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The residual effect of different levels of rice mill ash on maize-soybean intercrop

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Abstract

A two year (2013 and 2014) field trial was conducted to study the residual effect of different fertility levels of rice mill ash (RMA) on maize-soybean intercrop. The experiment was arranged in a randomized complete block design (RCBD) comprising of nine (9) treatments and three (3) replications. The treatments where sole maize (SMO), sole soybean (SBO), maize/soybean intercrop without application of rice mill ash (IMBO), soybean + 10 t/ha rice mill ash (SB10), sole maize + 10 t/ha rice mill ash (SM10), maize - soybean intercrop + 10 t/ha rice mill ash (IMB10), sole maize + 20 t/ha rice mill ash (SM20); sole soybean + 20 t/ha rice mill ash (SB20) and maize/soybean intercrop + 20 t/ha rice mill ash (IMB20). Data generated was subjected to analysis of variance of which the result of the study showed that for 2 years under study, incorporated rice mill ash (RMA) and intercropping system significantly increased the soil productivity, yield and yield components of maize and soybean studied. The RMA at the rate of 20t/ha performed competitively better than the other treatments with strong residual impact on the parameters assessed. Findings from the study equally showed an intercrop advantage.

Keywords: Ash; Crop Production System; Intercrop; Mixed Cropping; Multiple Cropping; Residual Yield

1. Introduction

The use of chemical fertilizer to replenish lost nutrient and sustain agricultural soil is very minimal in Nigeria and most of the African countries at large. The reason being that most farmers cannot afford the cost and the attendant problems such as unavailability at the point of need, soil acidity, nutrient imbalance etc. In this contest therefore, the management of waste is very critical in keeping the agricultural soil supplied with essential plant nutrients for healthy growth of crops .Wastes are bound in urban cities and in mini and large agricultural processing industries but the problem is the policy articulation and adequate management of the wastes to ensure maximum benefits from them. When wastes are properly managed especially with respect to soil it becomes source of fertilizer that reduce the cost of production and the use of chemical fertilizer in crop production. It can also be used to reclaim degraded and marginal soils. The good thing about soil is that it is a natural filter, thus important medium for wastes disposal. The essence of life on this planet earth depend largely on the sustainability of the soil. In all cases also, man and animal depend on plant for life sustenance. Therefore the fertility status of any given soil should be paramount to farmers. As it is a measure of the availability of the nutrients to the plant in their right proportion and balances.

One of the major ways to reduce the problem of chemical fertilizer is to add organic waste to keep the soil alive, productive and healthy environment. Soil is non-renewable resource on which we exercise our crop production activities [1], hence should be treated as a living entity especially the top soil. The addition of waste according to Ijeh et al. [2] increase the stability of soil aggregates an index used in predicting the capacity of soil to sustain long term crop production. Contaminant, toxic elements and soil organism (especially nematode) harmful to crops, animals and man

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have been reported to reduce and inactive by the use of organic waste in crop production [3, 4, 5]. Organic waste resuscitate and improve degraded soil, conserve water and plant nutrients for efficient crop production [6, 7].

The objective of intercropping is to produce more crop yield on a piece of land by making use of resources otherwise would not have been utilized by a single crop. This wonderful method of cropping if properly planned and implemented in Nigeria soils especially southeastern region soils taken into account the climate, crop type and variety, disease and pest, as Nweke [8] argued could be a panacea for sustainable food production, environmental harmony and a strong check to land degradation in the area. This new and improved method of cropping advocated has been avoided by farmers especially the large and commercial farmers on the pretense of complications of planting and harvesting. Nonetheless, intercropping usually give benefit from increased light interception, root contact with more soils and more nutrients, increased microbial activity and can act as a deterrent to pest and weed of the other crop. Available growth resources such as light, water and nutrient are more completely absorbed and converted to crop biomass by the intercropping as a result of differences in competitive ability for growth factor between intercropping components [8, 9]. However food production is based on continuous availability of plant nutrients in the soil, and continuous cropping without adequate input and to the depletion of soil nutrients with resultant poor yield of cultivated crops. With this trend soil nutrients that will boost crop growth and yield decline progressively unless the nutrients are replenished through organic wastes or chemical fertilizers. Soils and crops differs in their response to organic wastes amendments and therefore important to investigate more closely the influence of these organic wastes on a range of crops and of soil physical, chemical, and biological properties. Thus the objective of this study is to determine the residual effect of rice mill ash at different fertility levels on the maize-soybean intercrop.

