

Original Research Article

Differential response of four sugarcane (*Saccharum officinarum* L.) varieties to NPK 20:10:10 fertilizer in South-Western Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author KAN designed the study, wrote the protocol and wrote the first draft of the manuscript. Author OOO and KAN reviewed the experimental design and all drafts of the manuscript. Authors KAN and VOC managed the analyses of the study. Authors KAN and VOC performed the statistical analysis. All authors read and approved the final manuscript

ABSTRACT

The study was carried out during the wet cropping season of 2000 and dry season of 2001, respectively at the farm site of Olabisi Onabanjo University, Ago-iwoye, Ogun State in South-West zone of Nigeria to determine ~~and compare~~ the weight of cane, dry matter and yield of four varieties of sugarcane (*Saccharum officinarum* L.) in response to NPK 20: 10: 10 fertilizer. Varieties of sugarcane used ~~in the study~~ were Co62175, NCS005, NCS004 ~~and~~ AND NCS003 and the treatments were laid out in Randomized Complete Block Design (RCBD) replicated three times. The statistical analysis was done using Analysis of Variance (ANOVA) and means were separated with LSD (Least Significant Difference) at ~~$P \leq 0.05$~~ $P < 0.05$. Results ~~after statistical analysis~~ showed ~~that there were~~ significant differences ~~amongbetween~~ the varieties of the sugarcane with respect to the cane - weight and yield for both wet and irrigated seasons. During the wet season, the values of cane weight per plot ranged from 0.48 to 1.35 kg to 0.48kg plot⁻¹. NCS005 had the highest cane weight value of 1.35 kg plot⁻¹ while the lowest value was obtained from NCS003 (0.48kg plot⁻¹). This was also reflected in the yield which ranged from 4.11 to 9.74 ton/ha to 4.11 ton/ha with NCS005 having the highest (9.74 t/ha) and NCS003 the lowest (4.11 t/ha), suggesting close relationship between weight of cane and yield. The application of NPK 20:10:10 fertilizer ~~also~~ significantly increased the dry matter components of the plant cane, namely ~~and which were found to be significant in~~ % sucrose, % glucose, total sugar and crude fibre. The highest % sucrose, % glucose and total sugar was obtained from Co6215, while the lowest was obtained from NCS003. Crude fibre percentage

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Comment [b21]: Clarify? We do have wet and dry seasons OR rainfed and irrigated agriculture / crop production

Comment [b22]: On SI units, you have been using either ton/ha or t/ha. Please choose one and let be consistent in the article

39 | was ~~also found to be~~ significantly different among in the four varieties ~~at $p < 0.05$ level~~ with the
40 | highest obtained in NCS003 and lowest in Co6215. The same trend was obtained under ~~the~~
41 | irrigation in 2001 cropping season. In conclusion, the application of NPK fertilizer increased sugar
42 | concentration and sugar-cane yield for NCS005 and Co6215 compared to NCS003 and NCS004 varieties

43 | Keywords: Sugarcane; NPK 20:10:10 fertilizer; Dry matter; Sugarcane -Yield, Nigeria

44 |

45 | 1. INTRODUCTION

46 |

47 | Sugarcane belongs to the genus *Saccharum* L. of the tribe Andropogoneae in the grass family

48 | (*Poaceae*) and the most importance source of cane-sugar (~~Derr, 1949~~; FAO 2004; Sreenivasan et

49 | al. 1987). The stems are the main target of cultivation from which sugar is extracted (Daniels &

50 | Roach 1987; D'Hont et al. 1996; Mackintosh, 2000; Bakker 1999). It is widely grown throughout

51 | the tropical and sub-tropical regions of the world. It inversely depletes the soil of its major

52 | nutrients hence there is need to constantly supply ~~supplementary~~ nutrients to the soil under

53 | cultivation in order to sustain and replenish the lost nutrients and to increase the yield tonnage.

54 | ~~of the plant.~~ Although, Sugarcane is an important sugar crop in Nigeria, the rate of

55 | consumption of sugar in Nigeria is extremely high but the production is very low (Oworu, 1985)

56 | Sugarcane production trend in Nigeria.....

