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Maximizing Trash Mulch and Seed Rate Strategies for Weed and Disease Management in Sugarcane Production

[1]Bassey M. S *
National Cereals Research Institute,
P. M. B 8, Bida, Nigeria,

[2]Musa I.
National Cereals Research Institute,
P. M. B 8, Bida, Nigeria,

[3]Aliyu U.
National Cereals Research Institute,
P. M. B 8, Bida, Nigeria,

[4]Mohammed, S. U.
National Cereals Research Institute,
P. M. B 8, Bida, Nigeria,

[5]Bigun P.I.,
Department of Crop Production Technology,
Federal Polytechnic Bida, Nigeria
&
[6]Ekaette E.E.,
National Biotechnology and Development Agency,
Arochuwu, Nigeria.

Abstract

The impact of seed rate and trash mulching on weed and disease management for sustainable sugarcane production was examined through an experiment conducted during the 2022/2023 cropping season at the upland sugarcane research field of the National Cereals Research Institute (NCRI), Badeggi (lat. 9°45'N, long. 6°07'E). The experiment employed a factorial arrangement of three cane trash mulch rates (0, 5, and 10 t/ha) and three seed rates (44,444; 33,333; and 22,222 t/ha), organized in a split-plot design with three replications. Trash mulch treatments were assigned to the main plots, while seed rate treatments were applied to the subplots. Each gross plot measured 35 m² (7 m × 5 m), and the net plot size was 17.5 m² (3.5 m × 5 m), comprising four rows, each 5 meters long. The combination of the highest seed rate (44,444 t/ha) and the highest mulch rate (10 t/ha) resulted in the lowest weed biomass and reduced incidence of whip smut. Likewise, stalk height, girth, and brix content were significantly (P<0.05) increased, leading to improved sugarcane yield. The interaction between seed rate and trash mulch rate showed that higher seed rates combined with greater mulch application significantly reduced weed dry matter and whip smut incidence, while boosting overall sugarcane yield.

Keywords: Seed rate, trash mulch, Weed, Disease and Sugarcane.

* Corresponding Author: **Bassey M. S**
Email: mosessamuel36@yahoo.com
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Introduction

In Nigeria, sugarcane is cultivated on a small scale for household use and on a large industrial scale for producing refined sugar and its by-products. The small-scale sugarcane production is characterized by low productivity of the sugarcane crop as yield losses of over 50 % have been reported under the small-scale cultivation (Bassey *et al*., 2024). The low level of production can be linked to several factors, such as weed infestation, vulnerability of local sugarcane varieties to pests and diseases, limited adoption of improved technologies, low soil productivity, and the high cost of inputs—particularly nitrogen-based fertilizers—among others. The national average yield of sugarcane is less than 65 t ha $^{-1}$ which is much lower than the world average of 175.1 t ha $^{-1}$ (Wakgari *et al*., 2020; Msomba *et al*., 2021).

The practice of burning sugarcane trash after harvest is on the increase. This has negative effect on soils coupled with inappropriate rate of planting materials. One of the cheapest ways of reviving low fertility soils and increasing sugarcane productivity is through cane trash mulching and using of appropriate rate of planting materials (Melo *et al.,* 2020; Mazaron *et al.,* 2022).

Enhancing sugarcane yield through optimized seed rate and trash mulching can improve both the quantity and quality of the harvest. Higher seed rates, especially in conjunction with trash mulch, can increase the quantity of harvestable stalks and the total cane weight. Trash mulch also benefits soil health by improving water retention and reducing the need for inter-row cultivation (Navnit *et al*., 2024). This study aims to evaluate the combined effects of seed rate and sugarcane trash mulch on weed and disease infestation as well as on sugarcane productivity.

Materials and Methods

The experiment was conducted during the 2022 and 2023 cropping season at the Upland Sugarcane Experimental Field of the National Cereals Research Institute (NCRI), Badeggi (lat. 9°45′N, long. 6°07′E). The treatments involved a factorial combination of three levels of cane trash mulch (0, 5, and 10 t ha^{-1}) and three seed rates (44,444; 33,333; and 22,222 t ha^{-1}), arranged in a split-plot design with three replications. Cane trash mulch was assigned to the main plots, while seed rate was allocated to the subplots. The gross plot measured 35 m² (7 m

× 5 m), with a net plot size of 17.5 m² (3.5 m × 5 m), each consisting of four rows of 5 m in length.