2. Materials and methods

The experiment was carried out at Teaching and Research farm of Crop Science and Horticulture of Chukwuemeka Odumegwu Ojukwu University, Igbariam Campus Anambra State Nigeria, Between May-September 2013 and 2014 planting season. The area is located between the latitude 06 14 `N and longitude 06 45 `E and within the humid tropical rainforest zone characterized by both wet and dry season with high rainfall and high temperature.

2.1. Land Preparation /Treatment Allocation and Experimental Design

The land area measuring 434 m^2 was manually cleared with cutlass and debris removed. The dominant weed species in the area before they were cleared were *Imperata cylindrical* (spear glass), *Talinum triangular* (water leaf), *Eleusine indica* (crow foot grass) and *Aspila africana* (wild marigold). The experiment was laid out in a randomized complete block design (RCBD) with 9 treatments.

The treatments are:

- Sole maize (SMo)
- Sole soybean (SBo)
- Maize-Soybean intercrop (IMBo)
- Sole maize treated with a 10 t/ha rice mill ash (SM_{10})
- Sole soybean treated with 10 t/ha rice mill ash (SB_{10})
- Maize-Soybean intercrop treated with 10 t/ha rice mill ash (IMB_{10})
- Sole maize treated with 20 t/ha rice mill ash (SM_{20})
- Sole soybean treated with 20 t/ha rice mill ash (SB_{20})
- Maize -soybean treated with 20 t/ha rice mill ash (IMB_{20})

The treatments were randomly assigned to each plot measuring 3 m x 4 m (12 m^2) and adjacent plots were spaced at 0.5 m within each block and 1m between blocks. The treatments were replicated 3 times. Two seeds of maize and soybean were sown directly on their respective plots. Supply on non-germinated seeds were done two weeks after planting for maize and 28 days after planting for soybean. Weeding was done manually every other week with either hoes or hand pulling. The maize and soybean was harvested when they are matured and dried for their seed and grain yield. The same procedures were followed in 2014 with exception of application of rice mill ash. Soil samples were collected from 0 – 25 cm depth randomly from the land area before cultivation and bulk together as composite sample. After harvest soil samples were collected from each plot at the depth of 0 – 25 cm. These soil samples were air dried and sieved with 2 mm mesh sieve and used to analyze selected soil chemical properties and core samples used for the analysis of selected physical properties of the soil. The analysis of both physical and chemical properties follow the method outlined in Black [10].

Agronomic parameters measured include; number of nodules of which destructive sampling was used to determine number of nodules at 10 weeks after planting using ten (10) randomly tagged plants which were uprooted, weight of nodules, weight of pods, maize grain yield, and soybean seed yield (t/ha).

2.2. Relative yield of maize

This was used to evaluate the yield of maize expressed as sole crop and intercrop using the equation;

$$RY = \frac{YIMB}{YSM}$$

Where RY = Relative Yield, YIMB = Yield of maize as intercrop in soybean

YSM = Yield of maize as a sole crop.

2.3. Relative yield of soybeans

The yield of soybean expressed as sole crop and intercrop using the equation;

$$RY = \frac{YISM}{YSB}$$

Where; RY =Relative yield, YISM = Yield of soybean as intercrop in maize
YSB = Yield of soybean as a sole crop

2.4. Equivalent yield of maize and soybean

This was done by calculating the total yield of maize grain as compared to soybean seed in t/ha. The following equations were used;

$$EYs = YSB + \left(\frac{YIM \times PM}{PB}\right)$$

$$EYm = YSM + \left(\frac{YIB \times PB}{PM}\right)$$

Where:

EY_S = Equivalent yield of soybean
EY_M = Equivalent yield of maize
YSB= Yield of sole soybean
YSM= Yield of sole maize
YIM= Yield of maize in intercrop
YIB= Yield of soybean in intercrop
PM= Selling price of maize at the period of study
PB= Selling price of soybean at the period of study

2.5. Land equivalent ratio (LER)

This tool was used to evaluate the intercrop efficiency in yield to sole crop

$$LER = \frac{YIM}{YSM} + \frac{YIB}{YSB}$$

Where;

LER = Land equivalent ratio
YIM = Yield of maize in intercrop
YSM = Yield of sole maize
YIB = Yield of soybean in intercrop
YSB = Yield of sole soybean

2.6. Data analysis

Data generated from the study was subjected to the analysis of variance test based on randomized complete block design (RCBD) and treatment means were separated using least significant difference at 5% alpha level.