57 | . And This makes Nigeria imports about 93% of its sugar requirement ~~from countries that~~

58 | ~~produce sugar in commercial sale~~ and this gulps millions of Naira from the country's foreign

59 | reserve (Oworu, 1985). The plant nutrients which are vital to the growth of sugarcane

60 | comprises of the major elements: nitrogen (N), phosphorus (P), and potassium (K), ~~others are~~

61 | ~~iron (Fe),~~ Magnesium (Mg) and Calcium (Ca). These nutrients are supposed to be, ~~which are~~

62 | supplied ~~in assimilable form~~ by the gradual soil transformation, which occur at a rate sufficient

Comment [b23]: Write a brief statement of the sugarcane production trend in Nigeria e.g. national tons of cane produced, average national yields tons / ha, national tons of sugar produced

63 | to provide other nutrients for the need of the plant. ~~However, study by~~ ~~It has been proved by~~
64 | ~~Weier et. al (1996)~~ ~~showed that P, K that Phosphorus, Potassium and~~ especially N are Nitrogen
65 | ~~were~~ used at a higher rate by the plant than what the soil can ~~replenish generate~~ (Barnes
66 | ~~1954~~). These nutrients N,P and K elements have been found to have different effects and
67 | performance on the growth and development of the sugarcane. Phosphorus stimulates the
68 | rooting and tillering of the plant while potassium is essential for the synthesis of sugar in the
69 | leaf, with movement to the storage cells in the stem (Barnes, 1954; Freyney et al. 1994; Bull,
70 | 2000). Findings by Researchers such as Humbert (1968) reported that nitrogen fertilizer use increased
71 | the attainable tonnage of sugar Humbert, 1968 Nitrogen was found to increase the sugar tonnage
72 | of the crop (Humbert, 1968). Also, According to Lakshmi, et al., (2003), application of the
73 | recommended dose of fertilizer (150 kg ha⁻¹) in two equal splits either at planting and within 30
74 | days after planting (DAP) or at 30 and 60 DAP benefited the crop so that more millable canes
75 | were produced at harvest which ultimately resulted in increased cane and sugar yield.
76 | Application of N in splits increased the fertilization program cost, but its use was justified by
77 | increased sugar yield (Obreza and Pitts, 1998; Iftikhar et al 2000 and 2005; Weier et al. 1996;
78 | Freyney et al.1996 ;Bohl et al. 2000).
79 | ~~Sugar is a very important dry matter of Sugarcane.~~ The principal components of dry matter in
80 | sugarcane include: total sugar, sucrose, reducing sugar (i.e glucose and fructose) and crude
81 | fibre (Lingle and Irvine, 1994; Kang et al; 1983). It has also been noted that, the amount of
82 | sugar stored by different sugarcane varieties ~~and clones~~ depend on the size and efficiency of
83 | the photosynthetic system, ability of the sugarcane to translocate, the size of the storage
84 | tissues and partition of the photosynthetes for growth and storage (Oworu, 1988; Iftikhar et al

Comment [b24]: State the fertilizer type in terms of nutrient element e.g. NPK, urea, TSP etc.

2000). Sucrose stored in the sugarcane decreases relative to low soil fertility and soil moisture (Loehwin, 1953; Clement, 1959). Fibre is an important component of dry matter because of its inverse relationship to juice extraction. Breaux (1972) reported that sugarcane varieties with low sucrose concentration have high fibre content.

In lieu of this, a study was carried out to determine the effect of NPK (20:10:10) fertilizer on the weight of cane, yield and dry matter components of ~~four different~~ sugarcane varieties (~~*Saccharum officinarum* L.~~), in order to identify the variety that ~~is can be~~ greatly influenced by the NPK fertilizer to increase sugarcane tonnage, ~~in the country~~.

2.0 Materials and Methods

Characterization of the Study Area:

The study was carried out as field experiments. The field trials were conducted in 2000/2001 cropping seasons at the Teaching and Research Farm of Olabisi Onabanjo University, Ago-Iwoye (Latitude N 06.47; Longitude 03.58E) (longitude 03° 58'E, latitude 06° 47'N).

