CLIMATE SMART AGRICULTURE, FOOD SECURITY AND SUSTAINABLE DEVELOPMENT

GLOBAL ISSUES & LOCAL PERSPECTIVES volume One

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Climate Change Mitigation Strategies Adopted by Palm Wine Tappers in Akwa Ibom State Nigeria

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Preface

This book adopts an exegetical approach as well as a pedagogic model, making it attractive agriculture and environmental economics teachers, professional practitioners and scholars. It is eschews pedantry and lays bars the issues in such clarity that conduces to learning. The book elaborates on contemporaneous **Climate Smart Agriculture, Food Security and Sustainable Development** issues of global significance and at the same time, is mindful of local or national perspectives making it appealing both to international and national interests. The book explores the ways in which climate smart agriculture (CSA) food security, Sustainable Development issues are and should be presented to increase the public's stock of knowledge, increase awareness about burning issues and empower the scholars and public to engage in the participatory dialogue climate smart agriculture, food security, and sustainable development necessary in policy making process that will stimulate increase in food production and environmental sustainability.

Climate Smart Agriculture, Food Security and Sustainable Development: *Global Issues & Local Perspectives* is organized in three parts. Part One deals with The Concept of **Climate Smart Agriculture**, Part Two is concerned with The Concept of **Food Security And** and Part Three deals with the Concept of **Sustainable Development**

Eteyen Nyong; October 2025

Chapter Three
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1.0 Introduction

1.1 Climate Change and Sugarcane Production

change is rapidly altering the physical environment in which agriculture operates, increasing average global temperatures, changing precipitation patterns, and amplifying the frequency and intensity of extreme weather events. Observational syntheses indicate that the past decade has been the warmest on record, and 2024 was the hottest year globally, with mean surface temperatures reaching approximately 1.52 °C above the pre-industrial baseline (Copernicus Climate Change Service [C3S], 2025; European State of the Climate [ESOTC], 2025). Such climatic shifts are already affecting crop phenology, water availability, and the dynamics of pests, diseases, and weeds factors that collectively influence crop productivity and food security (Malhi et al., 2021; Msomba et al., 2024).

Sugarcane (*Saccharum officinarum* L. and interspecific hybrids) is a major C4, perennial cash crop cultivated across tropical and subtropical regions for sugar, ethanol, molasses for livestock feeds, and bagasse for bioenergy (De Aquino et al., 2017). Its production systems are highly sensitive to climatic variations, with recent studies highlighting changes in sugarcane phenology, increased vulnerability to pests and pathogens, and shifts in crop suitability zones due to climate change (Subedi et al., 2023; Msomba et al., 2024). These challenges have significant implications for growers and sugar industries in developing regions.

1.2 Weed Pressure in Sugarcane Systems

Weeds are among the principal biotic constraints in sugarcane systems. They compete with crop plants for light, water, and nutrients, reduce plant establishment and tillering, and can significantly depress cane yields when left unmanaged (Bassey et al., 2023; Yuan et al., 2025). Yield reductions of 30–67% have been reported under severe weed pressure, depending on species composition, crop stage, and management history (Mehdi et al., 2024; Shittu & Bassey, 2022).

Recent studies highlight that early-season weed interference, especially within the first 45–60 days after planting, causes the most severe yield penalties due to competition for nitrogen and soil moisture (Hossain et al., 2023; Mir et al., 2023). Common problematic species such as *Cyperus rotundus*, *Echinochloa colona*, and *Sorghum halepense* are particularly aggressive, reducing sucrose content and biomass accumulation (Kubiak et al., 2022; Mahgoub, 2023).

Moreover, weed communities are evolving in response to herbicide dependence, with cases of resistance to atrazine, ametryn, and metribuzin increasingly documented in tropical and subtropical sugarcane zones (Haq et al., 2023). This trend underscores the need for integrated weed management (IWM) strategies that combine chemical, mechanical, and cultural approaches to delay resistance development and sustain long-term productivity (Gazoulis et al., 2021). In addition, precision agriculture tools such as drone-based weed mapping and variable-rate herbicide application are showing promise for improving efficiency and minimizing environmental impact (Guebsi et al., 2024). Integrating such technologies can support site-specific decision-making and reduce unnecessary chemical use. In general, effective weed management remains a cornerstone of sustainable sugarcane production, demanding adaptive and integrated strategies in the face of changing weed ecology and climatic variability.

1.3 Role of Trash Mulching in Climate-Smart Agriculture

Trash mulching, the retention or deliberate application of sugarcane tops and leaves on the soil surface has gained renewed attention as a climate-smart agronomic practice that conserves soil moisture, moderates soil temperature, enhances soil organic matter and microbial activity, and suppresses weed emergence (Carvalho et al., 2017; Borges et al., 2020; Bassey et al., 2024). Experimental trials and reviews show that appropriate mulch rates can reduce weed biomass, improve soil physical and chemical properties, and stabilize yield under variable weather conditions (Iqbal et al., 2020; Shittu et al., 2024). However, the magnitude of these benefits depends on mulch quality, environmental conditions, and integration with other management strategies (Bassey et al., 2017; Shittu et al., 2023).

1.4 Knowledge Gaps and Rationale

In Nigeria, sugarcane is cultivated mainly under rainfed conditions where weed competition is severe and input use is low. Recent studies have explored genotype selection, trash mulching, and weed control practices, demonstrating promising outcomes for yield and weed suppression (Kumar et al., 2024; Dragumilo et al., 2025; Thakur et al., 2025). Nonetheless, these studies are often limited in geographic coverage, genotype diversity, or recent climate context. As climate variability intensifies, there remains a lack of contemporary, location-specific evidence on how sugarcane genotypes interact with different mulch rates and weed management strategies to optimize yield and suppress weeds under changing climatic conditions.

