Albanian j. agric. sci. 2013;12 (3): 397-403 *Agricultural University of Tirana*

RESEARCH ARTICLE **(Open Access)**

Influence of weeding regime on severity of sugarcane mosaic disease in selected improved sugarcane germplasm accessions in the Southern Guinea Savanna agroecology of Nigeria

TAIYE HUSSEIN ALIYU* AND OLUSEGUN SAMUEL BALOGUN

Department Of Crop Protection, Faculty Of Agriculture, University Of Ilorin P. M . B 1515, Ilorin – Kwara State. Nigeria

Abstract

Experiment was conducted during 2011 to 2012 cropping season using potted plants, to evaluate the influence of weeding regime on sugarcane mosaic disease severity in selected improved sugarcane varieties from the University of Ilorin – Nigeria sugarcane germplasm. The experiment was laid out following a split plot arrangement where the weeding regime constitutes the main plot and the sugarcane varieties were the subplot. Disease parameters such as symptom manifestation, number of diseased leaves, percentage severity were measured. Growth and yield parameters such as stalk length, number of leaves, number of tillers and yield parameters such as fresh and dry shoot weights, percentage dry matter at harvest were also measured. Analysis of variance showed that percentage severity of sugarcane mosaic disease, increased in non-weeded plots compared with weeded plots. Twice weeding (52.1%) and the weed free plots (53.7%) had the significantly lowest severities. Varietal influence significantly influenced severity and variety NCO-270 produced the significantly lowest severity (45.8%).The interaction of weeding regime and variety indicated that variety CB36411 in the weed free plots, produced the lowest severity (33.5%).Yield parameters showed that significantly highest shoot weight was recorded in the weed free plot, while variety NCO-270 gave the highest fresh and dry shoot weights (254.8g and 50.2g respectively). The results indicate that variety NCO-270 was the most tolerant and that weeding at least once in six months is required to mitigate the effect of sugarcane mosaic disease, as witnessed in significantly increased growth and yield attributes of plants in the weeded plots.

Keywords: Sugarcane, Germplasm, Virus disease, Weeding, Agroecology

1. Introduction

Sugarcane *(Saccharum officinarum* L.*)*, is a tall growing monocotyledonous crop plant that is cultivated in the tropical and subtropical regions of the world primarily for its ability to store high concentrations of sucrose, or sugar in the internodes of the stem [12]. In the world economy, sugarcane is among the most important cultivated crops [4]. It is classified as a political crop and its world production in 2009 was 1,661.25 million tons [5]. Nigeria is one of the most important producers of the crop with a land potential of over 500,000 hectares of suitable cane field capable of producing over 3.0 million metric tons of sugarcane [15]. In Nigeria, industrial sugarcane is mostly cultivated in the Southern Guinea savanna ecology [16].

Sugarcane presents more than 200 diseases caused by fungi, viruses, bacteria, phytoplasmas and nematodes and figure as one of the main factors contributing to sugar losses worldwide [2]. Viruses especially, cause remarkable epidemics and losses of major proportions, as a consequence sugarcane viruses always must be taken into account in breeding programmes worldwide where selection and elimination of susceptible clones following resistance tests have become a routine procedure [1]. Sugarcane mosaic is caused by a number of potyviruses such as the sugarcane mosaic virus. Sugarcane mosaic disease is responsible for drastic epidemics in sugarcane, accounting for near collapse of the sugarcane industry [25].

The most distinctive symptom is a pattern of contrasting shades of green, often islands of normal green on a background of paler green or yellowish chlorotic areas on the leaf blade. Generally, the chlorotic areas are diffuse, but they may be sharply defined in some clones infected with certain strains of the virus. The infection may be accompanied by varying degrees of leaf reddening or necrosis. Chlorotic areas are most evident at the base of the leaf. Chlorotic areas may also be present on the leaf sheath, but rarely on the stalk. Young, rapidly growing plants are more susceptible to infection than more mature, slower growing plants [7]. Yield losses ranging from 11 up to 50% have been reported in susceptible varieties under severe infection with mosaic [22].

