Effect of Land Configuration and Cow Dung on Maize Performance in Minna, Southern Guinea Savanna Zone of Nigeria

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***Abstract*— Field trials were carried out during the 2014 and 2015 growing season to evaluate the performance of maize as affected by different land configurations and rates of application of cow dung in Minna, Nigerian southern guinea savanna zone . The land configuration (ridge, flat and mound) and cow dung application rate (0, 5 and 10 tons ha^{-1}) treatments were arranged in a randomized complete block design and replicated four times. Agronomic practices carried out included land preparation, planting, thinning, weed control, fertilization, harvesting and processing of maize cobs. Plant height at seedling emergence, vegetative growth, tasseling and maturity stages, grain and stover yields, cob length and cob weight after crop harvest were determined. In this study, it was found that land configuration had significant ($P \leq 0.05$) influence on cob length and plant height at the seedling establishment and tasseling growth stages. Planting on the flat and on ridges, and application of 10 tons ha^{-1} of cow dung produced the tallest ($P \leq 0.05$) maize plants. Land configuration did not significantly affect grain yield, stover yield, cob length and cob weight, while 10 tons ha^{-1} cow dung application rate resulted in the highest grain yield, cob length and cob weight. Application of cow dung as manure at 10 tons ha^{-1} has the potential for improving maize performance for sustainable food security.**

***Keywords*— Land configuration, cow dung, maize performance and southern guinea savanna zone**

I. INTRODUCTION

Crop yield is adversely affected in the southern Guinea Savanna zone of Nigeria due to the low nutrient and organic matter status of the soils found in this agro-ecological zone. The soils found in this zone are mostly coarse-textured (sandy in nature). The implication is that the soils are prone to drought. The potential for crop and soil productivity is quite high considering the vast land area available for crop production in the southern Guinea Savanna zone. Nottidge et al. (2005) reported that low crop yields in the southern Guinea Savanna zone result from low soil fertility, especially low nitrogen and organic matter content.

In an increasingly expanding population with a resultant scarcity of land for arable crop production, continuous cultivation of available land may be a key option for food security. However, continuous cultivation of already fragile agricultural lands gives rise to soil nutrient depletion. The challenge of continuous cropping is further aggravated by overgrazing and removal of crop residues after harvest with little or no application of chemical fertilizers which are often costly and inaccessible to most farming communities. These problems enumerated above often reduce the productive capacity of both soil and crops (Uwah et al., 2014). Thus, it may be necessary to take advantage of soil and crop management practices that would not only maintain favourable soil physical and chemical conditions, but would also replenish the depleted soil nutrients necessary for increased crop yield.

Application of organic manures as soil amendment as a viable option that is beneficial for improvement of soil physical condition as well as a source of nutrients essential for enhancement of crop growth and increased yields is widely documented. According to Udom et al. (2007), application of organic fertilizers reduces cost of production, supply plant nutrients; improve soil physical condition and crop growth, with a consequent increase in crop yield. Amos et al. (2015) and Udom et al. (2007) noted that cow dung manure produced good crop growth and higher yield because of its ease of mineralization. Furthermore, organic manures reduce soil bulk density, improve moisture storage, increase organic matter content and enhance concentration of essential nutrients. Management strategies that would favour sustainable crop productivity are those that maintain soil fertility at reduced cost and increase crop yield.

Land configuration is the modification of the soil surface into various shapes or forms and sizes by employing tillage practices. The emphasis is usually on the configuration or shape of the soil surface irrespective of the type of tillage and tillage implement used. Hence, several researchers have referred to land configuration as planting or sowing methods, land configuration practices and land shaping methods (Chiroma et al., 2006; Haque et al., 2002; Deshmukh et al., 2016). Major land configuration practices are ridges (open or tied), furrows, raised bed, broad bed furrows and mounds or heaps. Deshmukh et al. (2016) reported that poor crop growth and lower yield resulted from sowing on flat bed without any appropriate land configuration. These planting methods are aimed at pulverizing and gathering the top soil to provide a favourable environment for crop growth and enhanced yields. This arises from the fact that most soil nutrients and organic matter are concentrated in the upper soil layer. According to Chiroma et al. (2008), water use efficiency and nutrient availability to crops are increased under land configuration practices. The effectiveness of any crop management practice (nutrient application, irrigation and crop variety) is determined mainly by land configuration. Therefore, identifying suitable land configuration practice is essential for proper growth and development of particular crops.