Despite the recognized agronomic and ecological benefits of trash mulching and integrated weed management, there is a notable evidence gap for Nigerian sugarcane systems: it is not yet well-established which sugarcane genotypes interact most effectively with specific trash mulch rates and weed control methods under current and emerging climate scenarios. This knowledge gap limits the ability of farmers, extension agents, and industry stakeholders to adopt climate-resilient, low-input weed management strategies tailored to local production environments (Shittu et al., 2024; Msomba et al., 2024).

1. 5 Study Objectives

This study therefore evaluates the performance of multiple sugarcane genotypes across a range of trash-mulch rates and weed-control methods, with the aim of:

i. quantifying effects on weed infestation and biomass,
ii. assessing impacts on cane establishment and yield components, and
iii. identifying genotype × mulch × weed-control combinations that maximize productivity and resilience under the changing climatic conditions of Badeggi, Nigeria.

2.0 Materials and Methods

2.1 Experimental Site

Field trials were conducted during the 2016 and 2017 planting seasons at the upland sugarcane experimental field of the National Cereals Research Institute (NCRI), Badeggi, located in the Southern Guinea Savanna agro-ecological zone of Nigeria (latitude 9°45′ N, longitude 6°07′ E). The soil at the experimental site is classified as Ultisol, with a sandy loam texture and a bulk density of 1.459 g cm^{-3} (Ayotade & Fagade, 1993). The area receives an average annual rainfall of approximately 1,124 mm, and the mean temperature ranges between 23 °C and 33 °C.

2.2 Treatments and Experimental Design

The experiment was arranged in a 2 × 4 × 4 factorial using a randomized complete block design (RCBD) with a split-plot arrangement and three replications. The treatments consisted of two sugarcane genotypes [chewing cane (Bida local) and industrial cane (NCS 001)], four cane trash mulching rates (0, 3, 6, 9 t ha^{-1}), and four weed control methods [weedy check, monthly hoe weeding for five months (5 MHW), application of PE diuron + POE 3-maize force, and application of PE diuron plus POE 3-maize force + 2 MHW]. Weed control methods and trash mulch were allocated to the main plot, while sugarcane genotypes were assigned to the subplot. The gross plot size was 20 m^2 (5 m x 4 m), while the net plot size was 10 m^2 (5 m x 2 m).
Weed control methods and trash mulch rates were assigned to the main plots, while sugarcane genotypes were allocated to the subplots. Each gross plot measured 20 m^2 (5 m × 4 m), and the net plot area was 10 m^2 (5 m × 2 m).

2.3 Agronomic Practices

Before land preparation, the existing vegetation was cleared, then the field was ploughed and harrowed. The total experimental area covered 2,375 m^2. Each subplot consisted of four rows,

each 5 m long. Tender, healthy stalks from six-month-old sugarcane were used as planting materials. Stalks were cut into setts, each containing three eye buds, and planted in furrows.
A pre-emergence herbicide (diuron) was applied one day after planting at 2.0 kg a.i. ha^{-1}, while the post-emergence (supplementary) herbicide was applied at five weeks after planting (WAP) at a rate of 179.2 g a.i. ha^{-1}. Weed identification was carried out using the *Handbook of West African Weeds* (Akobundu et al., 2016). NPK fertilizer was applied at 150 kg N, 60 kg P, and 90 kg K ha^{-1}, split equally between planting and 8-10 WAP.

2.4 Data Collection

2.4.1 Weed Assessment
Weed density and biomass data were collected at 3, 6, and 9 months after planting (MAP). Weed density was assessed using two randomly placed 1.0 m^2 quadrats per subplot on each sampling date. All weed seedlings within each quadrat were uprooted and counted.
For weed biomass determination, weeds from each quadrat were harvested, bulked per plot, and oven-dried at 80 °C for 48 hours to a constant weight. Weed species were identified following Akobundu et al. (2016). The composition of the weed flora was analyzed by calculating the relative abundance (RA) of each species within the experimental field using standard procedures.

$$RA = \frac{\text{Total number of individuals of a species in all the quadrats}}{\text{Total number of quadrats in which the species}}$$

$$RA = \frac{(\sum Wi)}{n}$$

Where ∑Wi is the sum of individual of a species occurring in all the quadrats, “n” is the number of quadrats in which the species occurred (Das, 2001).

2..4.2 Sugarcane Growth and Yield Parameters
Data on sugarcane growth and yield were collected at specific intervals during the growing period. Stalk height was measured at 6 and 9 months after planting (MAP) using a graduated wooden ruler (3 m). Measurements were taken from the base of the plant at ground level to the tip of the last unfolded leaf, or to the last visible node at the top of the stalk for stalk length.
Stalk girth (diameter) was recorded at 6, 8, and 10 MAP using a digital vernier caliper. At harvest (11 MAP), the percent brix of the cane juice was determined with a hand-held refractometer to assess soluble sugar concentration.
For cane yield, harvested stalks from the net plot area were cut, tied into bundles, and weighed. The weight was converted to tonnes per hectare (t ha^{-1}) to determine cane yield.

2.5 Data Analysis

All collected data were subjected to analysis of variance (ANOVA) to evaluate treatment effects using the SAS statistical software (Version 9.0). Treatment means were separated using Duncan's Multiple Range Test (DMRT) at a 5% level of probability.

