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IMPACT OF NATURAL WEED INFESTATION ON THE PERFORMANCE OF SELECTED SUGARCANE VARIETIES IN THE SOUTHERN GUINEA SAVANNA OF NIGERIA

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Abstract
Experiments were conducted to evaluate the performance of some sugarcane varieties against natural weed infestation. The trials were laid out in a randomized complete block design with split-plot arrangement and three replications. The sugarcane varieties were the main plots while the sub-plots consisted of weeding regimes. Recommended cultural and agronomic practices were followed to raise the crops. Data were collected on weed density, weed biomass, sugarcane tiller count and cane yield. Our results revealed that Rottboellia cochinchinensis (Lour.) W.D.Clayton, Panicum maximum Jacq, Imperata cylindrica L., Panicum repens L., Cynodon dactylon L. and Cyperus rotundus L. were the major weed problems of sugarcane in Ilorin. The monthly hoe weeded treatment had significantly higher tiller count which translated to higher cane yield (22.61 to 72.54 t/ha) than other weed control treatments. The reduction in cane yield was between 80.51 and 97.55% depending on duration of weed infestation. Association of weed parameters with cane yield was negative and significant showed that a decrease in weed infestations will result in simultaneous increase in sugarcane yield. Therefore, in selecting sugarcane variety(s) for breeding programmes, emphasis should be placed on sugarcane growth parameters that negatively and significantly correlated with weed infestation.

Key Words: *Weeds, sugarcane, plant crop, ratoon, cane yield, tiller count*

Introduction

In Nigeria, sugarcane is widely grown on a small scale for home consumption and on a large industrial scale for the manufacture of refined sugar and it's 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 (Ndarubu *et al*., 2006). This suboptimal production levels can be attributed to many factors including susceptibility of the local sugarcane varieties to pests and diseases, low level of adoption of improved technologies, marginal productivity of their farm land and high cost of inputs, especially nitrogenous fertilizers among others. The national average yield of sugarcane is less than 30 t ha^{-1} which is much lower than the world average, of 65 t ha^{-1} (Anon., 2008).

Sugarcane differs from other crops in that it takes twelve months to mature and at least three harvests (plant crop and two rations), and in some cases four to five harvests are made from a single planting. Consequently, the soil on the row top where the sugarcane grows is not appreciably disturbed during the multi-year crop which allows the weeds to become well established and difficult to control. The yield potential of sugarcane crop is affected by 20-25 percent (%) due to weed infestation (Khan *et al*., 2004). Weed management therefore in sugarcane accounts for over 35% of the cost of production.

Weeds constitute a major factor limiting sugarcane production in Nigeria. The competition for water, light, nutrients and space between weeds and the crop can reduce sugarcane stalk population and yield. Weed interference is a major biotic constraint to optimal crop production. Singh *et al*. (1980) reported that weed - crop competition is effective for 120 days of crop and zero weed-crop competition for first 120 days of growth period enhanced 45% cane yield. However, after 120 days, zero competition was not beneficial. The weed competition starting from 3, 6 and 9 weeks after planting reduces yield by 77.6, 50.6 and 41.7 %, respectively (Zimdahl, 1980). Punzelan and Cruzz (1981) concluded that weed-crop competition for first

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two months (60 days) after planting the crop reduced cane yield by 8% at harvest compared to weed free. Study conducted by Phogat *et al.* (1990) showed that weeds posed serious threat to sugarcane crop especially between 60-120 days after crop planting while results of study conducted by Nayyar *et al.* (1994), revealed that 86.7 t ha^{-1} cane yields was obtained from weed free duration up to 90 days, closely followed by weed free duration up to 56 days with an average yield of 80 t ha^{-1}. Srivastava et al. (2003) opined that weeds infestation caused between 12-72 l% reductions in cane yield. Singh and Tomar (2003) reported that when weeds were removed after competition for 30, 45, 60, and 75 days, a reduction of 17.5, 23.8, 59.7, and 74.7%, respectively in cane yield was recorded while Patel et. al. (2007) revealed that cane yield increased to 98.1% with increasing weed free period and decreased to 38.1%, when weed-crop competition for 3-4 months.

Plant breeding programme develop varieties primarily to increase yield and resistance to diseases/insects with little emphasis on weeds and herbicides tolerance. Hence, the importation sugarcane varieties also take advantage of the available high yielding sugarcane genotypes which may exhibit poor yielding ability in the new environment. One of the reasons for low yield may be poor competitive ability with the native weeds. The study reported herein was therefore undertaken to assess the effect of natural weed infestation on the growth and cane yield of sugarcane.