Correspondence: Taiye Hussein Aliyu, Department Of Crop Protection, Faculty Of Agriculture, University Of Ilorin; Email: **aliyutaiyehussein@yahoo.com**
(Accepted for publication 29 May 2013)
***ISSN**: 2218-2020,*

Ibrahim [10], reported that weeds cause 40% losses in cane-yield. It was noted [9], that the weeds alone are responsible for causing as much as, 71% reduction in the total yield per hectare of sugarcane. The critical period of weed interference (CPWI) is one of the baseline information necessary to evolve effective weed management strategies. CPWI is the portion of the life cycle of a crop during when it must be kept free of weeds to prevent unacceptable yield loss [13]. It helps to determine the sensitivity of a crop to early competition from weeds, and the period of weed control in the crop necessary to prevent yield loss from late emerging weeds [24].

Weed species have also been found to be natural reservoirs for viruses [6] and can serve as alternative hosts for viruses [21]. *Echinochloa* spp. has been reported by [18], as being an alternative hosts for green leafhopper and the source of Tungro virus and dwarf virus. It has also been reported by [11], that certain weeds, like *Rumex dentatus*, *Convovulus arvensis*, *Melilotus* spp., *Launaea procumbens* and *Chenopodium album*, are good hosts of White Fly (*Bemisa tabaci*), which is a carrier of leaf curl-virus.

The objective of the study therefore were to: (i) evaluate the severity of sugarcane mosaic disease in selected improved sugarcane germplasm accessions in the southern guinea savanna agroecology of Nigeria. (ii) evaluate the influence of weeding regime on sugarcane mosaic disease severity and (iii) evaluate the growth and yield of the sugarcane varieties under the experimental conditions. This will help to identify outstanding varieties in the germplasm and provide benchmark data for the effective utilization of these varieties in sugarcane breeding programmes and pre-breeding activities.

2. Materials and Methods

Source and collection of sugarcane: four improved varieties of sugarcane were obtained from the sugarcane germplasm of the University of Ilorin. They are: CB36411, CO-602, RH411M112 and NCO-279.

Soil preparation and arrangement of pots: Sandy loam soil was collected and sieved to remove stones, pebbles and other debris. 12kg of soil was then weighed into 64 (10 litre capacity), plastic pots. The pots were arranged into 4 groups of 16 each, in the open pavilion, following split plot arrangement.

Planting operation: Sugarcane stalks were cut into small pieces called setts, with at least one centrally located bud per sett. The planting was done putting a sett per pot. Each variety was replicated four times per main plot, making 16 pots per variety. This indicates that the varieties were the subplots. The plants were watered daily.

Weeding operation: Weeding was manually carried out following a regime in which one main plot was left unweeded throughout the 6 month experimental period, the second main plot was weeded once after 8 weeks and 16 weeks after planting, while the fourth main plot was weeded always to give it a weed – free environment.

Data collection and analysis: Data were collected on three categories namely; Disease parameters, growth parameters and yield parameters. These include number of days to sprouting, number of days to first appearance of disease symptoms, number of leaves per plant, number of diseased leaves per plant, number of tillers per plant, length of the main stalk, fresh shoot and dry shoot weights at harvest. Percentage dried weight and percentage dry matter was determined using [14]. All data were subjected to Analysis of Variance using the split plot model of the Genstat 5 ver 3.2 statistical package. Comparison between means was done using the Least Significant Difference (LSD) at 5% level of significance.

3. Results

Effect on disease manifestation and symptom severity: Table 1 shows the main and interaction effects of weeding regime and variety on some disease parameters in sugarcane infected by the sugarcane mosaic disease. The results showed that weeding regime, varietal differences and the interaction of the two treatments, did not have any significant effect on the mean number of days to first disease symptoms manifestation.

Further consideration of the result showed that there was no significant difference in the total number of diseased leaves per plant between plots that were weeded once (10.8) and twice (13.7), but there was significant difference between plots that was not weeded at all (5.3). Consideration of the effect of varietal differences on total number of diseased leaves per plant shows no significant differences between variety CO-602 (15.5) and RH411M112 (14.6), but there was significant difference between varieties CB36411 (7.1) and NCO-270 (19.6).