3. Results

3.1. On farm observation

The maize seed germinated within 4 - 5 days after sowing while the soybean germinated 14 days after planting. Pest attack was a major problem, in the soybean plot amended with rice mill ash. It seems the ash attracted the pest as their effects declined in 2014 planting year that ash was not applied. Flea flies and grasshopper were major pest while in the sole plots these insects were not seen but maggot was noticed to eat the leaf of the plant which often lead to death of the affected plant. Another problem is the bush rat that dug up a hole and eat up the nodules of soybean, mostly observed in plots amended with 10 t/ha of rice mill ash. Soil erosion problem was partly observed but was controlled. On the whole, number of plants survived to maturity was observed to be higher in sole cropping compared to intercropping. However the above numerated problems were drastically reduced in the second year of the planting season (2014).

3.2. Initial soil properties

The chemical characteristics of the studied soil indicated low level in all the parameters tested, except for base saturation (BS) value and available P that is of moderate value (Table 1).

Table 1 Initial soil properties

Parameter	**value**
Sand	770 gkg^{-1}
Silt	780 gkg^{-1}
Clay	152 gkg^{-1}
Textural class	Sandy loam
pHH_2O	6.46
Available P	26.10 $mgkg^{-1}$
Total N	0.126%
OC	0.77%
OM	1.32%
Ca	5.60 $cmolkg^{-1}$
Mg	2.40 $cmolkg^{-1}$
K	0.118 $cmolkg^{-1}$
Na	0.096 $cmolkg^{-1}$
EA	0.40 $cmolkg^{-1}$
ECEC	8.614 $cmolkg^{-1}$
BS	95%

3.3. Nutrient content of rice mill ash before the study

The properties of rice mill ash before application in Table 2 showed that the pH of the ash is strongly alkaline (11.40) however the ash contains lower levels of exchangeable bases, P, organic carbon (OC) and total nitrogen (TN).

Table 2 Chemical properties of rice mill ash before the commencement of the study

Parameter	Value
pHH_2O	11.4
OC%	0.16
N%	0.22
P $mgkg^{-1}$	0.45
Ca $comlkg^{-1}$	3.84
Mg $cmolkg^{-1}$	1.28
K $cmolkg^{-1}$	0.78
Na $cmolkg^{-1}$	2.25

3.4. Effect of different fertility levels of rice mill ash and intercrop system on the chemical properties of the studied soil

Table 3 Effect of different fertility levels of RMA on the chemical properties of the studied soil

	Treat	ment		Ot/haRMA	10t/haRMA	20t/haRMA	LSD 0.05
2013 planting season	pH	H_2O		6.97	7.47	8.23	0.47
	P	$mgkg^{-1}$		15.8	21.6	28.5	3.16
	N	%		0.06	0.13	0.24	0.29
	OC	%		0.85	1.01	1.09	0.19
	Ca		$Cmolkg^{-1}$	3.2	4.8	5.6	1.34
	Mg			1.6	2.4	2	0.34
	K			0.13	0.15	0.23	NS
	Na			0.89	0.12	0.17	NS
	EA			0.3	0.4	0.6	NS
	ECEC			5.34	7.91	8.56	2.35
	BS	%		94	95	93	NS
2014 planting season	pH	H_2O		6.1	5.9	5.4	0.25
	P	$mgkg^{-1}$		20.52	20.52	21.45	NS
	N	%		0.07	0.07	0.04	NS
	OC	%		0.37	0.46	0.33	0.37
	Ca		$Cmolkg^{-1}$	2	1.8	2.4	NS
	Mg			1	1.4	1	NS
	K			0.13	0.13	0.13	NS
	Na			0.08	0.08	0.06	NS
	EA			1.8	1.6	1	NS
	ECEC			9.6	9.6	9.6	NS
	BS	%		33.44	33.52	37.4	1.58