The objective of this study was to determine the influence of sowing methods and cow dung manure on the performance of maize.

II. MATERIALS AND METHODS

Description of Study Site

Field trials were conducted during the 2014 and 2015 growing season at the Teaching and Research Farm of Federal University of Technology, Minna (latitude 9˚ 31' N and longitude 6˚ 26' E, at 208 m above mean sea level). Minna is located in the southern Guinea savanna zone of Nigeria. Minna has a sub-humid climate with an annual rainfall of 1,300 mm and a mean temperature of about 30 ˚C (Ojanuga, 2006). Rainfall commences in April and ends in October. The soils are developed from basement complex rocks, and are mostly sandy in texture. Sparsely arranged trees and shrubs with tall and short grasses in abundance are common features of the southern Guinea savanna zone of Nigeria. Yams, groundnut, cowpea, cereals (sorghum, millet, rice and maize) and vegetables (Amaranthus spp, tomatoes, pepper and okra) are the major crops grown in Minna.

Treatments and Experimental Design

The treatments were land configuration (ridge, flat and mound) and cow dung application rate (0, 5 and 10 tons ha^{-1}). The treatment combinations were nine in number. They were arranged in a randomized complete block design and replicated four times.

Cultural Practices

The experimental plots (4 x 4 m each) were marked out and levelled after ploughing with a tractor. The net plot was 4 m^2. The various forms of land configuration were constructed followed by the application of cow dung manure. Three to four seeds of Oba super 1 maize variety were sown at a depth of 3 cm and at a spacing of 0.75 m along rows and 0.50 m within rows. Thinning of maize seedlings to two plants per stand was carried out at two weeks after planting (WAP). NPK (15:15:15) fertilizer was applied at the recommended rate (90:30:30). Due to the sandy nature of the soil, nitrogen was applied in split doses at two and six WAP. Weeds control was done manually using hand-hoe at two and five WAP. Maize cobs were harvested at physiological maturity (12 WAP), sun-dried for about two weeks and threshed.

Measurement of Plant Height and Yield Parameters

Plant height was determined using a meter rule, from the base of the plant to the tallest flag leaf at seedling emergence, vegetative growth, tasseling and maturity stages. Grain yield, stover yield, cob length and cob weight were the yield parameters determined after crop harvest.

Statistical Analysis

Data obtained were subjected to analysis of variance (ANOVA) at 0.05 level of significance to determine differences between means. Means separation was carried out using Duncan's multiple range test.

III. RESULTS AND DISCUSSION

Results in Table 1 show the effect of land configuration and cow dung manure on the height of maize plants at various growth stages (seedling emergence, vegetative growth, tasseling and maturity). Land configuration had significant ($P \leq 0.05$) influence on plant height at all the stages of crop growth with the exception of the vegetative growth stage. Planting on mounds or heaps produced the tallest ($P \leq 0.05$) maize plants at the seedling emergence stage, but this trend was not sustained throughout the stages of crop growth. Ridge planting method gave rise to the tallest plants, while the mound sowing method produced the shortest ($P \leq 0.05$) plants at both tasseling and maturity stages of crop growth. Rate of application of cow dung manure significantly ($P \leq 0.05$) affected plant height throughout the cropping season (Table 1). Plant height increased with cow dung application rate throughout the crop growth periods. The application rate produced the tallest plants whereas; the shortest plants were produced when cow dung was not applied at all. The superiority of the application of 10 tons/ha of cow dung compared with 0 and 5 tons/ha application rates attests to the fact, increasing cow dung application rate will improve crop growth.

The yield parameters under study were grain yield, stover yield, cob length and cob weight. As shown in Table 2, land configuration had significant ($P \leq 0.05$) influence on cob length only. Mound planting method resulted in longer cobs than planting when no land configuration treatment was applied (planting on the flat).

