon used was Sugar baby.

The manures were weighed according to the treatment level and incorporated on prepared seed bed and allowed for two weeks before sowing of the seeds.

Data Collection

Soil sampling and processing. At the commencement of the experiment, composite soil samples were collected at random points within the experiment plot which were bulked using a soil auger at the 0 – 25 cm for both years.

Post manuring and planting soil samples were collected from each treatment and replication and each treatment was bulked for the three replications at the end of the experiment. The samples were air dried and sieved through a 2mm mesh ready for laboratory analysis.

Plant Sampling: A net plot of inner ridges for each treatment was used with five tagged plants for the yield components parameters. The fruit yields for each net plot was extrapolated to yield in tonnes per hectare.

Soil Analysis: Routine analysis was conducted for the composite sample to determine the particle size distribution using the Bouyouchos Hydrometer method as outlined by [22]. Soil pH using glass electrode pH meter and soil N by the Macro Kjeldahl apparatus as described by [22].

Soil organic matter was analysed using the Walkley – Black wet Oxidation method as outlined by [23].

The excess was titrated against ferrous sulphate. The org. carbon was then calculated using the relationship. % org. C. = N (V1 – V2) 03 f. The % org. matter in soil = % org. C x 1.729.

Soil phosphorus was determine using the Bray 1 method as described by [23].

Statistical Analysis:

Analysis of variance (ANOVA) forRCBD was performed on the watermelon plant yield parameters using the computer software Genstat[24]. FLSD was calculated on the means at P>0.05 to separate the means.

III. Results

The properties of the soils and the manures use in this study are presented in Tables 1 and 2.The pH of the soil was moderately acidicfor both years and textural class of the soils was sandy loam. Total N, available P and organic matter were low in the experimented soils. However, exchangeable Ca, K and Mg were adequate. The pre-treatment soil also have low ECEC and exch Na with a low exchangeable acidity and an adequate Base saturation of 78.2% and 74.4% respectively for the 2017 and 2018 experimental soils. The Rice mill waste (RMW) and poultry drippings (PD) nutrients composition (Table 2) showed that PD has higher content of N, P, K, Ca, and Mg than the RMW. The organic C content of RMW was higher (28.1 and 26.41) for 2017 and 2018 respectively than the PD with 9.2 and 9.05% respectively for the two years. The RMW has of wider C/N ratio (30:1 and 28:1) than PD (5:1 and 5:1).

TABLE 1: PRE-CROPPING SOIL PHYSICAL AND CHEMICAL PROPERTIES AT THE EXPERIMENTAL SITE

Parameter	2017	2018
Sand (g/kg)	853	797
Silt (g/kg)	79	106
Clay (g/kg)	68	97
Texture class	S/L	S/L
pH (water)	5.60	5.56
pH (KCL)	4.50	4.42
Organic matter (%)	1.26	1.34
Total nitrogen (g/kg)	0.8	0.9
Available p (mg/kg)	4.8	4.0
Exch. Ca (cmolkg^{-1})	3.60	3.52
Exchange k (cmolkg^{-1})	0.24	0.31
Exchange.mg (cmolkg^{-1})	1.44	1.42
Exchange Na (cmolkg^{-1})	0.07	0.09
Exchange acidity	2.25	2.13
ECEC (cmolkg$^{-1)}$	7.6	7.75
Base saturation (%)	70.39	71.7

Table 2. Nutrients Composition of the Rice Mill Waste and Poultry droppings

PROPPERTIES	RICE MILL WASTE (RMW)		POULTRY DROPPING	
	2017	2018	2017	2018
Total Nitrogen (0%)	0.94	0.95	1.72	1.65
Total Phosphorus (m_g / k_g)	0.92	0.92	2.2	2.1
Total Potassium (cmol / K_g)	0.38	0.37	2.55	2.46
Calcium (cmol / k_g)	2.21	2.19	7.0	7.3
Magnesium (cmol / k_g)	0.53	0.61	1.13	1.21
Sodium (cmol / k_g)	0.21	0.22	0.11	0.10
Org. carbon (%)	28.1	26.41	9.2	9.05
C:N Ratio	29.89	27.80	4.78	5.48

IV. Postharvest Soil Properties

The effects of combined application of rice mill waste and poultry droppings on soil properties (Tables 3 and 4) indicated that soil pH was raised from the pre-treatment 5.60 and 5.80 in 2017 and 2018 respectively by rice mill waste combined with poultry droppings at rate of 2, 3 and 4t ha^{-1} to 6.0, 6.3 and 6.4 respectively in 2017 and to 6.1. 6.4 and 6.3 respectively in 2018. This values were above the control, and RMW sole. OM was raised from low (1.26% and 1.34%) of the pre-treatment soils to moderate of 1.79%, 1.83%, 1.85% and 1.86% in 2017 and 1.81%, 1.87%, 1.88% and 1.89% in 2018 by all treatments of RMW combined with poultry dropping above the control with no manure.