RMA = Rice mill ash

The result of the chemical properties of the studied soil presented in Table 3 showed significant difference among the treatments in 2013 planting season except for the results of K, Na, EA, ECEC and BS while the 2014 planting season result showed non-significant ($P < 0.05$) different among the treatments in all the parameters assessed except for pH, OC and BS. Most of the parameters tested in 2013 and 2014 planting season showed increment in value as the RMA levels increased. Also decreased value were recorded in 2014 planting season relative to 2013 planting season results in all the parameters assessed in the study. The RMA increased the pH of the soil to alkaline in 2013 planting season but slightly acidic in 2014 planting season. The residual effect of RMA on the parameters were strong but relatively alike in value. Most of the values obtained in 2014 planting season from 10 t/ha RMA and 20 t/ha RMA fertility levels were the same and statistically equal. The obtained values in the study were however higher in amended plots relative to the control plots though more pronounced in 2013 planting season than 2014 planting season result.

3.5. Effect of different fertility levels and intercrop system on the physical properties of the studied soil

The physical properties of the soil showed that apart from % clay result the treatment differed significantly ($P < 0.05$) in 2013 planting season (Table 4). But in 2014 planting season the particle size result indicated non-significant but showed significant effect on the result of bulk density (BD) and total porosity (TP). The value of BD decreased and TP increased with incremental increase in RMA in 2013 planting season while there was no particular order in the result in 2014 planting season. However the highest recorded value for BD and TP were obtained from 10 t/ha RMA and 20 t/ha RMA respectively. There was a little bit decrease in BD value of 2013 planting season relative to 2014 planting season while the 2014 planting showed increased TP value relative to the 2013 planting season result. The particle size data indicated increased constant sand and silt and decreased constant clay in 2014 planting season compared to the obtained value of the parameters in 2013 planting season.

Table 4 Effect of different fertility levels of RMA on the physical properties of the studied soil

	2013 planting season						2014 planting season					
Treatment	**Sand %**	**Silt %**	**Clay %**	**TC**	**BD gcm^{-3}**	**TP %**	**Sand %**	**Silt %**	**Clay %**	**TC**	**BD gcm^{-3}**	**TP %**
0t/haRMA	78	6.50	15.2	LS	1.5	43	82	12	6	LS	1.38	47,92
10t/haRMA	74	5.50	15.2	LS	1.4	47	82	12	6	LS	1.45	45.28
20t/haRMA	80	4.80	15.2	LS	1.3	51	82	12	6	LS	1.21	54.34
LSD0.05	1.38	0.58	NS		0.09	2.87	NS	NS	NS		0.19	2.98

RMA = Rice mill ash; TC =Textural class; BD = Bulk density; TP = Total porosity

3.6. Effect of different fertility levels and intercrop system on maize grain yield, soybean seed yield, pod yield (t/ha) and number of nodules and weight of nodules.

The result presented in Table 5 showed significant difference ($P < 0.05$) in all the parameters measured in both 2013 and 2014 cropping season except for pod weight in 2013 cropping season and number of nodules in 2014 cropping season. The sole maize (SM_O) showed higher in value (2.81 t/ha) compared to the intercrop maize (IMB_O), 2.64 t/ha. The plot amended with 10 t/ha RMA and 20 t/ha RMA varied in their yield results. SM_{20} recorded the highest maize grain yield of 6.96 t/ha, this was closely followed by SM_{10}, IMB_{20} and IMB_{10}. Soybean seed yield and pod weight showed a result variation of $SB_{20} > SB_{10} > SB_0 > IMB_{20} > IMB_{10} > IMB_0$, respectively. The highest number of nodules and weight of nodules were recorded in SB_{20}, the next in rank is SB_{10} for the two parameters. No value was recorded for this two parameters in SB_0 and IMB_0, respectively. For the 2014 cropping season the trend of the result was almost the same with the 2013 planting season results. The highest maize grain yield was recorded in IMB_{10}, the next in rank was SM_{10} and the least value of 0.72 t/ha obtain from SM_{20}. IMB_O recorded the least soybean seed and pod weight yield of 0.04 t/ha and 0.09 t/ha, respectively. The two values were respectively found to be 84.62% and 84.15% decreased in value relative to IMB_{10} that recorded the highest (0.26 t/ha and 0.59 t/ha) of soybean seed and pod weight respectively. The result obtained from SB_{10}, IMB_{10}, SB_{20} and IMB_{20} showed statistically similar result for the two parameters. SB_{20} and IMB_{20} recorded the same value for the number of nodules with the highest value of 26.30 recorded by IMB_{10}.The least value of weight of nodules was obtained from IMB_0 as against the highest value of 1.55 $_g$ recorded in IMB_{10}. In all the parameters assessed the values obtain in first planting season (2013), showed higher values compared to the values recorded in the second planting season (2014).