3.0 Results and Discussion

3.1 Weed Flora Composition

During the 2016 and 2017 cropping seasons, a total of 70 weed species were recorded in the experimental plots. These consisted of 45 annual and 25 perennial species (Table 1). Based on growth form, 41 were broadleaved, 21 were grasses, and 8 were sedges. The most prevalent species were *Kyllinga squamulata*, *Paspalum scrobiculatum*, *Eleusine indica*, *Digitaria horizontalis*, *Brachiaria jubata*, *Setaria barbata*, *Brachiaria deflexa*, *Setaria pumila*, *Cyperus esculentus*, and *Dactyloctenium aegyptium*. Among these, *K. squamulata*, *B. deflexa*, *S. barbata*, and *P. scrobiculatum* were particularly noxious, collectively accounting for approximately 60% of the total weed population. This composition reflects the typical weed flora of sugarcane fields in the Southern Guinea savanna, where grasses and sedges dominate during early crop growth stages, while broadleaf weeds proliferate under reduced tillage and mulch systems (Akobundu et al., 2016; Bassey, 2020; Henry et al., 2021; Tadele et al., 2024). Similar weed community structures have been reported in sugarcane fields in India and Brazil, particularly under unburnt trash management and herbicide-based weed control regimes (Cherubin et al., 2021; Gongka et al., 2025).

3.2 Weed Biomass

Sugarcane genotype significantly ($P < 0.05$) affected weed biomass at 3 MAP in both 2016 and 2017, and at 9 MAP in 2017 only (Table 2). The industrial sugarcane genotype consistently recorded lower weed biomass than the local chewing cane. This superiority can be attributed to its higher tillering ability, rapid canopy formation, and stronger weed-suppressing capacity. Similar observations were reported by Bassey et al. (2023) and Desalegn et al. (2023), who noted that improved industrial varieties adapt better and suppress weed germination and growth more effectively than local types.

Weed biomass production also varied significantly ($P < 0.05$) among trash mulching rates (Table 2). Application of 9 t ha^{-1} of cane trash consistently reduced weed growth, performing similarly to 6 t ha^{-1} at 3, 6, and 9 MAP in both years. This result highlights the role of trash mulching in weed suppression, which increased with mulch rate. The suppressive effect of the 9 t ha^{-1} rate may be attributed to improved soil moisture retention (Singh & Chamroy 2025), inhibition of weed seed germination, and restricted weed growth and development (Nikolić et al., 2021; Nosratti et al., 2025).

Weed control methods also significantly ($P < 0.05$) affected weed biomass at 3, 6, and 9 MAP (Table 2). At 3 and 6 MAP, the application of PE diuron + POE 3-maize force resulted in the lowest biomass, similar to 5 monthly hoe weedings and PE diuron + POE 3-maize force + 2 hoe weedings at 6 MAP. By 9 MAP, the PE diuron + POE 3-maize force + 2 hoe weedings treatment gave the greatest biomass reduction compared to the weedy check. These findings demonstrate the comparative effectiveness of manual, pre-emergence, and post-emergence weed control methods. Similar results have been reported by Berg et al. (2025) and Saile et al. (2022), who indicated that effective sugarcane weed control can be achieved through mechanical, chemical, or integrated approaches.

Treatment interactions were also significant. At 3 MAP, the interaction between sugarcane type and weed management showed that PE diuron + POE 3-maize force resulted in lower weed biomass (Table 3). Increasing mulch levels consistently reduced weed biomass across all weed management practices at 3 MAP in the interactions between mulching and weed management (Table 4), genotype × mulching × weed control (Table 5), and mulching × weed control (Tables 6–8).

At 9 MAP, similar trends were observed. The interaction between sugarcane genotype and mulching showed that 9 t ha^{-1} trash produced the lowest weed biomass (Table 9). Increasing mulch levels similarly reduced weed biomass across weed control methods in mulching × weed management (Table 10) and genotype × mulching × weed control interactions (Table 11).

3.3 Stalk Height

Sugarcane genotype significantly ($P < 0.05$) influenced stalk height at 12 MAP (Table 12). The industrial sugarcane produced taller stalks than the local chewing cane, likely due to its greater drought tolerance. This aligns with the findings of Mehdi et al. (2024), who reported that industrial sugarcane establishes faster and grows taller under moisture stress conditions.

Trash mulch rates also significantly influenced stalk height. Application of 9 t ha^{-1} produced the tallest stalks, closely followed by 6 and 3 t ha^{-1} (Table 12). This indicates that mulch enhances growth, likely due to improved soil organic matter (Pavlů et al., 2021; Mou et al., 2025), better soil physical and chemical properties, and enhanced water availability. Minhas et al. (2022) also reported that retaining unburned cane trash on the surface annually recycles about 105 kg N ha^{-1}, complementing fertilizer requirements.

Weed management practices also had a significant ($P < 0.05$) effect on stalk height (Table 12). Taller stalks were recorded under 5 monthly hoe weedings, PE diuron + POE 3-maize force + 2 hoe weedings, and PE diuron + POE 3-maize force. This indicates the effectiveness of both manual and integrated herbicide approaches in promoting sugarcane growth. These results are consistent with Surendran et al. (2016) and Kousta et al., 2023, who highlighted the role of mechanical, chemical, and integrated methods, as well as mulching, in improving growth parameters. Furthermore, in the interaction between trash mulching and weed control, increasing mulch levels led to increased stalk height across weed control methods at 12 MAP (Table 13).

3.4 Stalk Girth

Sugarcane genotype significantly affected stalk girth at 10 MAP (Table 12). The local chewing cane produced larger stalk girth than the industrial cane, likely due to its softer, more water-filled stems with lower sucrose content. This agrees with Mehdi et al. (2024) and Aroh et al. (2020), who reported similar observations.