Consideration of the effect of weeding regime on relative severity of symptom per plant showed no significant differences among the plots. Varietal effect also showed no significant differences between varieties CB36411 (60.2%), CO-602 (63.3%)

Table 1: Main and interaction effects of Weeding Regime and Variety on some disease parameters in sugarcane infected by the sugarcane mosaic disease

Weeding regime	*Mean number of days to first disease symptoms*	*Total number of diseased leaves per plant*	*Percentage symptom severity (%)*
No weeding	15.4	5.3	60.8
Once	14.8	10.8	62.8
Twice	15.4	13.7	52.1
Weed free	15.3	26.9	53.7
SEM	0.21	1.57	3.78
LSD	0.68	5.04	12.10
Variety			
CB36411	15.7	7.1	60.2
CO-602	15.1	15.5	63.3
RH411M112	15.3	14.6	60.0
NCO-270	15.5	19.6	45.8
SEM	0.29	1.43	2.41
LSD	0.84	4.09	6.90
Weeding Regime Variety			
No weeding CB36411	15.8	5.0	79.8
CO-602	16.5	7.0	77.3
RH411M112	14.8	4.0	69.1
NCO-270	15.5	5.0	56.9
Once CB36411	15.8	5.0	76.2
CO-602	15.5	11.0	49.0
RH411M112	15.5	6.5	58.8
NCO-270	14.5	20.8	67.2
Twice CB36411	16.0	7.5	51.5
CO-602	15.0	11.8	51.5
RH411M112	16.0	17.8	64.2
NCO-270	16.3	17.8	41.3
Weed free CB36411	15.3	10.8	33.5
CO-602	15.3	32.3	75.5
RH411M112	14.8	30.0	58.0
NCO-270	14.8	34.8	47.9
SEM	0.55	2.93	5.63
LSD	1.57	8.37	16.21

and RH41M112 (60.0%) but variety NCO-270 (45.8%) had the significantly lowest severity symptom.

The interaction effects of weeding and variety on total number of diseased leaves and percentage severity (table 1), shows that significant difference occurred between the treatment combinations. Variety CB36411 with no weeding having the highest percentage severity (79.8%), while the same variety under a weed free plots produced the significantly lowest severity (33.5%).

Effect on growth attributes: Table 2 shows the main and interaction effects of weeding regime and variety on some growth attributes in sugarcane infected by the sugarcane mosaic disease. The result shows that weeding regime, varietal differences and the interaction of the two treatments had no significant effect on the number of days to sprouting and tillering.

The total number of tillers at harvest was significantly affected by the treatments. At harvest, the weed free plots produced the highest number of tillers (6.1), and variety NCO-270 also produced the highest numbers of tillers at harvest (6.6). Assessment of the effect of treatments on the mean number of leaves per tiller was also of significant effect. Variety NCO-270 and the weed free plots produced the significantly highest number of leaves per tiller at harvest (7.1 and 8.1 respectively). The significantly shortest stalk length at harvest was in the non-weeded plots (76.2cm), while variety NCO-270 had the longest stalk length of 148.1cm. The interaction effect of weeding and variety on stalk length shows that variety CB36411 in the non-weeded plot had the lowest stalk length (44.2cm), while variety NCO-270 in the weed free plot had the significantly highest stalk length (249.0cm).

Table 2: Main and interaction effects of Weeding Regime and Variety on some growth attributes in sugarcane infected by the sugarcane mosaic disease