However, the difference between the mound and ridge planting methods was not significant. Also, the difference between the ridge treatment and flat planting method was not significant. Cow dung application rate significantly ($P \leq 0.05$) affected grain yield, cob length and cob weight. These yield indices increased with cow dung application rate. Application of 10 tons/ha resulted in the highest grain yield, cob length and cob weight, while with zero application rate, these yield parameters were lowest.

Application of organic fertilizers reduces cost of production, supply plant nutrients; improve soil physical condition and crop growth, with a consequent increase in crop yield (Udom et al. 2007). Cow dung manure produced good crop growth and higher yield because of its ease of mineralization (Amos et al. (2015); Udom et al. 2007). Furthermore, organic manures reduce soil bulk density, improve moisture storage, increase organic matter content and enhance concentration of essential nutrients. Management strategies that would favour sustainable crop productivity are those that maintain soil fertility at reduced cost and increase crop yield. Poor crop growth and lower yield resulted from sowing on flat bed without any appropriate land configuration according to Deshmukh et al. (2016). Kiran et al. (2008) reported that plant height and total dry matter of sorghum increased with ridges and furrows than with the flat bed planting method. Ridges and furrows were observed to perform better due to higher soil moisture conservation.

IV. CONCLUSION

- Planting on the flat and on ridges, and application of 10 tons ha^{-1} of cow dung produced the tallest maize plants.
- 10 tons ha^{-1} cow dung application rate resulted in the highest grain yield, cob length and cob weight.
- Application of cow dung as manure at 10 tons ha^{-1} has the potential for improving maize performance for sustainable food security.

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Table 1: Effect of land configuration and cow dung 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
Land configuration (A)												
Ridge	37.0b	28.5a	32.7a	82.1a	108.6a	95.4a	160.2a	210.6a	185.4	167.7a	228.4a	198.0a
Flat	40.0b	28.5a	34.2a	84.5a	107.7a	96.1a	160.8a	214.0a	187.4a	171.2a	230.1a	200.6a
Mound	46.1a	24.7b	35.4a	90.7a	95.2a	93.0a	172.6a	193.8b	183.2a	180.1a	211.8b	195.9a
SE±	2.6	1.7	1.7	6.0	6.1	4.4	8.9	8.1	5.9	8.1	6.9	5.2
Cow dung rate (B)												
0 t/ha	35.8b	24.1b	30.0b	75.8b	82.9c	79.3c	155.6a	192.0b	173.8b	163.4a	209.9b	186.6b
5 t/ha	42.3a	26.9b	34.6a	86.8b	103.5b	95.2b	167.9a	208.3ab	188.1a	176.8a	224.4a	200.6a
10 t/ha	45.0a	30.6a	37.8a	94.7a	125.1a	109.9a	170.1a	218.2a	194.1a	178.8a	235.9a	207.4a
SE±	2.6	1.7	1.7	6.0	6.1	4.4	8.9	8.1	5.9	8.1	6.9	5.2
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

Table 2: Effect of land configuration and cow dung 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
Land configuration (A)												
Ridge	4,944a	3,019a	3,981a	9,833a	4,031a	6,932a	13.4a	13.6a	13.5ab	1,306a	684a	995a
Flat	5,083a	2,727a	3,905a	10,694a	4,031a	7,363a	12.9a	12.9a	12.9b	1,306a	592a	949a
Mound	6,278a	2,921a	4,600a	12,778a	3,990a	8,384a	13.5a	14.0a	13.7a	1,556a	632a	1,094a
SE±	617	270	335	1,203	192	627	0.4	0.5	0.3	171	52	88
Cow dung rate (B)												
0 t/ha	4,708b	2,396b	3,552b	10,472a	3,938a	7,205a	13.6a	12.4b	13.0b	1,306a	560b	933a
5 t/ha	5,236ab	2,926ab	4,081b	10,583a	3,938a	7,260a	12.6b	13.8a	13.2b	1,361a	629ab	995a
10 t/ha	6,361a	3,345a	4,853a	12,250a	4,177a	8,214a	13.6a	14.2a	13.9a	1,500a	721a	1,110a
SE±	617	270	335	1,203	192	627	0.4	0.5	0.3	171	52	88
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