# EFFECT OF METHOD AND RATE OF APPLICATION OF RICE HUSK-RESIDUE ON MAIZE PLANT HEIGHT AND YIELD IN MINNA, NIGERIA.

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**ABSTRACT**
*A 2 x 3 factorial experiment was conducted during the 2014 and 2015 cropping seasons in the Teaching and Research Farm of Federal University of Technology, Minna. The objective of this study was to determine the effect of the method and rate of application of rice husk-residue on maize plant height and yield indices. The treatments consist of two methods of application (surface application and incorporation) and three rates (0, 10 and 15 tons ha$^{-1}$) of application of rice husk-residue, laid out in a randomized complete block design with four replications. Cultural practices were carried out. Plant height was measured at seedling emergence, vegetative growth, tasseling and maturity stages. Yield indices measured were grain yield, stover yield, cob length and cob weight. Results obtained indicated that incorporation of rice husk-residue and application of residue at 15 tons/ha produced the tallest ($P \leq 0.05$) maize plants and longest maize cobs. Method of application of rice husk-residue had no significant effect on grain yield, stover yield and cob weight. Residue incorporation produced longer cobs than surface application. However, 15 tons/ha residue application rate resulted in the highest ($P \leq 0.05$) grain yield and cob length and cob weight. The study suggests that incorporation of rice husk-residue rather than surface application as mulch, and increasing application rate to 15 tons/ha will ensure better maize performance in Minna, Nigeria.*

**KEYWORDS:** Rice husk-residue, plant height, maize yield

## INTRODUCTION

Maize is staple food crop that ranks third in the world after rice and wheat (IITA, 2006; Enujeke *et al.,* 2013). Also, it ranks third in Northern Nigeria after sorghum and millet, while in both South-east and South-west regions of Nigeria, it is the most important cereal crop followed by rice (FAO, 1996). The basis for this characterization is the extent of land cultivated and the quantity of maize produced per hectare of land. Maize is an energy source in the diets of communities where it serves as staple food, and in livestock feed. It is a major raw material in the production of beverages, corn oil, corn syrup and flakes (Adeyemo and Agele, 2010). However, in most Sub-Saharan African countries, maize yield is as low as 1.3 t/ha, whereas, average yield in advanced countries is about 7 times higher (IITA, 2007). Hussaini and Khan (2002) noted that soil fertility status and management practice are among the factors that affect the productivity of maize. Inorganic fertilizers are often commonly applied as source of mineral nutrients required to enhance maize growth with a consequent increase in yield (Akinloye and Olaniyan, 2012). However, these mineral fertilizers are beyond the reach of most farmers because they are quite costly (Agyenim-Boateng *et al.,* 2006). Also, increase in soil acidity, nutrient imbalance and poor soil physical condition result from application of inorganic fertilizers over a long period of time (Kang and Juo, 1980). Under these conditions, it may be necessary to employ management practices that would minimize the cost of maintaining soil fertility, enhance crop growth and increase yields.

Crop residues are plant parts such as stalks, stubble, leaves, seed pods and roots left after crop harvest. They are also plant materials such as husk and molasses, which are by products that remain after the harvested crop is processed into a usable form. Crop residues are applied to the soil as organic amendments, rather than being regarded as agricultural waste (McKinney, 2004). They could be

left on the soil surface after harvest or applied as mulch. They could also be burnt or chopped into smaller pieces and incorporated into the soil. Most crop residues unlike rice husk face competition especially as livestock feed and material for construction and fencing (Eze *et al.,* 2014b; Eze *et al.,* 2015b). Rice husk is a milling by-product from rice paddy processing. It is produced in appreciable quantity in rice producing communities in Nigeria and on a global basis. The husk is 80 % organic material, and make up 20 % of rice paddy, with an annual total production of 120 million tonnes worldwide (Giddel and Jivan, 2007). Application of rice husk residue at a rate less than 10 tons/ha has been reported to be insufficient to provide adequate coverage on the soil surface (Chiroma, 2004).

Application of crop residues as organic amendment and a management practice designed to increase soil productivity, improve crop growth and increase crop yields in various agro-ecological zones is well documented (Chiroma et al., 2003 & 2005; Ogbodo, 2004; Eze *et al.,* 2014a and b & 2015b). When crop residues are returned to the soil either as mulch or incorporated into the soil, they have considerable influence on soil properties and crop performance (Ogban *et al.,* 2006; Abbasi *et al.,* 2009). Therefore, the objective of this study was to determine effect of crop residue management practice on the performance of maize.