Materials and Methods

Site Description

This study was conducted at the University of Ilorin Sugar Research Institute's Farm between 2009 - 2011 growing seasons. The farm is located at Bolorunduro, Ilorin, in the southern Guinea savanna ecological zone (Latitude 90 29' N and Longitude 40 35' E) of Nigeria, and is 307 m above sea level.

The study was established in 2009 using a site that had been under continuous sugarcane cropping for more than a decade, the site used in 2010 (plant crop) and 2011 (ratoon crop) was under fallow for about a decade and had never been cropped to sugarcane while 2011 site was sugarcane growing field that was under fallow for about 5 years prior to the commencement of the study.

Experimental Layout

In each year, the experiment was laid out in a randomized complete block design (RCBD) with a split-plot arrangement and three replications. The main plots consisted of five sugarcane varieties (B47419, Co 61275, Co 957, ILS 001 and ILS 002) while the sub plots consisted of six weed infestation, made up of a weedy check, one hoe weeding at 4 weeks after planting (WAP), hoe weeding at 8 WAP, one hoe weeding at 12 WAP, one hoe weeding at 12 WAP, one hoe weeding at 20 WAP and a monthly hoe weeding till 30 WAP.

Field Establishment

Prior to cultivation, the vegetation cover of the experimental sites was slashed to ground level, after which the land was disc ploughed, harrowed and ridged. The experimental site for each year had an area of 4212 m^2. Each sub plot consisted of four rows of 5m long. Ten three-eyed cane setts were laid horizontally end-to-end per row. NPK fertilizer was applied at 150 kg N, 60 kg P and 90 kg K in equal halves at planting and 8-10WAP.

Data Collection

Data on weed density and biomass were collected at 16, 20, 40WAP and 12, 16, 20, 30, 40 WAP, respectively. Weed density was monitored in four randomly placed (0.25 m^2) quadrats discreetly per sub plot on each assessment date. Weed seedlings in each quadrat were counted pulled out. Dry matter production by the weeds was determined from the harvested weeds within each quadrat during each sampling periods. Samples from the same plots were bulked and oven dried at 80^oc to a constant weight. The crop data collected were sugarcane tiller count per plot at 12, 16, 20, 30, 40 WAP and cane yield extrapolated to tones per hectare at harvest.

Data Analysis

Average weed density and weed biomass, tiller count at 40 WAP and cane yield at harvest were subjected to analysis of variance (ANOVA) using Genstat Discovery Edition for each year of study. Where F-ratios were significant ($p<0.05$); means were separated using Fisher's protected least significant difference. The cane yield and tiller count data were correlated against the weed parameters.

Results

Weed Species Composition

Thirty-five (35) weed species, made up of 18 annual and 17 perennial weed species within 30 genera were identified in all sites used for the study. Weed species indentified comprised of 20 broadleaves, 12 grasses and three (3) sedges. Twenty-seven weed species were encountered in 2009, 29 in 2010, 31 in 2011 and 30 in the ratoon crop site (Table 1). Ten weed species constituted more than 60% of total weed species in each site. Eight of these weed species: *Panicum maximum*, *Rottboellia cochinchinensis*, *Cynodon dactylon*, *Eleusine indica*, *Imperata cylindrica*, *Panicum repens*, *Cyperus rotundus* and *Andropogon gayanus* were enumerated in the four trial sites (Table 2) while the five most abundant weed species are grasses and are arranged in this sequence as follows: *Rottboellia cochinchinensis* (10.916 %), *Panicum maximum* (9.399 %), *Imperata cylindrica* (8.644 %), *Panicum repens* (7.747%, and *Cynodon dactylon* (6.659 %).

Weed infestation and dry matter production

Mean weed density was significantly influenced by sugarcane variety and weeding regime except the ratoon crop in 2011 where sugarcane varieties had similar effect on mean weed population (Table 3). Var. Co 957 had significantly lower mean weed density in 2009 and 2011 and significantly higher in 2010 while var. B47419 had significantly lower in 2009 and 2011 which was similar to what was obtained in var. ILS 001 in 2009 and var. ILS 002 in 2011 plots.

Monthly hoe weeded plots had significantly lower mean weed density while the plots where no weed was removed had significantly higher mean weed density which was similar to other hoe weeded plots except plots hoe weeded at 20 WAP.

Interaction effect between sugarcane variety and weeding regime on mean weed density was observed in 2010 (Table 4). Sugarcane variety had similar mean weed density across the weeding regimes except under monthly hoe weeded where significantly lower mean weed population was observed across the sugarcane varieties.