Different mulch rates also significantly affected stalk girth. Application of 9 t ha^{-1} produced the largest stalk girth, similar to 6 and 3 t ha^{-1} (Table 13), likely due to higher soil moisture, increased organic matter, and improved soil fertility (Mgolozeli et al., 2025; Sajjad et al., 2025). Weed control methods significantly influenced stalk girth at 10 MAP (Table 13). Larger girths were observed with 5 monthly hoe weedings, PE diuron + POE 3-maize force + 2 hoe weedings, and PE diuron + POE 3-maize force. These findings are consistent with Smith et al. (2021) and Acharya et al. (2022), who observed increased girth under effective weed management. Jaybhaye et al. (2020) also reported that Atrazine (0.50 kg/ha PE) followed by tembotrione (0.120 kg/ha POE) effectively controlled weeds throughout crop growth.

Interaction effects showed that increasing mulch levels resulted in increased stalk girth across weed management practices (Table 14), sugarcane types (Table 15), and genotype × mulching × weed control interactions (Table 16).

3.5 Brix

Sugarcane genotype significantly influenced brix at 12 MAP (Table 17). Industrial sugarcane recorded higher brix than the local chewing cane due to its thinner, harder stems, thick nodes, and higher sucrose-to-water ratio, consistent with Momotaz et al. (2024) and Desalegn et al. (2023). Mulch rate also significantly ($P < 0.05$) affected brix. The 9 t ha^{-1} rate produced the highest brix, closely followed by 6 and 3 t ha^{-1} (Table 17). This may be due to improved moisture conservation, weed suppression, and nutrient availability, as also reported by Bassey et al. (2019) and Kumar et al. (2024).

Weed control methods significantly affected brix, with the highest values observed under 5 monthly hoe weedings, PE diuron + POE 3-maize force + 2 hoe weedings, and PE diuron + POE

3-maize force (Table 17). Effective weed control likely improved yield attributes, aligning with Smith et al. (2021). In interactions, increasing mulch rates consistently improved brix across weed management practices (Tables 18 and 19).

3.6 Sugarcane Yield

Sugarcane genotype significantly affected yield at harvest (Table 20). The industrial cane produced higher yields than the local chewing cane, reflecting genetic differences in resource use efficiency. These findings are in agreement with Urgesa and Keyata (2021), and Desalegn et al. (2023). Mulch rate significantly influenced yield. In 2016, 9 t ha^{-1} produced the highest yield, statistically similar to 6 t ha^{-1}. In 2017, 6 t ha^{-1} gave the highest yield, followed by 9 t ha^{-1}, while the control plot recorded the lowest yield (Table 20). These results corroborate Bassey et al. (2017), and Adamczewska-Sowińska et al. (2025) who observed that higher mulch quantities enhance field productivity.

Weed control methods significantly affected yield (Table 20). In 2016, the highest yields were obtained under 5 monthly hoe weeding's, PE diuron + POE 3-maize force, and PE diuron + POE 3-maize force + 2 hoe weeding's. In 2017, PE diuron + POE 3-maize force produced the highest yield, followed closely by the other two treatments. Effective weed control contributed to increased yield, consistent with Fang et al. (2022).

Interaction effects revealed that 9 t ha^{-1} of trash applied to different sugarcane types produced the highest yields (Tables 21-24). Additionally, specific treatment combinations, such as 5 MHW at 3 t ha^{-1}, PE diuron + POE 3-maize force + 2 HW at 9 t ha^{-1}, and PE diuron + POE 3-maize force at 3 t ha^{-1}, produced the highest yields at harvest (Table 25).

4. Conclusion

The results of this study demonstrated that sugarcane genotypes responded positively to both trash mulching and weed control methods, with clear genotype-specific differences. The industrial cane genotype (NCS 001) consistently outperformed the chewing cane (Bida local) in terms of key growth and yield attributes. Its superior establishment, enhanced weed suppression capacity, and favorable response to higher trash mulching rates (6-9 t ha^{-1}) significantly contributed to increased sugarcane productivity.

Among the management practices evaluated, the combination of trash mulching at 9 t ha^{-1} with the application of pre-emergence diuron plus post-emergence 3-maize force and two supplementary hoe weedings proved most effective in suppressing weed growth, maintaining a cleaner field environment, and sustaining higher cane yields.

Overall, integrating appropriate sugarcane genotypes with optimized trash mulching and strategic weed control methods offers a sustainable and climate-resilient strategy for sugarcane production in the Southern Guinea Savanna of Nigeria. This integrated approach not only improves yield but also supports long-term soil health and reduces reliance on intensive chemical weed control.

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Table 1: Weed species encountered on sugarcane field during 2016 and 2017 cropping season

Weed species	Relative abundance (%) Months							
	LC	MG	Plant crop 2016			Plant crop 2017		
			3	6	9	3	6	9
Paspalum scrobiculatum Linn.	P	G	47.95	39.35	29.02	6.83	8.29	6.86
Setaria pumila (Poir)	A	G	45.4	48.4	38.8	-	-	-
Cynadon dactylon (Linn.)	P	S	12.67	10	9.33	8.12	22.14	19.57
Hibiscus asper (Hoek.f.)	A	B	2	-	-	2.46	3.23	-
Phyllanthus niruri (Schum.&Thonn)	A	S	3	2	-	20	16	11.09
Commelina diffusa (Burm.)	P	S	11.13	11	8.8	-	-	-
Kyllinga squamulata (Thorn.ex Vahl	A	S	77.33	52.97	36	4	8.86	-
Eragrostis tremula (Hochst.ex.Steud	A	G	24.67	29.33	22	-	-	-
Sacciolepis Africana (Hubb & Snowden	P	G	23.5	22.50	18.22	-	2	-
Panicum laxum Sw.	A	G	29.2	20.4	25.67	-	2	-
Brachiaria deflexa (Schumach) C.E	A	G	50	39.58	30.35	-	17	14.29
Euphorbia hirta (Linn.)	A	B	4.4	3.20	4.67	2	-	-
Andropogon tectorum Schum.&Thonn	P	G	22	21	-	-	-	-
Digitaria horizontalis (Willd.)	A	G	43.57	34.38	22.53	-	4.75	-
Tridax procumbens (Linn.)	A	B	3.25	2	4.67	2	2	2
Phyllanthus amarus (Schum & Thonn)	A	S	5.5	4.67	-	-	-	-
Eleusine indica(L) Gaertn.	A	G	40.18	31.8	25.13	5.56	-	-
Ludwigia hyssopifolia (G.Don)	A	B	4.81	3.5	4	-	-	-
Brachiaria jubata (Fig&De Not.)	A	G	31	28.88	22.86	-	-	-
Cyperus esculentus (Linn.)	P	S	27.69	20.15	16.4	26.75	12.71	10.59