~~The trial sites reports a~~ The mean monthly temperature of 27.6°C and a mean annual rainfall of 1506 mm for the growing period of about 270 days. Rainy seasons, annually starts about March and ends in November, followed by dry season. The climate of this area is referred to typical tropical lowland rainforest.

~~, with the raining season starting about March and ending in November, followed by dry season. The mean annual rainfall is 1506mm and the growing period of 270 days.~~

The soils of the study area are ~~formed from dominant parent material known as~~ basement complex rock. The soils are well drained and the chemical properties are slightly acidic, low organic matter content, very-low CEC owing to predominance of kaolinite in their clay fraction hence inherently low in fertility status which cannot adequately support sugarcane production. The soil texture of the study site is sandy loam (Table 1).

~~well drained. The dominant parent material is basement complex rock, with the chemical properties such as slightly acidic, low organic matter content, very low CEC owing to predominance~~

Comment [b25]: Give a citation for this in case you used secondary information

112 of kaolinite in their clay fraction, low inherent fertility status and high base saturation which cannot
 113 adequately support sugarcane production. The soil characteristic of the experimental site is sandy
 114 loam in texture (Table 1).

115 Table 1: Chemical and physical properties of the study site **PRE-PLANTING SOIL ANALYTICAL RESULTS**

Soil properties	Values	Rating	Method of analysis
pH (H ₂ O)	5.6	Acid or Alkaline	Ratio of soil to water used!!!5-6
Organic carbon (g kg ⁻¹)	2.11	Low or Moderate of High	Dichromate wet oxidation or another method!!!!
Total Nitrogen (g kg ⁻¹)	0.30		
Available P (mg kg ⁻¹)	0.06		
Exchangeable Ca (cmol kg ⁻¹)	0.30		
Exchangeable Mg (cmol kg ⁻¹)	0.31		
Exchangeable Mn (cmol kg ⁻¹)	72.10		
Exchangeable K (cmol kg ⁻¹)	0.03		
Exchangeable Na (cmol kg ⁻¹)	0.74		
Sand (g kg ⁻¹) %	670		
Silt (g kg ⁻¹) %	170		
Clay (g kg ⁻¹) %	160		

Comment [b26]: Revise the table as suggested in case you collected the information yourself (primary data). Please indicate the source in case you used the data as secondary.

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Comment [b27]: If % are the figures ok. 670 % or 67 % etc

116

117 **Field Trial**

118 Four varieties of sugarcane were used for the study namely used in the study were: Co62175,
 119 NCS 005, NCS 004 and NCS 003 (where NCS means National Cereal Sugarcane).

120 What are the attributes of the varieties used.... The experiment was laid out in a Randomized

Comment [b28]: Example the maturity period, potential yield in tons /ha and also quality pol %

121 Complete Block Design (RCBD) design with three replicates ~~The experiment was laid out using a~~

122 ~~Randomized Complete Block Design (RCBD) and replicated three times.~~ The total land area

123 used was 8m by 11m (88m²), with plot size of 2m by 2m with 1m alley way between the plots.

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124 | Planting of the sugarcane setts was done on.....Setts of sugarcane of 18cm in length with at
 125 | least 2 auxiliary buds treated with furadam (fungicide) as seed dressing were planted in the
 126 | furrows at an angle of 45° with one cuttings-per stand at a spacing of 90 x 90 cm and spacing
 127 | between furrows was 1.5m apart. The first weeding was carried out 3 Weeks after Planting
 128 | (WAP) and followed by subsequent ones at 6 and 8 weeks respectively. The choice of
 129 | compound fertilizer NPK 20:-10:10 was based on the fact of readily available input within the
 130 | reach of sugarcane farmers, that will make use of the results to improve their sugarcane
 131 | production. Basal application of NPK fertilizer (20:10:10) was carried out at 6 weeks, at a
 132 | recommended rate of 112 Kg NPK/ha. The recommended rate of N, P and K for sugarcane
 133 | growing is kg N/ha, ...kg P/ha and kg K/ha in sugar zone of Nigeria. Rodents attack on
 134 | the crop was prevented by use of traps and clearing of the surrounding bushes about 1m away.
 135 | Diseases infestations were also controlled. The sugarcane was harvested at maturity in
 136 | week on date..... as plant crop harvest. Data were collected on cane weight, yield and dry
 137 | matter components (i.e. % Sucrose, Total sugar, Reducing sugars and Crude fibre). The data
 138 | were later subjected to 2 ways of analysis of variance (ANOVA) and means separated using
 139 | Least Significant Difference (LSD) at $P < 0.05$.
 140 | What was the purpose of having the experiment carried during the wet season and dry season /
 141 | or rainfed / irrigated cropping?