Weeding regime	*Mean number of days to sprouting after planting*	*Total number of leaves at Harvest*	*Mean number of days to Tillering*	*Total number of Tillers at Harvest*	*Mean no. of leaves per Tiller*	*Stalk length at harvest (cm)*
No weeding	10.7	10.1	76.2	2.3	5.8	76.2
Once	10.8	17.9	76.2	3.9	5.2	114.6
Twice	11.6	26.3	78.4	4.6	5.8	130.2
Weed free	11.1	50.0	76.9	6.1	8.1	162.8
SEM	0.25	2.66	0.31	0.39	0.36	5.05
LSD	0.80	8.51	0.99	1.25	1.17	16.17
Variety						
CB36411	10.9	14.9	76.2	2.7	5.6	80.6
CO-602	10.8	25.1	77.0	4.1	6.4	131.5
RH411M112	11.1	24.3	77.3	3.6	5.9	123.5
NCO-270	11.4	39.9	77.3	6.6	7.1	148.1
SEM	0.24	2.41	0.34	0.44	0.42	5.63
LSD	0.68	6.91	0.97	1.27	1.20	16.14
Weeding regime variety						
No weeding CB36411	11.0	6.2	75.8	1.3	5.4	44.2
CO-602	10.3	9.0	76.8	1.3	7.8	119.5
RH411M112	10.8	6.7	76.3	1.0	6.8	59.2
NCO-270	10.8	18.3	76.0	5.8	3.3	82.0
Once CB36411	10.5	6.5	75.5	1.5	4.8	93.7
CO-602	11.0	22.8	76.5	4.8	5.0	122.2
RH411M112	10.8	11.3	76.3	2.3	6.8	105.7
NCO-270	11.0	31.3	76.5	7.3	4.3	136.5
Twice CB36411	11.3	14.0	76.5	3.5	4.8	86.2
CO-602	11.0	26.0	78.0	4.3	5.8	139.8
RH411M112	11.5	27.5	79.5	5.0	6.4	169.8
NCO-270	12.8	37.5	79.8	5.5	6.5	125.0
Weed free CB36411	11.0	32.7	77.0	4.5	7.6	98.2
CO-602	11.0	42.7	76.8	6.0	7.2	144.5
RH411M112	11.5	51.7	77.3	6.3	8.3	159.3
NCO-270	11.0	72.7	76.8	7.8	9.5	249.0
SEM	0.48	4.95	0.66	0.83	0.81	10.98
LSD	1.37	14.12	1.88	2.46	2.32	31.27

Effect on yield attributes: Table 3 shows the main and interaction effects of weeding regime and variety on some yield attributes such as the fresh shoot weight, dry shoot weight and the percentage dry matter in sugarcane infected by the sugarcane mosaic disease. Evaluation of weeding regime showed that the significantly highest fresh shoot weight was obtained in the weed free plots (238.8g), although this value was not significantly different from the value obtained in the twice weeded plots (231.1g). Dried shoot weight and percentage dry matter was also significantly highest in the weed free plots with the values of 47.3g and 19.8% respectively

Consideration of varietal effect on the parameters showed that variety NCO-270 produced the significantly highest fresh shoot weight (254.8g), dried shoot weight (50.2g) and percentage dry matter (19.5%). Consideration of the interaction effect indicated that the treatment combinations differ significantly from each other. Variety NCO-270 in the weed free plots produced the significantly highest fresh shoot weight (394.4g) and dried shoot weight (79.9g), while variety CB36411 in the weed free plots produced the significantly highest percentage dry matter (20.7%), which was not significantly different from variety NCO-270 in the weed free plots (20.2%).

4. Discussion:

All the four improved varieties collected from the University of Ilorin germplasm accessions manifested symptoms of sugarcane mosaic disease and the appearance was as early as two weeks after sprouting. The observation here is in line with that reported by

[25], that mosaic symptoms in sugarcane, can also be asymptomatic due to varied concentration of chlorophyll on the leaf tissues. Similar observations were reported by [17], who evaluated some local varieties of sugarcane from the University of Ilorin germplasm. The variability in time of Symptom manifestation, was attributed by [8], to the slow build up in titre concentration of the virus in the sugarcane varieties. The inherent potential of a variety to manifest late mosaic disease symptoms is therefore of paramount importance for sustaining high productivity in sugarcane.