Seteria barbata (Lasr.)Kunth	A	G	49.1	58	28	21.41	11.83	-
Imperata cylindrical (Linn.)	P	G	17.75	22.33	15.6	-	15.33	10.67
Commelina benghalensis (L.)	P	B	17.20	14	10.4	3	8.33	7.76
Trianthema portulacastrum (Linn.)	A	B	8	7.5	11	-	-	-
Tephrosia bracteolate (Guill&Perr.)	A	B	3.75	3.33	2.5	-	2.5	-
Dactylactenum aegyptium (Linn.)	A	G	43.88	41.5	25.75	8.18	12.57	9.81
Setaria longiseta (P.Beauv.)	A	G	35	42.33	27.33	24	-	-
Corchorus olitorius (L.)	A	B	1.5	3	3	2	7.87	6.14
Rottboellia cochinchinensis (Lour.)	A	G	30	-	-	2	2	2.67
Cleome hirta	A	B	6.5	6.5	5	3.33	-	-
Chloris pilosa (Schumach)	A	G	13.5	36	13	-	-	-
Evolvulus alsinoides (Linn.)	A	B	6	-	-	-	-	-
Setaria verticilillata	A	G	14	10.67	8.67	-	-	-
Cyperus rotundus (Linn.)	P	S	7	5	5	8.75	9.71	-
Cassia mimosoides (L.)	P	B	2	2	-	-	-	-
Cleome viscose (L.)	A	B	10.67	7.67	7	2	3.33	-
Digitaria milangina	A	G	36.22	26.38	16.5	-	6	-
Desmodium tortuosum (Sw.) DC.	A	B	8	4	6	-	-	-
Acanthospernum hispidum DC.	A	B	2	2	-	-	-	-
Euphorbia hyssopifolia (Linn.)	A	B	2	2	-	-	-	-
Sida corymbosa (R.E. Fries)	A	B	2	2	-	2.5	4	-
Sesamum alatum (Thonning)	A	B	2	-	-	16	2	4
Gomphrena celosiodes (Mart.)	A	B	2	-	-	-	-	6
Hydrolea glabra (Schum.&Thonn)	P	B	2	2	-	-	-	-
Ipomoea asarifolia (Desr.) Roem	P	B	2	2	4	3.33	4.77	-
Solanum nigrum (L.)	A	B	2	-	-	-	-	-
Merremia aegyptia (Linn.)	A	B	2	-	-	2	-	-
Hyptis suaveolens (Poit)	A	B	2	4	3.33	21.89	13.33	16.63
Andropogon gayanus	P	G	-	30	29	-	-	-
Digitaria nuda	A	G	-	-	-	6.17	19.23	16.5
Oldenlandia herbacea	P	B	-	-	-	2.67	-	-
Boerhavia diffusa	A	B	-	-	-	11.75	41.25	38.33
Physalis angulata	A	B	-	-	-	8.67	3	2
Senna obtusifolia	A	B	-	-	-	2	-	-
Anoxopus compresus	A	G	-	-	-	2	-	-
Passiflora foetida	P	B	-	-	-	2	4.29	
Schwenckia Americana	P	B	-	-	-	2	5	5.2
Phyllanthus pentandrus	A	S	-	-	-	-	4.33	-

Sebastiana chamaelea	P	B	-	-	-	-	5.29	4
Scoparia dulcis	P	B	-	-	-	-	3.71	-
Celosia leptostachya	P	B	-	-	-	-	3	-
Tephrosia pedicellata	A	B	-	-	-	-	2.71	-
Tephrosia linearis	A	B	-	-	-	-	8	5
Alysicarpus vaginalis	P	B	-	-	-	-	2	-
Stylosanthus guinnensis	P	B	-	-	-	-	8	-
Albizia zygia	P	B	-	-	-	-	10	-
Calopogonium mucunoides	P	B	-	-	-	-	2	4
Trichodesma zeylanium	P	B	-	-	-	-	2	-
Mitracarpus villosus	P	B	-	-	-	-	3	-
Leucas martinicensis	A	B	-	-	-	-	2	2

LC-Life cycle, MG-Morphological group, P-Perennial, A-Annual, G-Grass, B-Broad leaf, S-Sedges

Table 2: Response of sugarcane genotypes, trash mulching and weed control methods on weed biomass at 3, 6 and 9 MAP in 2016 and 2017 plant crop