Comment [b29]: State the date.
Date/month/year or month/year

Comment [b210]: Which weeding method?
Manual, chemical or both (integrated)

Comment [b211]: Insert the statement and fill
appropriately

Comment [b212]: Insert week / date at time of
harvest including the crop cycle (plant / ratoon 1,
2..etc.

Comment [b213]: State briefly how the data
was collected and computed

Comment [b214]: Insert a statement to answer
the que

142 | 3.0 Results and Discussion

143 | ~~PRE-PLANTING SOIL ANALYSIS:~~ The result of the pre-planting soil analysis (to affirm the soil
 144 | conditions) is presented in Table 1.

145 | 3.1a. Response cane weight and yield of the sugarcane varieties to NPK fertilization during
146 | the wet season 2000

147 | The response of the cane-weight and yield of sugarcane (*Saccharum officinarum* L) to NPK
148 | fertilization are shown below in Figure 1 and, 2.

149 | The application of NPK (20:10:10) Fertilizer showed significant differences between the
150 | sugarcane varieties in terms of cane-weight and yield. The values of cane weight ranged from 0.48
151 | to 1.35 kg/plot. ~~The values of cane weight ranged from 1.35 to 0.48 kg/plot.~~

152 | NCS 005 had the highest value of 1.35 kg while the lowest was obtained from NCS 003 (0.48kg)
153 | (Figure 1). The same ~~trend was result were~~ recorded for sugar-cane yield and it ranged from 4.11
154 | ~~ton/ha to 9.74 ton/ha.~~
155 | ~~This result reflected in the yield of the sugar cane which ranged from 9.74 t/ha to 4.11 t/ha.~~

156 | The NCS 005 had the highest yields of 9.74 ton/ha while the lowest value was from NCS 005
157 | (4.11 ton/ha) (Figure. 2)-, ~~hence a suggesting a close~~ relationship between the cane weight and
158 | yield of the sugarcane. The study carried out by Lakshmi *et al.*, 2003 corroborated this findings,

159 | where application of the recommended dose of fertilizer (150 kg ha⁻¹) in two equal splits, either at
160 | planting and within 30 days after planting (DAP) or at 30 and 60 DAP benefited the sugarcane crop
161 | so that more millable canes were produced at harvest which ultimately resulted in increased cane
162 | and sugar yield. Also, the findings of Obreza and Pitts (1998) showed that application of N₂ in splits
163 | slightly increased the cane ~~weight~~, but its use was justified by increased sugar yield.

Comment [b215]: Chose one si unit and consistently use it subsequently e.g. t/ha or ton/ha including the y label in the graphs

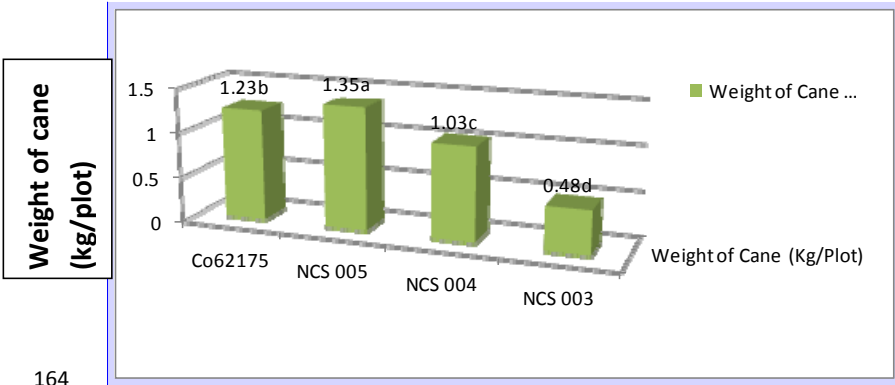
Comment [b216]: 005 or 003!!!!