## METHODOLOGY

A field study was carried out during the 2014 and 2015 cropping seasons at the Teaching and Research Farm of Federal University of Technology, Minna to determine the effect of method and rate of application of rice husk-residue on maize plant height and yield indices. The experimental site is located on latitude 9˚ 31' N and longitude 6˚ 26' E.The weather of Minna is characterized by a distinct wet and dry season. It has a mean annual rainfall of about 1,300 mm, usually between April and October. The temperature of the study site is varies from 24 to 33.5˚C, particularly between March and June (Ojanuga, 2006).The soils are predominantly sandy in nature and are developed from basement complex. Minna is found in the southern Guinea savanna zone of Nigeria. Its vegetation consists of few trees and shrubs with vast grassland. The common crops grown in the study area are yams, groundnut, cowpea, cereals (sorghum, millet, rice and maize) and vegetables (Amaranthus spp, tomatoes, pepper and okra).

### Treatments and Experimental Design

It was a 2 x 3 factorial experiment consisting of two methods of application (surface application and incorporation) and three rates (0, 10 and 15 tons $ha^{-1}$) of application of rice husk-residue. The treatments were laid out in a randomized complete block design with four replications.

### Agronomic Practices

The land was ploughed using a tractor. The experimental plots were marked out and levelled. Each plot size was 4 x 4 m. Following the application of rice husk-residue, about four seeds of maize (Oba super 1 variety) were sown at a depth of 3 cm and at a spacing of 0.75 x 0.50 m inter-row and intra-row, respectively. The maize seedlings were thinned to two plants per stand at two weeks after planting (WAP). NPK (15:15:15) fertilizer was applied at the recommended rate (90:60:60). Nitrogen was applied in two split doses at two and six WAP. Removal of weeds was done manually using hand-hoe at two and six WAP. At physiological maturity (12 WAP), maize cobs were harvested, sun-dried for about two weeks and threshed.

Plant height was measured at seedling emergence, vegetative growth, tasseling and maturity stages. Plant height was determined using a meter rule, from the base of the plant to the tallest flag leaf. Yield indices measured were grain yield, stover yield, cob length and cob weight. Grains from the net plot were weighed and expressed in kg/ha as grain yield. Stover (above-ground plant parts) yield and cob weight were determined by weighing the stover and cobs, respectively. Cob length was measured using a meter rule.

### Data Analysis

Data collected were subjected to statistical analysis (Analysis of variance, ANOVA) at 0.05 level of probability using Statistix 8.0 software (Statistix, 2010). Duncan's multiple range test was employed for mean separation where significant differences between means were found.

## RESULTS AND DISCUSSION

Results in Table 1 indicated that method of application and rate of application of crop residue had significant effect of plant height at seedling emergence, vegetative growth, tasseling and maturity stages. Incorporation of crop residue resulted in significantly ($P \leq 0.05$) taller maize plants than surface application during all the growth stages. Also, application of 15 tons/ha of rice husk-residue produced the tallest maize plants. These observations were found to be consistent throughout the growing season and in the two-year study period (2014 and

2015). Incorporation of crop residue increased plant height considerably ($P \leq 0.05$) by a range of between 6 and 10 %, while application of residue at 15 tons/ha increased the height of plants by a range of between 10 and 33 %. Kumar and Goh (2000) noted that the benefits that accrue when crop residues are incorporated in the soil include replenishment of soil organic matter, faster mineralization to release essential nutrients for enhancement of crop growth and increase yields.

Method of application of crop residue had no significant influence on grain yield, stover yield and cob weight of maize. However, it significantly affected the length of cobs (Table 2). Incorporation of crop residue as soil organic amendment produced significantly ($P \leq 0.05$) longer cobs compared with surface application of residue, although the better crop growth and longer cobs that resulted from residue incorporation in this study did not translate to significantly higher grain and stover yields. It must be noted however, that incorporation of crop residue has the potential to improve crop yield judging from the fact that this treatment produced significantly taller plants and longer cobs. Results obtained from this work showed that rate of application of crop residue had significant effect on maize yield parameters (Table 2). Application of 15 tons/ha of residue produced highest ($P \leq 0.05$) grain yield, cob length and cob weight compared with 0 and 10 tons/ha application rates. Fifteen tons/ha application rate increased grain yield by over 50 % more than 0 tons/ha and by over 20 % more than 10 tons/ha application rates. It also increased cob length and cob weight by about 25 and 40 %, respectively. The better performance arising from returning crop residue to the soil is attributed to improvement of soil properties and supply of nutrients through mineralization of the applied crop residues (Abbasi, et al., 2009; Eze *et al.,* 2014a and b & 2015a & b). Thus, crop residues are not agricultural wastes, and should not be regarded as nuisance to the environment because these residues have unlimited potential for improving soil productivity and crop performance, as have been proven in the current study.