Treatment	Weed biomass (g m^{-2})					
	Months after planting (MAP)					
	3		6		9	
Sugarcane genotypes (S)	2016	2017	2016	2017	2016	2017
Chewing	0.53b	0.55b	0.43	0.41	0.24	0.21b
Industrial	0.54a	0.61a	0.44	0.43	0.26	0.24a
LSD (0.05)	0.01	0.03	0.02	0.02	0.05	0.02
Mulching (M) (t ha^{-1})						
0	0.68a	0.72a	0.55a	0.51a	0.31a	0.31a
3	0.58b	0.63b	0.46b	0.46b	0.24b	0.23b
6	0.46c	0.50c	0.38c	0.36c	0.22b	0.21b

9	0.42d	0.46d	0.35c	0.34c	0.22b	0.16c
LSD (0.05)	0.02	0.04	0.02	0.03	0.07	0.03
Weed management (W)						
Weedy check	0.59a	0.64a	0.49a	0.46a	0.32a	0.27a
MHW	0.55b	0.59b	0.45b	0.44a	0.25ab	0.22b
PE +POE+ 2HW	0.52c	0.57b	0.42b	0.41b	0.22b	0.23b
PE + POE	0.48d	0.52c	0.38c	0.37c	0.20b	0.18c
LSD (0.05)	0.02	0.04	0.02	0.03	0.07	0.03
Interaction						
S x M	NS	NS	NS	NS	NS	*
S x W	*	NS	NS	NS	NS	NS
M x W	*	*	*	NS	*	*
S x M x W	*	NS	NS	NS	NS	*

MHW-Monthly hoe weeding, PE +POE +2HW-Diuron at 2 kg a.i/ha (Pre-emergence) + 3-Maize force at 179.2 g/ha (post-emergence herbicides) + Two hoe weeding, PE +POE -Diuron at 2 kg a.i/ha (Pre-emergence) + 3-Maize force at 179.2 g/ha (post-emergence herbicides)] only, NS- Not significant.

Table 3: Interaction of sugarcane genotypes and weed control methods on weed biomass at 3 MAP in 2016

Sugarcane genotypes	Weed control methods			
	Weedy check	MHW	PE + POE + 2HW	PE + POE
Chewing	0.59a	0.52ab	0.52ab	0.48b
Industrial	0.60a	0.58ab	0.51ab	0.48b
LSD (0.05)				

Table 4: Interaction of mulching and weed control methods on weed biomass at 3 MAP in 2016

	Weed control methods			
Mulching (t ha^{-1})	Weedy check	MHW	PE + POE + 2HW	PE + POE
0	0.81a	0.68b	0.64bc	0.59 bcd
3	0.63bc	0.59 bcd	0.50 def	0.56 cde
6	0.46fg	0.49ef	0.51 def	0.39g
9	0.47 e-g	0.44fg	0.42fg	0.38g

LSD (0.05)

Table 5: Interaction of sugarcane genotypes, mulching and weed control methods on weed biomass at 3 MAP in 2016

Sugarcane genotypes	Mulching (t ha^{-1})	Weed control methods			
		Weedy check	MHW	PE + POE + 2HW	PE + POE
Chewing	0	0.80a	0.60de	0.64c	0.58ef
	3	0.65c	0.58ef	0.52hi	0.56fg
	6	0.46k-m	0.46k-m	0.53gh	0.39n
	9	0.47k-m	0.44m	0.37n	0.38n
Industrial	0	0.82a	0.76b	0.63cd	0.59ef
	3	0.65c	0.59ef	0.49i-k	0.56fg
	6	0.46k-m	0.51h-j	0.48j-l	0.39n
	9	0.47k-m	0.45lm	0.46k-m	0.38n
LSD (0.05)					

Table 6: Interaction of mulching and weed control methods on weed biomass at 3 MAP in 2017

	Weed control methods			
Mulching (t ha^{-1})	Weedy check	MHW	PE + POE + 2HW	PE + POE
0	0.82a	0.73b	0.71bc	0.63cd
3	0.73b	0.64cd	0.56d-f	0.61de
6	0.47gh	0.53e-g	0.52fg	0.43h
9	0.54e-g	0.47gh	0.49f-h	0.41h
LSD (0.05)				

Table 7: Interaction of mulching and weed control methods on weed biomass at 6 MAP in 2016

	Weed control methods			
Mulching (t ha^{-1})	Weedy check	MHW	PE + POE + 2HW	PE + POE

0	0.68a	0.54b	0.51b	0.47bc
3	0.53b	0.46b-d	0.42cde	0.42cde
6	0.36ef	0.42cde	0.42cde	0.32f
9	0.39c-f	0.38d-f	0.33f	0.31f
LSD (0.05)				

Table 8: Interaction between mulching and weed management control methods on weed biomass at 9 MAP in 2016

	Weed control methods			
Mulching (t ha^{-1})	Weedy check	MHW	PE + POE + 2HW	PE + POE
0	0.51a	0.24bcd	0.20bcd	0.30bc
3	0.36ab	0.09d	0.25bcd	0.25bcd
6	0.18bcd	0.25bcd	0.31bc	0.15cd
9	0.24bcd	0.23bcd	0.25bcd	0.18bcd
LSD (0.05)				

Table 9: Interaction between sugarcane genotypes and mulching on weed biomass at 9 MAP in 2017

	Mulching (t ha^{-1})			
Sugarcane genotypes	0	3	6	9
Chewing	0.37a	0.24a	0.21a	0.16a
Industrial	0.25a	0.22a	0.21a	0.15a
LSD (0.05)				

Table 10: Interaction between mulching and weed control methods on weed biomass at 9 MAP in 2017

	Weed control methods			
Mulching (t ha^{-1})	Weedy check	MHW	PE + POE + 2HW	PE + POE
0	0.42a	0.29bc	0.29bc	0.23b-f
3	0.31b	0.14f	0.25b-e	0.23b-f
6	0.19c-f	0.26bcd	0.23b-f	0.15ef
9	0.16d-f	0.19c-f	0.15ef	0.13f
LSD (0.05)				