Comment [b217]: Is it corroborated or corroborated

Comment [b218]: Name the fertilizer type?

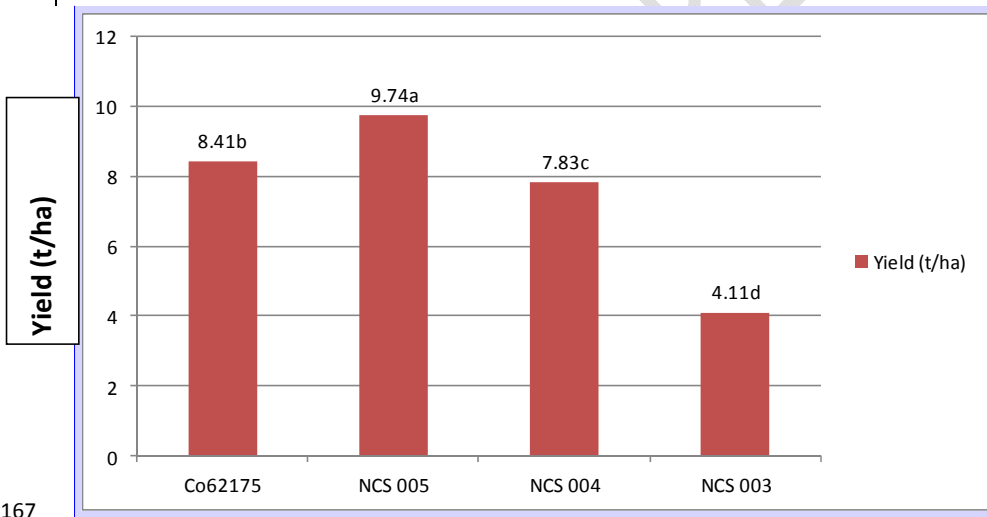
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Comment [b219]: Vague. Rephrase the statement and connection to the statement before comma



Comment [b220]: Label the x axis as sugarcane variety

164
165 **Figure.1:** Effect of NPK (20:10:10) Fertilizer on Cane-weight of different sugarcane varieties
166 during the wet season, in South-western Nigeria.



Comment [b221]: Insert the x axis as sugarcane variety

167
168 **Figure 2:** Yield response of different sugarcane varieties to NPK Fertilizer (20:10:10) during the
169 wet season in South-Western Nigeria.

170 **3.1b Response of the dry matter components of the sugarcane varieties to NPK fertilization**

171 The response of the dry matter components to NPK 201010 fertilizer is shown in the Table 12.
172 below.

173 There were significant differences among between the varieties for the dry matter components
174 (% sucrose, % glucose, % total sugar and % crude fibre) except in % Fructose (Table 12). The
175 value of % sucrose ranged from 6.83 for variety Co62175 to 2.73 for variety NCS 003 to 6.83
176 for variety Co62175 (Table 12). Similar trend results were obtained for % glucose, % fructose
177 and % total sugar. Highest value of % glucose (2.33) was obtained for Co62175 and lowest

178 value of 0.55 in the NCS 003 (Table 24). while for % fructose, highest value was also recorded in
179 variety Co62175 with 1.27 and lowest value of 0.39 was obtained in the NCS 003 (Table 1). This
180 result corroborated the findings of Iftikhar et al., 2005 and Iftikhar et al., 2000; Bull, 2000).