## CONCLUSION AND RECOMMENDATIONS

Based on the results obtained in this study, the following conclusions are made:

i.) Residue incorporation produced tallest plants and longer cobs than surface application.

ii.) 15 tons/ha residue application rate resulted in the tallest plants, highest grain yield and cob weight, and longest cobs.

Therefore, incorporation of rice husk-residue rather than surface application as mulch, and application of 15 tons/ha of crop residue are recommended for the enhancement of maize performance in Minna, Nigeria.


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Table 1: Effect of method and rate of application of rice husk-residue on plant height (cm) of maize.

| | Crop growth stages | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Seedling emergence | | | Vegetative growth | | | Tasseling | | | Maturity | |
| Treatment | 2014 | 2015 | Combined | 2014 | 2015 | Combined | 2014 | 2015 | Combined | 2014 | 2015 |
| Combined | | | | | | | | | | | |
| Application method (A) | | | | | | | | | | | |
| Surface | 41.4a | 26.1b | 33.7b | 113.0b | 112.6b | 112.8b | 182.6b | 181.1b | 181.8b | 176.0a | 181.2b |
| 178.6b | | | | | | | | | | | |
| Incorporation | 45.4a | 29.7a | 37.5a | 128.3a | 124.2a | 126.2a | 193.2a | 193.5a | 193.3a | 195.8a | |
| 192.5a 194.2a | | | | | | | | | | | |
| SE± | 2.3 | 1.3 | 1.4 | 5.8 | 5.0 | 4.1 | 4.5 | 5.4 | 3.4 | 9.9 | 4.6 |
| 5.4 | | | | | | | | | | | |
| Application rate (B) | | | | | | | | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 t/ha | 40.6b | 20.9b | 30.7c | 110.6b | 77.3b | 94.0c | 185.9a | 153.9b | 169.9c | 188.8a | 157.7b 173.3b |
| 10 t/ha | 40.7b | 30.8a | 35.7b | 117.9b | 132.9a | 125.4b | 185.1a | 198.5a | 191.8b | 186.9a | 196.9a 191.9a |
| 15 t/ha | 48.8a | 32.0a | 40.4a | 133.5a | 145.0a | 139.2a | 192.6a | 209.6a | 201.1a | 181.9a | 206.0a 194.0a |
| SE± | 2.8 | 1.6 | 1.8 | 7.1 | 6.1 | 5.0 | 5.6 | 6.6 | 4.2 | 12.1 | 5.7 6.7 |
| Interaction | | | | | | | | | | | |
| A x B | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS NS |

Means with different letter(s) on the same column are significantly ($P \leq 0.05$) different at 0.05 level of probability
NS: Not significant

Table 2: Effect of method and rate of application of rice husk-residue on yield parameters of maize.

| | Grain yield (kg/ha) | | | Stover yield (kg/ha) | | | Cob length (cm) | | | Cob weight (g/plot) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Treatment | 2014 | 2015 | Combined | 2014 | 2015 | Combined | 2014 | 2015 | Combined | 2014 | 2015 Combined |
| Application method (A) | | | | | | | | | | | |
| Surface | 6,556a | 3,776a | 5,166a | 15,583a | 3,677a | 9,630a | 14.3a | 13.7b | 14.0a | 1,597a | 852a 1,225a |
| Incorporation | 7,069a | 4,355a | 5,712a | 16,500a | 4,229a | 10,365a | 14.1a | 14.7a | 14.4a | 1,667a | 932a 1,299a |
| SE± | 614 | 318 | 352 | 1,109 | 494 | 671 | 0.51 | 0.41 | 0.33 | 98 | 72 61 |
| Application rate (B) | | | | | | | | | | | |
| 0 t/ha | 5,896a | 2,626c | 4,261b | 15,500a | 3,328a | 9,414a | 13.4a | 13.0b | 13.2b | 1,500a | 631b 1,065b |
| 10 t/ha | 7,000a | 4,294b | 5,647a | 15,959a | 3,828a | 9,893a | 14.4a | 14.4a | 14.4a | 1,667a | 980a 1,323a |
| 15 t/ha | 7,542a | 5,277a | 6,409a | 16,667a | 4,703a | 10,685a | 14.8a | 15.1a | 14.9a | 1,729a | 1,065a 1.397a |
| SE± | 752 | 390 | 431 | 1,358 | 606 | 822 | 0.63 | 0.5 | 0.4 | 119 | 88 75 |
| Interaction | | | | | | | | | | | |
| A x B | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS NS |

Means with different letter(s) on the same column are significantly different at 0.05 level of probability
NS: Not significant

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