Table 11: Interaction between sugarcane genotypes, mulching and weed on weed control methods biomass at 9 MAP in 2017

Sugarcane genotypes	Mulching (t ha^{-1})	Weed control methods			
		Weedy check	MHW	PE + POE + 2HW	PE + POE
Chewing	0	0.49a	0.33b-e	0.36b	0.28e-h
	3	0.35bc	0.16m-p	0.18l-o	0.27f-i
	6	0.17l-p	0.22i-l	0.29d-h	0.15n-p
	9	0.16m-p	0.21j-m	0.15n-p	0.13op
Industrial	0	0.34b-d	0.25b-j	0.24h-k	0.17l-p
	3	0.27f-i	0.12p	0.31b-f	0.19k-n
	6	0.21j-m	0.30c-g	0.17l-p	0.15n-p
	9	0.16m-p	0.17l-p	0.14n-p	0.14n-p
LSD (0.05)					

Table 12. Response of sugarcane genotypes, mulching and weed control methods on stalk height and girth in 2016 and 2017 seasons

Treatments	Stalk height (cm) at 12 MAP		Stalk girth (cm) at 10 MAP	
	2016	2017	2016	2017
Sugarcane genotypes (SG)				
Chewing	138.95b	158.19b	2.97a	3.27a
Industrial	173.61a	187.42a	2.58b	2.68b
LSD (0.05)	12.16	11.37	0.13	0.11
Mulching (M) (t ha^{-1})				
0	123.09c	156.04b	2.09c	2.65c
3	157.18b	167.92b	2.90b	2.97b
6	161.36b	171.5b	2.93b	3.01b
9	183.48a	195.75a	3.16a	3.28a
LSD (0.05)	17.19	16.08	0.19	0.16
Weed control methods (WCM)				
Weedy check	123.62c	156.92b	2.10c	2.66c

MHW	181.46a	191.79a	3.15a	3.24a
PE + POE + 2HW	161.35b	171.96b	2.93b	2.99b
PE + POE	158.69b	170.54b	2.91b	3.24a
LSD (0.05)	17.19	16.08	0.19	0.16
Interaction				
SG x M	NS	NS	NS	*
SG x WCM	NS	NS	NS	NS
M x WCM	*	NS	*	NS
SGx M x WCM	NS	NS	NS	*

MHW-Monthly hoe weeding, PE +POE +2HW-Diuron at 2 kg a.i/ha (Pre-emergence) + 3-Maize force at 179.2 g/ha (post-emergence herbicides) + Two hoe weeding, PE +POE -Diuron at 2 kg a.i/ha (Pre-emergence) + 3-Maize force at 179.2 g/ha (post-emergence herbicides)] only, NS- Not significant.

Table 13: Interaction between mulching and weed control methods on stalk height at 12 MAP in 2016

	Weed control methods			
Sugarcane genotypes (SG)	Weedy check	MHW	PE + POE + 2HW	PE + POE
0	19.88b	173.85a	147.70a	150.92a
3	131.75a	183.78a	162.77a	150.43a
6	162.22a	175.15a	154.20a	153.88a
9	180.62a	193.05a	180.73a	173.53a
LSD (0.05)				

Table 14: Interaction of mulching and weed control methods on stalk girth at 10 MAP in 2016

	Weed control methods			
Mulching (t ha^{-1})	Weedy check	MHW	PE + POE + 2HW	PE + POE
0	0.21b	2.83a	2.63a	2.69a
3	2.56a	3.29a	2.95a	2.80a
6	2.68a	3.06a	3.02a	2.98a
9	2.95a	3.42a	3.11a	3.16a
LSD (0.05)				

Table 15: Interaction of sugarcane genotypes and mulching on stalk girth at 10 MAP in 2017

	Mulching (t ha^{-1})			
Sugarcane genotypes	0	3	6	9

Chewing	2.15b	2.69ab	2.79ab	3.11ab
Industrial	3.16ab	3.23ab	3.23ab	3.45a
LSD (0.05)				

Table 16: Interaction of sugarcane genotypes, mulching and weed control methods on stalk girth at 10 MAP in 2017

Sugarcane genotypes	Mulching (t ha^{-1})	Weed control methods			
		Weedy check	MHW	PE + POE + 2HW	PE + POE
Chewing	0	1.29q	2.49n-p	2.46n-p	2.34op
	3	2.28p	2.99g-k	2.67l-n	2.86i-l
	6	2.54mno	3.03f-j	2.82j-l	2.77k-m
	9	2.99g-k	3.23c-g	3.06e-j	3.16d-g
Industrial	0	2.83j-l	3.49b	2.91h-l	3.42bc
	3	3.0g-k	3.79a	3.23c-g	2.91h-l
	6	3.17d-g	3.09e-i	3.3b-e	3.35bcd
	9	3.15d-h	3.85a	3.51b	3.27b-f
LSD (0.05)					

Table 17. Response of sugarcane genotypes, mulching and weed control methods on brix and sugarcane yield in 2016 and 2017 plant crop

Treatment	Brix at 12 MAP		Yield (t ha^{-1}) at harvest	
	2016	2017	2016	2017
Sugarcane genotypes				
Chewing	15.50b	16.74b	52.12b	57.24b
Industrial	17.62a	18.29a	82.27a	66.18a
LSD (0.05)	0.92	0.58	4.63	4.61
Mulching(M) (t ha^{-1})				
0	13.50c	16.36b	52.36c	41.47c
3	16.28b	16.60b	68.71b	67.13b
6	17.82a	18.14a	70.95b	70.24a
9	18.63a	18.95a	76.74a	68.99ab
LSD (0.05)	1.29	0.82	5.91	3.70