181 The value of % total sugar ranged from 12.61 for variety Co62175 to 7.81 for NCS 003 variety to
182 12.61 for variety Co62175 (Table 1). Conversely, the % crude fibre values ranged from 2.61 for
183 variety Co62175 to 9.34 for variety NCS 003 to 2.61 for variety Co62175 (Table 12).

Comment [b222]: Delete statement on fructose because the results were not significant

Comment [b223]: I guess you meant corroborated or just use a simpler term e.g. confirm..validate etc.

Comment [b224]: Substantiate further but briefly how your results confirm those by the authors you have cited

185 Table 24: Dry Matter Components of Four (4) Varieties of Sugarcane as Influenced by NPK
186 fertilizer (20:10:10) during the wet season in South-western Nigeria.

Varieties	% Sucrose	% Glucose	% Fructose	% Total Sugar	% Crude Fibre
Co62175	6.83	2.33	1.27	12.61	2.61
NCS 005	5.75	2.07	1.25	10.98	4.74
NCS 004	4.93	1.40	1.20	10.66	4.01
NCS 003	2.73	0.55	0.39	7.81	9.34

LSD ($P \leq 0.05$)	1.680	1.780	17.53	2.225	2.063
CV (%)	7.64	20.43	25.07	7.02	9.27
	~~“XX”~~	~~“XX”~~	NS	~~“XX”~~	~~“XX”~~
		~~XX~~		~~XX~~	~~XX~~

~~“XX” = highly significant, NCS = National Cereal Sugarcane hybrid, NS = Not significant.~~

3.2. Response of the four varieties of sugarcane to NPK fertilization under irrigation

Comment [b225]: Replace title table 2 as table 3 in subsequent text

The results of the dry matter, cane weight and yield of sugarcane (*Saccharum officinarum* L) under irrigation are shown below in Table 23, Figure 3 and 4 respectively. The same trend that was observed under wet season was recorded during the irrigation.

The values of cane weight ranged from 0.70 to 1.75 kg/plot. NCS 005 had the highest value of 1.75 kg while the lowest was obtained from NCS 003 (0.70kg) (Figure 3). The same result was recorded in the yield of the sugar-cane which ranged from 3.95 to 10.1 ton/ha. The NCS 005 had the highest yields of 10.1 ton/ha while the lowest value was from NCS 003 (3.95 ton/ha) (Figure 4). There was significant differences amongbetween_ the varieties in terms of cane-weight and yield to the application of NPK (20:10:10) Fertilizer.

Also, there were significant differences amongbetween_ the varieties for all the dry matter components (% sucrose, % glucose, % total sugar and % crude fibre) except % in Fructose (Table 2). The value of % sucrose ranged from 3.70 for variety NCS 003 to 7.15 for variety Co62175_ to 3.70 for variety NCS 003 (Table 2). Similar trendresults_ were obtained for %

glucose, % fructose and % total sugar. Highest value of % glucose (3.40) was obtained for Co62175 and lowest value of 1.23 in the NCS 003 (Table 32) while in the % fructose, highest value was also recorded in variety Co62175 with 2.21 and lowest value of 1.03 was obtained in the NCS 003 (Table 2). (Iftikhar et al., 2005 and Iftikhar et al., 2000; Bull, 2000)

The value of % total sugar ranged from 8.41 for NCS 003 variety to 12.90 for variety Co62175 to 8.41 for NCS 003 variety (Table 32). Conversely, the % crude fibre values ranged from 9.63 for variety NCS 003 to 3.14 for variety Co62175 (Table 32).

Comment [b226]: How are your findings linking up with the findings of the authors you have cited. Very important!!!!