Table 3: Main and interaction effects of Weeding Regime and Variety on some yield attributes in sugarcane infected by the sugarcane mosaic disease

Weeding regime	Fresh Shoot Weight (g)	Dried Shoot Weight (g)	Percentage dry Matter (%)
No weeding	71.6	13.6	19.2
Once	122.9	24.0	19.3
Twice	231.1	45.7	19.4
Weed free	238.8	47.3	19.8
SEM	11.79	2.48	0.30
LSD	37.71	7.93	0.97
Variety			
CB36411	85.7	17.1	19.9
CO-602	161.5	31.6	19.0
RH411M112	162.3	31.8	19.3
NCO-270	254.8	50.2	19.5
SEM	13.86	2.93	0.35
LSD	39.74	8.40	1.01
Weeding regime variety			
No weeding CB36411	40.3	8.1	18.2
CO-602	85.8	15.9	18.5
RH411M112	67.1	12.9	19.2
NCO-270	93.0	17.6	18.8
Once CB36411	83.8	16.3	19.4
CO-602	129.0	25.6	19.9
RH411M112	68.5	12.8	18.4
NCO-270	210.4	41.4	19.7
Twice CB36411	100.5	19.5	19.4
CO-602	234.9	47.2	18.7
RH411M112	267.4	54.3	18.4
NCO-270	321.5	61.7	19.2
Weed free CB36411	118.3	24.4	20.7
CO-602	196.1	37.7	19.1
RH411M112	246.3	47.3	19.2
NCO-270	394.4	79.9	20.2
SEM	26.74	5.65	0.68
LSD	76.16	16.09	1.94

The results revealed that the varieties reacted to differing levels as regards the severity of the symptoms under different weeding regime in this study. It was further observed that plants under non-weeded condition performed generally worse in term of growth and yield response under infection with the virus. Whereas variety CB36411 in the non-weeded plot was the most severely affected, variety NCO-270 under the same condition had the lowest symptom severity. This indicates that variety NCO-279 may be better under a situation where weeding may be a challenge to the sugarcane grower. It was reported [23], that the critical period of weed crop competition in sugarcane ranged between 27 and 50 days. The effect of more weed biomass leading to higher symptom severity, reduced growth parameters and reduced yield attributes, may be due to the varying weed crop competition for sunlight, air, space, moisture, nutrients and weeds serving as vector/host of the viral pathogens. These results are in agreement with [19] who concluded that zero weed-crop competition gave more cane yield than different weed-crop competition periods and [3],who reported 40% symptom severity caused by sugarcane mosaic virus under varying conditions.

Under the influence of weed, varieties CO-602 and CB36411 were not significantly different from each other in severity levels. This shows that the varieties were genetically different from one another. It also indicates the fact that the use of tolerant varieties as well as the manipulation of weeding regime may be effective ways of mitigating the

disease effects in sugarcane. This finding is in agreement with [20].

5. Conclusion

It can be concluded that variety NCO-270 was the most tolerant of all the varieties considered in this study and considering that the symptom severity was more in non-weeded plots than in weeded plots, it can also be recommended that weeding at least once in 6 months is required to mitigate the effect of sugarcane mosaic disease, as witnessed in significantly increased growth and yield attributes of plants in weeded plots.