Table 5 Effect of different fertility level and intercrop system on maize grain yield, soya bean seed, pod yield (t/ha), number of nodules and weight of nodules 2013 Planting Season 2014 Planting Season

Treatment	Maize grain (t/ha)	Soya bean seed (t/ha)	Pod yield (t/ha)	No. of nodules	Weight of nodules g	Maize grain (t/ha)	Soya bean seed (t/ha)	Pod yield (t/ha)	No. of nodules	Weight of nodules g
SM_0: SB_0	2.81	0.40	0.56	0	0	0.79	0.11	0.25	11.0	0.79
IMB_0	2.64	0.22	0.44	0	0	1.14	0.04	0.09	9.0	0.37
SM_{10}:SB_{10}	5.94	0.68	0.96	36.0	1.50	1.67	0.21	0.54	13.0	0.90
IMB_{10}	4.94	0.30	0.47	10.3	1.33	2.24	0.26	0.59	26.3	1.55
SM_{20}:SB_{20}	6.96	1.06	1.39	79.8	3.65	0.72	0.24	0.50	11.0	0.50
IMB_{20}	5.25	0.38	0.49	13.7	1.31	1.43	0.18	0.46	11.0	0.55
LSD 0.05	1.62	0.60	NS	15.47	0.85	0.74	0.15	0.23	NS	NS

3.7. Effect of different fertility levels of rice mill ash and intercrop system on equivalent and relative yield of maize and soybean and land equivalent ratio

The equivalent yield result for maize and soybean in 2013 year planting season showed an order 20 t/ha RMA > 10 t/ha RMA > 0 t/ha RMA (Table 6). The 0 t/ha RMA recorded the highest value in relative yield (0.95 t/ha), for maize and soybean 20 t/ha RMA gave the highest of 0.52 t/ha. While the least value (0.10 t/ha) for relative yield of soybean was obtained from 0 t/ha RMA. The land equivalent ratio showed a result scenario of 0 t/ha RMA > 10 t/ha RMA > 20 t/ha RMA. The 2014 year planting season, the equivalent yield of maize and soybean respectively, indicated 10 t/ha RMA > 20 t/ha RMA > 0 t/ha RMA. The relative yield result for maize and soybean depicted 20 t/ha RMA and 10 t/ha RMA to have recorded the highest value of 1.98 t/ha and 1.24 t/ha respectively. While the land equivalent ratio showed an order of 20 t/ha RMA > 10 t/ha RMA > 0 t/ha RMA. The two seasons under study (2013 and 2014 season) varied greatly in the results generated and there was no consistent order in the value recorded for the parameters apart from equivalent yield value of first planting season. The relative yield of maize and soybean and land equivalent ratio (LER) result of 2014 planting season showed an increased value relative to the 2013 planting season result. The percentage increase in relative yield of maize and soybean in 2014 planting season relative to 2013 planting season were; 34.03%, 38.06%, 60.61% and 72.22%, 60.48%, 30.67% for 0 t/ha RMA, 10 t/ha RMA and 20 t/ha RMA respectively.