Data on weed density and biomass were recorded at 12, 24, and 36 WAP, and at 12, 24, 36, and 48 WAP, respectively. Weed density was assessed using two randomly placed quadrats (0.25 m²) per subplot on each sampling date, where all weed seedlings within each quadrat were uprooted and counted. Dry matter accumulation was estimated from weeds harvested within the quadrats during each sampling period. Samples from the same plots were pooled and oven-dried at 80 °C until a constant weight was obtained. Crop data collected included sugarcane tiller count per plot, stalk height, girth, and cane yield extrapolated to tonnes per hectare at harvest. All collected data were subjected to analysis of variance (ANOVA), and treatment means were separated using Duncan's Multiple Range Test (DMRT) at the 5% probability level with SAS version 9.0 statistical software.

Results and Discussion

A higher seed rate (44,444 ha^{-1}) combined with a higher level of trash mulch (10 t ha^{-1}) resulted in reduced weed biomass (Table 1). This reduction may be due to the increased plant population density, which created mutual shading among the crops, thereby limiting the availability of sunlight to weed species. Decrease in the weed biomass was attributed to changes in moisture, light, soil temperature caused by increase in trash mulch rate. These findings are in agreement with the works of Makhlouf et al., 2016; Gadallah *et al*., 2020; Welday *et al*., (2018) and Bassey *et al*. (2019), who reported the influence of increased seed rate and trash mulching on the dormancy and mortality of weed seeds, releasing allelopathic compounds, causing etiolation and weakening of stems.

Similarly, Higher seed rates (44, 444 t ha^{-1}) in combination with higher trash mulch (10 t ha^{-1}) produced lower Smut incidence (Table 2). The reduced smut incidence recorded in this study could be linked to dense plant populations and better cane trash suppressive ability which stimulate the release of chemicals for the inhibition of pathogens thus, reducing the chances of smut disease spread. This finding is similar to that gotten by Chalker-Scott (2007) and Bassey *et al*. (2024).

In addition, stalk height, girth, brix content, and cane yield were enhanced when 10 t ha^{-1} of trash mulch was applied in combination with the higher seed rate (44,444 ha^{-1}) (Table 3). The observed increase in sugarcane stalks, girth, brix content, and cane yield might be attributed to increased soil organic matter (Santos *et al.,* 2022), improved physical and chemical

properties and soil water regimes (Mazaron *et al.,* 2022) which translates into better crop growth. The increase was also due to effective weed control by increased plant density and enhanced soil fertility resulting from the application of trash mulch at higher rates. This finding is in agreement with the work of Awe *et al*. (2020), who reported that higher mulching application and plant density control weed and improves growth and yield of Sugarcane.

The interaction between seed rate and trash mulch rate on stalk height, brix content, and cane yield indicated that increasing the seed rate in combination with higher mulch levels significantly enhanced these parameters (Tables 4 and 5). This improvement may be attributed to the effects of mulching, such as better soil moisture conservation, moderated soil temperature and light penetration, enhanced microbial activity, increased organic matter and soil chemical properties, as well as reduced weed infestation, all of which contributed to improved sugarcane growth and yield. Ahmed *et al.* (2014); Bassey *et al.* (2023) in Badeggi, Nigeria and Flavio *et al*. (2013); Nikpay *et al*. (2023) in Sao Paulo, Brazil reported similar results on interaction between trash mulching and seed rates of sugarcane.

Conclusion: Weed dry matter and whip smut incidence were lowered with higher seed rates (44, 444 t ha^{-1}) in combination with higher trash mulch rates (10 t ha^{-1}). Increased trash mulching and seed rates were promising in managing weeds and disease, thus sustaining the productivity and yield of Sugarcane.