Total N was raised from 0.08% and 0.07% as initial levels to levels higher than the initial and the control and treatments that received only rice mill waste (Table 3). Available P was raised from very low (2.12mg/kg and 2.62mg/kg) in the initial soils to low in all treatments with combined RMW and PD for both years. Exchangeable cations (Table 4) indicated that exch. K was reduced from initial adequate levels

(3.60cmol/kg and 3.52cmol/kg) of the pre-treatment soil to below critical levels by the control and the sole RMW (0.11 and 0.14cm/kg) respectively in 2017 and 0.12cmol/kg and 0.13cmol/kg in 2018 respectively. The exch K in all the combined RMW and PD, however were increased above the initial levels of the experimental soils. The exch Ca and Mg levels in the soils was maintained by all treatments maintaining the adequacy levels. Apart from the control and the sole RMW, all manured treatments with PD reduced the soils exchangeable acidity and increased the soils ECEC. Base saturation was highest in treatments with combine RMW and PD.

The increase in the pH of the postharvest soils particularly soils with combine RMW and PD is an indication of the release of basic cations by this organic amendment that displaced the H^+ in the soil solution.

Table 3: Soil pH, organic matter, N and available P at the end of cropping

Treatment	pH	OM (%)	TOTAL N(%)	Av. P (Mg / Kg)
		2017		
Control (No manure)	5.40	1.32	0.08	2.12
RMW 10 t ha^{-1}	5.51	1.34	0.09	2.34
RMW 10 t ha^{-1}+ PD 1t ha-1	5.70	1.79	0.09	2.43
Control (no manure)	6.0	1.86	0.11	4.31
RMW 10 t ha^{-1}+ PD 3 t ha^{-1}	6.3	1.85	0.11	6.20
RMW 10 t ha^{-1}+ PD 4 t ha^{-1}	6.4	1.83	0.13	9.14
		2018		
Control – no manure	5.55	1.21.	0.07	2.62
RMW 10 t ha^{-1}	5.56	1.38	0.06	2.31
RMW 10 t ha^{-1}+ PD 1 t ha-1	5.68	1.88	0.10	3.21
RMW 10 t ha-1 + PD 2 t ha-1	6.1	1.87	0.12	4.31
RMW 10 t ha-1 + PD 3 t ha-1	6.4	1.89	0.11	6.10
RMW 10 t ha-1 + PD 4 t ha-1	6.3	1.81	0.13	8.40

Key: RMW = Rice mill waste PD = poultry dropping

Table 4: Exchangeable Cations of soil at the end of the cropping (Cmol/Kg)

Treatment	K	Ca	Mg	Na	Ea	ECEC	BS
Control (No manure)	**0.11**	**3.34**	**1.01**	**0.01**	**2.20**	**6.73**	**76.3**
RMW 10 t ha^{-1}	**0.14**	**3.29**	**1.12**	**0.06**	**2.16**	**6.77**	**68.1**
RMW 10 t ha^{-1}+ PD 1t ha-1	**0.28**	**3.88**	**1.88**	**0.09**	**1.98**	**8.11**	**75.6**
Control (no manure)	**0.37**	**3.95**	**2.09**	**0.11**	**1.04**	**7.56**	**86.**
RMW 10 t ha^{-1}+ PD 3 t ha^{-1}	**0.41**	**4.15**	**2.85**	**0.18**	**1.07**	**8.66**	**87.6**
RMW 10 t ha^{-1}+ PD 4 t ha^{-1}	**0.43**	**4.05**	**2.79**	**0.19**	**1.08**	**8.54**	**87.3**

WATER MELON YIELD

The yield and yield components of water melon (Table 5) indicate that application of combined RMW and PD significantly increased the yield of the crop. All the rice mill waste combined with poultry droppings in 2017 and 2018 produced significantly (P= 0.05) higher number of fruits per stand than the control and the sole rice mill waste 10 t ha^{-1}. Weight of each fruit in 2017, RMW 10 t ha + PD 4 t ha^{-1} and RMW 10 t ha^{-1} + PD 3t ha^{-1} produced significantly (P= 0.05) heaviest fruit, (4.4kg and 4.2kg) respectively, followed by RMW 10 t ha + PD 2 t ha-1 with fruit weight of 3.1kg and the least fruit weight was in the control as sole RMW. In 2018 the fruit weight follow same trend as RMW 10 t ha + PD 4 t ha^{-1} and RMW 10t ha^{-1} + PD 3 t ha^{-1} produced heaviest fruits followed by RMW10 t ha^{-1} + PD2 t ha^{-1} and RMW10 t ha^{-1} + PD1 t ha^{-1} and the least yield of 1.2kg from the control (Table 5). The fruit yield per unit area in 2017 showed RMW10t ha^{-1} + PD4 t ha^{-1} and RMW10t ha^{-1} + PD3 t ha^{-1} with significantly (p = 0.05) highest fruit yield (47.2 t ha^{-1} and 46.8t ha^{-1}) respectively. This was followed by RMW10 t ha^{-1} + PD2 t ha^{-1} , then RMW10 t ha^{-1} + PD1 t ha^{-1} with the least yield in the sole RMW and the control. The yield for 2018 follow same trend although the yield in 2018 was slightly higher than 2017.