Table 6 Effect of different fertility levels of rice mill ash and intercrop system on equivalent yield of maize and soybean and land equivalent ratio

Treatment	2013 planting season					2014 planting season				
	Equivalent yield Maize Soyabean		Relative yield Maize Soyabean		LER	Equivalent yield Maize Soyabean		Relative yield Maize Soyabean		LER
0t/ha RMA	1.38	3.95	0.95	0.10	1.94	0.87	0.68	1.44	0.36	1.81
10t/ha RMA	1.86	7.39	0.83	0.49	1.32	2.19	1.33	1.34	1.24	2.58
20t/ha RMA	2.32	7.89	0.78	0.52	1.31	1.08	0.96	1.98	0.75	2.74

4. Discussion

The soil analysis taken before the commencement of the study is of evidence that the soil is deficient in plant nutrients as the parameters assessed were low except for available P that showed moderate level and high BS. The low level value simply suggest that the soil is leached and strongly weathered resulting from high temperature and rain fall and rapid OM mineralization. Hence required to be ameliorated for efficient production. Thus the application of RMA become an ideal waste as it positively influenced the studied soil and maize/soybean intercrop. The positive impact of RMA may be due to its higher pH value of 11.4 (Table 2). This may have created an ideal environment for microbial activities leading to liberation of plant nutrients, P and N transformation in soil. This scenario might have been responsible for the increased plant nutrients and yield observed in amended soil relative to the control. Thus showing that the studied soil was adequately ameliorated by RMA. The reduction in value obtained for the parameters in 2014 planting season compared to 2013 planting season may be due to none addition of RMA in the 2014 planting season and the residual effect of 2013 planting year and reduced decomposition of organic matter. The low value recorded for OC and N can be linked to low presence of OM and OC in both the soil and RMA (Table 1 and 2) respectively. The value recorded for the nutrients (OC and N) in 2014 were found to be below their critical level for crop production in southeast, Nigeria [11]. While different in values may be attributed to differences in the nutrient content in the rates of RMA applied. The observed increased value of EA, ECEC and decreased pH value in 2014 year relative to the 2013 planting year can be attributed to leaching losses, plant uptake of base elements and adsorption of base elements in the soil colloids thereby increasing the content of H^+ ion in soil solution. The RMA imparted much on the availability of P of the studied soil considering the value of the element in the initial soil and RMA (Table 1 and 2) respectively, meaning that the solubility and mineralization affected the fixed P to dissolve and come into solution thus increasing the recorded value. The low content of P recorded in the control soil of 2013 year might be attributed to the absolute low content of P in the soil. The rise in soil pH of the amended plots relative to the control plots may be due to microbial decarboxylation of the RMA that releases certain exchangeable bases into the soil solution. Thus increased the pH level of the soil and nutrient availability to the crop plants that led to increased yield recorded in the study. The low value recorded for chemical parameters assessed in 2014 planting period compared to their relative value in 2013 year may be attributed to any or combination of the following factors; residual effect of 2013 planting season, none application of RMA, uptake of nutrients by the crops, high productivity and reduced decomposition of organic matter. The addition of RMA was observed to reduce the BD and increased the TP of the studied soil. This is very critical as the parameter ensures easy root penetration, development and proliferation as well as contain the required O_2 and water for soil microbes to survive in the soil. Tinker et al. [12] opined that plants absorb water and nutrients for their nutritional requirements from the soil through their roots