Comment [b227]: As in comment 20 or 21

Weight of cane
(kg/plot)

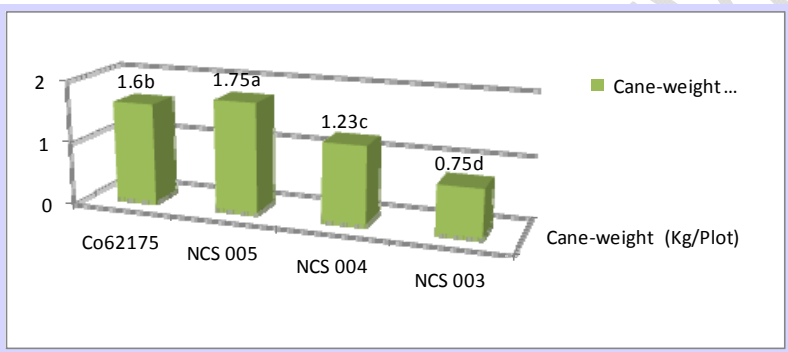
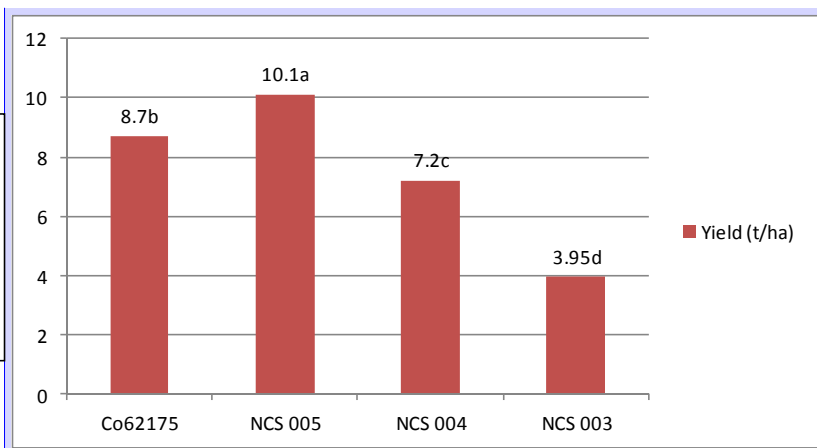


Figure 3: Effect of NPK (20:10:10) Fertilizer on Cane-weight of different sugarcane varieties under irrigation in South-western Nigeria.

Yield (t/ha)



Comment [b228]: As in comment 20 or 21

214
 215 **Figure 4:** Yield response of different sugarcane varieties to NPK Fertilizer (20:10:10) under
 216 irrigation in South-Western Nigeria.
 217 Table 32: Dry Matter Components of Four (4) Varieties of Sugarcane as Influenced by NPK
 218 fertilizer (20:10:10) under irrigation in South-western Nigeria.

Varieties	% Sucrose	% Glucose	% Fructose	% Total Sugar	% Crude Fibre
Co62175	7.15	3.40	2.21	12.90	3.14
NCS 005	6.50	3.12	2.13	10.24	4.81
NCS 004	5.12	2.40	2.06	9.78	4.25
NCS 003	3.70	1.23	1.03	8.41	9.63
LSD (P ≤ 0.05)					
CV (%)	xx	xx	xx	xx	xx
	xx	xx	NS	xx	xx

Comment [b229]: Insert the values like is in table 2

Comment [b230]: Insert the values like is in table 3

220 ~~xxx~~ – highly significant, NCS – National Cereal Sugarcane hybrid, NS – Not significant.

221

222 4. Conclusion:

223 The results obtained from the study showed that application of 112kg NPK/ha Fertilizer
224 increased the cane -weight, yield and improve the dry matter components of the sugarcane
225 (*Saccharum officinarum* L.) depending on the varieties of the cane. It also affirmed that
226 varieties Co66175 and NCS005 gave more sugar concentration and yield respectively in
227 response to NPK (20:10:10) fertilizer when compare to NCS 004 and NCS 003. Also, it showed
228 that NCS 003 gave the highest crude fibre content than the other varieties. Conclusively,

229 incorporation, incorporation of these two varieties (Co66175 and NCS005) into commercial
230 sugarcane production in Nigeria will increase the sugar tonnage in the country.

231 .

232 ACKNOLEDGEMENTS

233 234 COMPETING INTERESTS

235 236 Authors have declared that no competing interests exist

237

238

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Comment [b231]: Does it imply that these varieties are still undergoing evaluation and are yet to be released for commercial growing by the farmers? If so, a note need to be stated in the methodology or introduction

Comment [b232]: Need to insert

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