Table 5: Yield and components of Watermelon Influenced by combined Rice mill waste and poultry droppings

Treatment	No.of fruits /plant		Weight of fruit (kg)		Fruit yield (t ha^{-1}	
	2017	2018	2017	2018	2017	2018
Control (No manure)	5.00	6.00	1.1	1.2	3.8	3.9
RMW 10 t ha^{-1}	6.01	5.40	1.0	1.3	3.4	4.5
RMW 10 t ha^{-1}+PD1 t ha^{-1}	10.10	8.20	2.1	2.9	18.8	20.9
RMW 10 t ha^{-1} +PD2 t ha^{-1}	10.02	10.80	3.1	3.4	34.4	37.8
RMW 10 t ha^{-1} +PD3 t ha^{-1}	11.03	10.30	4.2	4.3	46.8	48.1
RMW 10 t ha^{-1} +PD4 t ha^{-1}	10.82	11.10	4.4	4.8	47.2	49.4

FLSD	2.1	2.21	0.01	0.81	10.8	11.6

Key: RMW =Rice mill waste, PD=Poultry dropping

V. Discussion

The initial soils for the experiment show low nutrients status but with adequate base saturation which is an indication that the soil will respond to additional nutrients application. The low nutrients content of the soil is a feature of tropical soils particularly soils of Cross River State as reported by [25]. The higher organic matter content and wider Carbon/Nitrogen ratio of the rice mill waste justifies the combination of the poultry droppings with higher nitrogen and low C:N ratio to the rice mill waste. This combination of PD and RMW is in line with the assertion of [26] that organic input with C:N ratio >16 immobilize nutrients for prolonged period especially N because soil microbes will outcompete growing plants for the available N.

The increase in the pH of the postharvest soils particularly soils with combine RMW and PD is an indication of the release of basic cations by this organic amendment that displaced the H^+ in the soil solution.

This increase of soil pH by organic manures has been reported by[27];[28]. The observed increase in soil organic matter (OM) by the application of RMW and PD over the control was the degradation process that was facilitated by the higher N in the poultry droppings. [29]reported significant increase in SOM using poultry droppings and its mixture with corn straw and saw dust. [16] reported similar increase in SOM using poultry droppings singly and in combination with cow dung.

The higher total N in the soils at the end of the experiment was probably due to the enhanced mineralization of N particularly in the PD combined treatments with a narrower C:N ratio. The lower total N values in the sole RMW could be the depletion of the released N by microbes in the process as a result of the C:N ratio in the RMW. This trend was also reported by [30], [31].

The higher values of available P in this study over the control and sole RMW could be the increase in pH and the SOM by combined PD and RMW. The use of organic manures to raise soil pH and consequent unlocking of bound P in soils was reported by [32]. The degradation of organic materials enhances mineralization of P as this element is organic bound [33]. The increase in exch K in soil was enhanced by the increase in soil pH which reduces its fixation and makes it more available in solution.

The increase in exch Ca and Mg content in the post cropping soil is an indication that the high content of these elements in the amendments mineralized which affected their concentration in the soils. This increase in exchangeable cations from organic wastes have been documented[29],[34],[35]. The decrease in exchangeable acidity of the post cropping soils due to application of the manures could be attributed to the precipitation of Al(OH)3 which occurred with the increase in pH. At pH above 6.0 Aluminium exist in the soil as insoluble and nontoxic to plants [33]. The increase in ECEC and base saturation could have resulted from the increase in SOM that increased the organic colloids in the soils and increase in basic cations and particularly the decrease in exch EA increased the base saturation.

The yield performance of watermelon in this experiment the mineralization and release of nutrients from the organic manures during the growth cycle of the crop. The higher yield obtained from the combined rice mill waste and poultry dropping over the sole rice mill waste showed the higher N content of poultry droppings to have enhanced mineralization especially N that promoted better growth culminating into yield. [36] reported increased yield of maize with combination of rice mill waste and poultry droppings and recommended the combination as best soil amendment.

The increase yield of water melon due to the organic amendments particularly with poultry manure are in line with earlier reports of [17],[20],[21].

The low yield of watermelon in the sole rice mill waste treatment can be attributed to the carbonaceous rice husk that slowed down the rate of mineralization of the amendment which is in agreement with the report of [37].

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VI. Conclusion:

The integration of poultry droppings with rice mill waste was found to be efficient in increasing soil nutrients status in this study. The synchrony between release and uptake of nutrients by the watermelon crop resulted in higher yield of the crop and increasing nutrients levels over the initial after crop harvest makes combination of poultry droppings addition to rice mill waste, particularly at higher rate, above 3t ha^{-1}, suitable for improved watermelon yield and soil sustainability.

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