The significant difference effect recorded in the maize grain yield and soybean seed yield indicated that intercropping system is positive and effective. Similar observation was made by Nweke and Anene [13] in maize/Bambara groundnut intercrop. The zero value recorded for the number of nodules and weight of nodules and non-significant effect in pod yield in 2013 planting year, number of nodules and weight of nodules in 2014 planting year could be due to competition of light energy and chemical nutrients making the intercropping system not to be efficient on the 3 parameters. The shedding of soybean, disease pest and bush rat attack as explained in the on farm observation may also have influenced the recorded results. The yield of maize and soybean were found to be increased in amended plots relative to the control plots, both in 2013 and 2014 year planting. Significant different observed suggest higher content of nutrients due to enrichment of the amended soil with OM by the rice mill ash. This increased the soil ability to absorb and retain water and plant nutrient elements required for optimal plant growth and yield recorded in this study. The differences in values recorded could suggest differences in nutrient content and availability status in the type and rate of waste used. Chime et al. [5] and Ibeh et al. [14], that worked on different organic wastes found increased plant nutrients and higher crop yield respectively in amended soil relative to the control soil. The 2014 year planting result values appeared to be reduced relative to 2013 planting season results in assessed parameters. This could be as a result of non-application of rice mill ash in the 2014 year of the crop production. Nonetheless, the rice mill ash and intercropping system showed strong residual effect on the maize production, number of nodules and weight of nodules of which the greatest recorded value was observed in IMB_{10}. The implication of the result is that without further application of the rice mill ash reasonable yield of maize can still be obtained. Nnadi et al [15], made similar observation in a 3 years study of wood ash and tillage methods when they found out that wood ash has strong residual effect on castor yield and yield components. The pod yield result showed non-significant effect of soybean intercropped with maize with considerable reduction in pod yield in intercrop relative to sole and amended crop of which quantitatively the plot amended with 10 t/ha RMA gave the highest value. The observed significant difference in grain and seed yield result in both 2013 and 2014 year planting attest to the evidence that intercropping system and RMA influenced the assessed parameters. This agrees with findings of Nweke and Anene [13] who worked on maize/Bambara groundnut intercrop and soil properties. The equivalent yield result was found to be increased with level of rice mill ash in the 2013 planting season this might be due to higher nutrient content in the level of rice mill ash applied. The 2014 planting season result however did not follow the same order and 10 t/ha showed strong residual effect among the other treatments. This might as well be due to different in the rate of decomposition of rice mill ash and nutrient release ability in the form required for the crop as well as competition among the crops in picking up the released nutrients. The findings are in line with the reports of [16] who reported that the rate of application of ash increased yield and plots that received organic biomass had a higher residual effect and gave 15% yield increase above the control. The observed reduction in value of the maize and soybean by the virtue of their equivalent yield recorded might have been influenced by both external and internal factor. The external factor probably might be due to the selling price of the product at the conclusion of the study. On the internal factor, probably may be attributed to the disproportionality in balance in soil nutrients. When optimum ratio of bases exit in soil, biological activity is increased of which will lead to more release of plant nutrients. Plant growing on such soil will be balanced in mineral levels. Nonetheless the result obtained showed that the study was very profitable as it agrees with findings of [17] who recorded the lowest net returns under sole groundnut compared to intercrop in a study of groundnut/sweet corn intercropping at different fertility levels and row proportions. Also in two (2) year study involving the performance of different hybrid maize varieties under intercropping system with groundnut, Alom et al. [18] made similar remark. The relative yield of maize and soybean was observed to have decreased in the 2013 planting season relative to 2014 planting season. This probably indicated that the effect of intercropping was more effective in the 2014 year planting compared to 2013 year planting. The general growth pattern of crop in the intercropping study suggest that the main factor responsible for the advantages is the use of early resources by the growing soybean complements the use of late resources by the longer season maize crop. Regardless of the intercrop yield parameters, the LER result showed the intercropping system to be positive, beneficial and advantage.

5. Conclusion

Intercropping system and soil application of rice mill ash have shown to have significant effect on the soil parameters studied, yield of maize and soybean. An alternative to the use of chemical fertilizer and pesticide. The rice mill ash at the rate of 20 t/ha performed better both in sole cropping and intercropping though its effect on yield declined in the 2014 planting season. The study confirmed that the way to achieve the aim of using organic waste to enhance fertility status of soil is to apply them to the soil in the right quantity and quality to match nutrient release and needs for crops. The equivalent and relative yield of both maize and soybeans in the intercrop were found to be greatly influenced relative to their individual sole yield results. The application of rice will ash at the rate of 20 t/ha competitively among other treatment increased fertility of the studied soil and the yield parameters assessed across the sole and intercrop. This however declined in the 2^{nd} year (2014) result but the residual impact was strong though relatively alike and statistical equal for 10 t/ha and 20 t/ha RMA results. The yield of soybean is an added advantage that will complement any loss in yield of maize. The study showed an intercrop advantage with land equivalent ratio (LER) for the 2 years study ranged 1.31 - 1.94 for 2013 year planting and 1.81 -2.74 for the 2014 year planting. Hence, the farmers in the locality are advised to embrace this package for effective crop production and zero tolerance of chemical inputs in the area. As organically produced food is safer and healthier to the humans and environment.

Compliance with ethical standards

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Disclosure of conflict of interest

There is no conflict of interest authors agreed on the publication of this article.

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