6. References

1. Ahmad YA, Costet L, Daugrois HH, Nibouche S, Letourmy P, Girard JC and Rott P: **Variation in infection capacity and in virulence exists between genotypes of sugarcane yellow leaf virus.** Plant Disease 2007 **91**: 253-259.
2. Allsopp P, Samson P, and Chandler K: **Pest management.** In *manual of cane growing*: M Hogarth, P Allsopp; 2000: 291-337.
3. Croft B, Magarey R, Whittle P: **Disease management.** In *manual of cane growing*: M Hogarth, P Allsopp; 2000: 91-108.
4. FAO: **Sugarcane as feed.** Food and Agriculture Organization Animal Production and Health Paper 1988 No. 72.
5. FAOSTAT: **Food and Agriculture Organization.**2009 Available: <http://faostat.fao.org>.
6. Garcı´a-Andre´sa S, Monci F, Navas-Castillo J and Moriones E: (2006) **Begomovirus genetic diversity in the native plant reservoir Solanum nigrum: evidence for the presence of a new virus species of recombinant nature**. Virology 2006 **350:** 433–442.
7. Goncalves MC, Galdeano DM, Maia IG, and Chagas CM: **Genetic variability of sugarcane mosaic virus genotypes causing maize mosaic in Brazil.** Pesquisa Agropecuara Brasileira 2011 **46**: 362-369.
8. Gonçalves MC, Klerks MM, Verbeek M, Vega J and van den Heuvel JFMJ: **The use of molecular beacons combined with NASBA for the sensitive detection of *Sugarcane yellow leaf virus*.** European Journal of Plant Pathology 2001 **108:** 401-407.
9. Gupta OP: **Weed control in sugarcane**, Ph.D. Dissertation. The Postgraduate school, Indian Agricultural Research Institute, New Delhi, 1960
10. Ibrahim ASS: (1984). ***Weed competition and control in sugarcane*.** Weed Research *1984* **2:** 227-271.
11. Khaskheli AM, and Memon MQ: **The World of White Fly**. In manual of cane growing: *M Hogarth, P Allsopp; 2000:* **3**: 30.
12. Mackintosh D: **Sugar milling**. In manual of cane growing: M, Hogarth, P, Allsopp;2000: 369-377.
13. Martin SG, Acker RC and Friesen LF: **Critical period of weed control in spring canola.** Weed Science 2001 **49:** 326-333.
14. Mertens DR, Bolton K, and Jorgensen M: **Measure dry matter routinely using a food dehydrator.** In Dairy Forage Research Summary, 2004: 49-52.
15. National sugar Development Council NSDC: **Information Brochure towards self-sufficiency in sugar**. In Abuja bulletin: 2003: 1-26.
16. Olaoye G: **Effects of rationing on yield and yield components of non-irrigated sugarcane germplasm accessions in the Southern Guinea savanna zone of Nigeria**. Ghana Journal of Agricultural Science 2001: **34:** 109-117.
17. Onidare FA: **Incidence and severity of sugarcane mosaic disease in some local cultivars of Unilorin Sugar Research Institute Germplasm.** M.Sc Dissertation. University of Ilorin, Nigeria. 2008.
18. Oudejan JH: **Agro-pesticide, Properties and functions in integrated crop protection.** United nations Economic and Social Commission for Asian and Pacific, United Nations Bangkok, 1994: 264-290.
19. Patel CL, Patel DD and Patel MN: **Critical period of crop weed competition in sugarcane (Var. Co Lk 8001).** Indian sugar 2007 **56:** 27-32.
20. Pursglove JW: **Tropical Crops: Monocotyledons.** Longman Scientific and Technical, New York. 1972.
21. Roye ME, McLaughlin WA, Nakhla MK, and Maxwell DP: **Genetic Diversity Among Geminiviruses Associated with the Weed Species Sida spp., Macroptilium lathyroides, and Wissadula amplissima from Jamaica.** Plant Disease 1997 **81:** 1251–1258.
22. Singh M, Singh A, Upadhyaya PP, and Rao GP: **Transmission studies on an Indian isolate of sugarcane mosaic potyvirus.** Sugar Technology 2005 **7:** 32-38.
23. Srivastava TK, Singh AK and Srivastava SN: **Critical period of weed competition in**

sugarcane ratoon. Indian Journal of Weed Science 2003 **34:** 320-321.

24. Webster TM, Faircloth WH, Flanders JT, Proskto EP and Grey TL: (2007). **The critical period of tropical spiderwort (*Commelina benghalensis*) control in peanut.** Weed Science 2007 **55:** 359-364.

25. Xu DL, Park JW, Mirkov TE, and Zhou GH: **Viruses causing mosaic disease in sugarcane and their genetic diversity in southern China.** Archives of Virology 2008 **153:** 1031-1039.

26. Yang ZN, and Mirkov TE: **Sequence and relationships of sugarcane mosaic and sorghum mosaic virus strains and development of RT-PCR- based RFLPs for strain discrimination.** Phytopathology 1997 **87:** 932-939.