Table 1: Response of seed rate and trash mulch rate on Weed dry weight

	Weed dry weight (g m^{-2})					
	3 MAP		6 MAP		9 MAP	
Treatments	2022	2023	2022	2023	2022	2023
Seed rate (t ha^{-1})						
44,444	0.63	0.61	0.54	0.51	0.38	0.32
33,333	0.60	0.59	0.49	0.42	0.33	0.30
22,222	0.56	0.54	0.46	0.43	0.27	0.23
LSD (0.05)	0.10	0.10	0.9	0.8	0.2	0.2
Mulch rate (t ha^{-1})						
0	0.68	0.62	0.56	0.51	0.48	0.45
5	0.61	0.60	0.50	0.50	0.31	0.30

10	0.51	0.49	0.40	0.39	0.18	0.16
LSD (0.05)	0.80	0.70	0.7	0.6	0.9	0.8

MAP – Months After Planting

Table 2: Response of seed rate and trash mulch rate on Smut disease incidence

	Smut incidence (%)			
	3 MAP		6 MAP	
Treatments	2022	2023	2022	2023
Seed rate (t ha^{-1})				
44,444	1.4	7.5	2.2	2.8
33,333	2.1	9.2	2.8	3.0
22,222	2.7	13.5	2.8	3.1
LSD (0.05)	0.2	1.5	0.4	0.6
Mulch rate (t ha^{-1})				
0	2.3	9.7	3.0	4.4
5	2.0	9.4	2.7	4.0
10	1.8	8.7	2.4	0.9
LSD (0.05)	0.2	1.6	0.3	0.6

MAP – Months After Planting

Table 3: Response of seed rate and trash mulch rate on yield attributes of sugarcane

	Stalk height (cm)		Stalk girth (cm)		Brix (%)		Cane yield (t ha^{-1})	
Treatments	2022	2023	2022	2023	2022	2023	2022	2023
Seed rate (t ha^{-1})								
44,444	171.2	191.5	2.48	2.35	16.2	16.5	66.0	86.5
33,333	161.1	171.4	2.62	2.47	17.6	17.8	60.4	70.8
22,222	158.8	168.5	2.67	2.46	17.4	17.6	55.6	65.8
LSD (0.05)	5.6	6.3	0.36	0.34	2.27	2.25	10.9	11.5
Mulch rate (t ha^{-1})								
0	161.2	151.6	2.35	2.47	15.2	15.5	51.5	61.7
5	161.2	171.4	2.64	2.55	16.9	16.6	56.0	66.3

10	168.7	178.9	2.77	2.86	19.1	20.3	74.6	84.9
LSD (0.05)	7.0	7.5	0.32	0.34	1.1	1.1	5.7	5.7
Interaction								
S x M	*	*	NS	NS	*	*	*	*

NS – Not Significant

Table 4: Interaction between seed rate and trash mulch rate on Stalk height and brix content

	Stalk height 2022		
	Seed rate (t ha^{-1})		
Mulch rate (t ha^{-1})	44, 444	33, 333	22, 222
0	167.3	162.7	153.7
5	170.3	155.0	158.3
10	176.0	165.7	164.3
LSD(0.05)		7.2	
	Stalk height 2023		
0	177.2	159.3	163.2
5	172.2	169.8	168.5
10	184.1	168.9	169.8
LSD(0.05)		6.2	
	Brix content 2022		
0	15.0	14.8	15.8
5	14.5	19.0	17.0
10	19.5	19.2	18.6
LSD(0.05)		2.5	

Table 5: Interaction between seed rate and trash mulch rate on brix content and Yield

	Brix content 2023		
	Seed rate (t ha^{-1})		
Mulch rate (t ha^{-1})	44, 444	33, 333	22, 222
0	14.0	14.1	15.0

5	15.2	19.2	17.5
10	20.8	19.4	18.2
LSD(0.05)		2.1	
		Cane yield 2022	
0	49.8	52.7	52.0
5	56.3	56.7	61.0
10	85.0	72.0	66.7
LSD(0.05)		3.9	
		Cane yield 2023	
0	59.6	55.2	56.3
5	61.5	59.4	65.6
10	89.3	75.6	69.9
LSD(0.05)		3.3	

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