Weed control methods (WCM)				
Weedy check	13.29b	16.30c	57.33c	54.91c
MHW	18.15a	18.38a	77.54a	61.29b
PE + POE + 2HW	17.11a	17.38b	66.08b	63.76b
PE + POE	17.68a	18.0ab	67.81b	66.87a
LSD (0.05)	1.29	0.82	8.36	5.23
Interaction				
S x M	NS	NS	*	*
S x WCM	NS	NS	*	*
M x WCM	*	*	*	*
S x M x WCM	NS	NS	*	*

MHW-Monthly hoe weeding, PE +POE +2HW-Diuron at 2 kg a.i/ha (Pre-emergence) + 3-Maize force at 179.2 g/ha (post-emergence herbicides) + Two hoe weeding, PE +POE -Diuron at 2 kg a.i/ha (Pre-emergence) + 3-Maize force at 179.2 g/ha (post-emergence herbicides)] only, NS- Not significant.

Table 18: Interaction of mulching and weed control methods on brix at 11 MAP in 2016

	Weed control methods			
Mulching (t ha^{-1})	Weedy check	MHW	PE + POE + 2HW	PE + POE
0	2.65b	17.73a	15.78a	17.83a
3	15.0a	17.50a	16.47a	16.17a
6	17.43a	18.23a	17.57a	18.03a
9	18.07	19.13a	18.63a	18.70a
LSD (0.05)				

Table 19: Interaction of mulching and weed control methods on brix at 11 MAP in 2017

	Weed control methods			
Mulching (t ha^{-1})	Weedy check	MHW	PE + POE + 2HW	PE + POE
0	13.52f	17.87abc	16.0de	18.05abc
3	15.42e	17.63a-d	16.93b-e	16.43cde
6	17.88abc	18.67ab	17.60a-d	18.40ab
9	18.38ab	19.33a	18.98a	19.12a
LSD (0.05)				

Table 20: Interaction of sugarcane genotypes and mulching on yield at 11 MAP in 2016

	Mulching (t ha^{-1})			
Sugarcane genotypes	0	3	6	9
Chewing	38.25c	37.86c	45.16c	51.76c
Industrial	51.58c	73.54b	78.29ab	93.31a
LSD (0.05)				

Table 21: Interaction of mulching and weed control methods on yield at 11 MAP in 2016

	Weed control methods			
Mulching (tha^{-1})	Weedy check	MHW	PE + POE + 2HW	PE + POE
0	24.0g	57.67cd	50.61de	47.38e
3	38.80f	76.83a	55.97d	51.20de
6	54.35de	69.58ab	57.87cd	65.10bc
9	71.18ab	75.50a	69.73ab	73.72a
LSD (0.05)				

Table 22: Interaction of sugarcane genotypes, mulching and weed control methods on yield at 11 MAP in 2016

Sugarcane genotypes	Mulching (t ha^{-1})	Weed control methods			
		Weedy check	MHW	PE + POE + 2HW	PE + POE
Chewing	0	24.0m	71.2d	62.03e	49.10h-j
	3	49.47g-j	101.5a	72.73d	70.47d
	6	69.87d	95.40b	62.23e	85.67c
	9	95.80ab	95.8ab	90.37bc	91.10bc
Industrial	0	24.0m	44.13jk	39.20k	45.67j
	3	28.13lm	52.17f-i	39.20k	31.93l
	6	38.83k	43.77jk	53.50f-h	44.53jk
	9	46.40ij	55.20fg	49.10h-j	56.33ef
LSD (0.05)					

Table 23: Interaction of sugarcane genotypes and mulching on yield at 11 MAP in 2017

	Mulching (t ha^{-1})			
Sugarcane genotypes	0	3	6	9
Chewing	33.62a	69.14a	62.55a	73.12a
Industrial	38.28a	60.19	64.48a	53.91a
LSD (0.05)				

Table 24: Interaction of sugarcane genotypes and mulching on yield at 11 MAP in 2017

	Mulching (t ha^{-1})			
Sugarcane genotypes	0	3	6	9
Chewing	49.98a	61.81a	62.83a	63.81a
Industrial	56.09a	51.52a	52.29a	56.95a
LSD (0.05)				

Table 25: Interaction of mulching and weed control methods on yield at 11 MAP in 2017

	Weed control methods			
Mulching (t ha^{-1})	Weedy check	MHW	PE + POE + 2HW	PE + POE
	13.33e	48.05cd	39.05d	48.38b-d
3	77.14a	62.09a-c	52.19a-d	67.24ab
6	58.86a-d	60.95a-c	67.57ab	66.67ab
9	62.81a-c	60.57a-c	71.43a	59.24a-d
LSD (0.05)				

Table 26: Interaction of sugarcane genotypes, mulching and weed control methods on yield at 11 MAP in 2017

Sugarcane genotypes	Mulching (t ha^{-1})	Weed control methods			
		Weedy check	MHW	PE + POE + 2HW	PE + POE
Chewing	0	9.52m	38.56k	40.0k	46.09j
	3	74.29bc	71.62bcd	55.24efg	75.43b
	6	47.62ij	67.43d	68.47d	66.67d
	9	68.47d	69.33cd	87.62a	67.05d

Industrial	0	17.14l	47.24ij	38.09k	50.67g-j
	3	80.0b	52.57f-i	49.14hij	59.05e
	6	70.09bcd	54.48e-h	66.67d	66.67d
	9	57.14ef	51.81f-j	55.24efg	51.43f-j
LSD (0.05)					