Mean weed biomass was significantly influenced by sugarcane variety and weeding regime except in 2009 and ratoon crop in 2011 where weeding regime and sugarcane varieties had similar effect on mean weed weight, respectively (Table 5). Var. Co 957 had significantly lower mean weed dry weight except in 2011 while B47419 had relatively higher weed biomass in all the trial years were significant differences were observed. Other sugarcane varieties evaluated were similar in one point to another with either var. Co 957 or var. B47419.

Mean weed dry weight obtained under the weeding regime plots showed that, monthly hoe weeding plots had significantly lower mean weed biomass while weedy check had relatively higher weed weight. The later plots had similar weed weight to other hoe weeded plots in 2011 and the ratoon crop.

Interaction effects between sugarcane variety and weeding regime mean weed biomass were observed in 2009 and 2010 growing seasons (Table 6) and similar trend as observed mean weed population was observed across the sugarcane varieties.

Effect of natural weed infestation on sugarcane tillering ability and cane yield

Mean tiller count per plot of the sugarcane varieties for four assessment periods each year is presented in Table 7. The varieties evaluated had similar tillering ability. Although var. ILS 002 and var. ILS 001 had higher number of tillers in 2009 and 2011, respectively while B47419 and Var. Co 957 had more number of tillers in 2010 and in the ratoon crop, respectively.

In a similar manner, weeding regimes significantly influenced the production of tillers in sugarcane crop. Monthly hoe weeded plots had significantly mean tiller count follow while weedy check had significantly lower number of tillers. Other weeding regimes had similar mean tiller count across the years. The earliness weed removal encourages increase in sugarcane tiller production.

Interaction effects of sugarcane varieties with weeding regime were highly significant for cane yield (Table 8). The monthly hoe weeded plots had significantly higher cane yield. A relatively higher cane yield was obtained from plots planted to var. Co 957 (52 – 72 t/ha) while the ratoon crop of the same var. above yielded 48t/ha. The ILS varieties followed var. Co 957 in cane yield. The cane yield obtained from other plots increases with earliness in weed removal. The percentage reduction in cane yield as compared to the yield obtained in monthly hoe weeded plots shows that, plots hoe weeded at 4 WAP suffered 80.51 – 90.52 % lost in cane yield, 88.55 – 92.95 % loss in cane yield was obtained in plots hoe weeded at 8 WAP while 91.74 – 94.55 %, 90.57-93.75 % and 94.95 – 97.55 % were cane yields lost recorded from plots hoe weeded at 12 WAP, 20 WAP and weedy check, respectively.

Coefficient of correlation of weed parameters and tiller count with the cane yield (Table 9) showed that weed density and weed biomass were negatively significant correlated while number of tillers positively correlated with cane yield. The correlations were more consistently significant between weed population and cane yield than between weed biomass and cane yield.

Discussion

Variety recommendations are based primarily on yield (tonnage and sugar), stubble longevity, disease/insect reaction, weed competition and herbicide tolerance. Sugarcane varieties can vary in growth characteristics which can directly affect weed competition. Sugarcane cultivars differ with regards to time of emergence following planting either in May as rainfed cultivation or November under irrigation; stalk population; canopy characteristics, such as leaf architecture; and ratooning ability (measured by survival and vigor of the crop following repeated annual harvests); all of which may affect the variety's competitiveness with weeds (Jones *et al*., 2006). The variability might be due to the variable genetic potential which showed different results in a particular set of environment and ecological conditions of the experimental crop.

In this study, *Rottboellia cochinchinensis* (Lour.)W.D.Clayton, *Panicum maximum* Jacq, *Imperata cylindrica* L., *Panicum repens* L., *Cynodon dactylon* L. and *Cyperus rotundus* L. were found to be the major weed problems of sugarcane in Ilorin. Webster (2000) reported that, annual grasses which include *Rottboellia cochinchinensis* (Lour.) W.D. Clayton, *Brachiaria platyphylla* (Griseb.) Nash, and *Panicum fasciculatum* Sw.; *Sorghum halepense* (L.) Pers. and *Cynodon dactylon* (L.) Pers.; *Ipomoea* spp.; and *Cyperus* spp were the major weed problems in sugarcane in the tropics while Ndarubu *et al*. (2006) reported grasses to be of highest density, followed by the broadleaved weeds, while the sedges had the least density in Nigeria.

In this study, the highest diversity of species was observed among the broadleaved weeds; followed by the grasses while the sedges had the least diversity. The occurrence of these weed species on the trial fields could be attributed to the long period of cultivation, monocropping with sugarcane and application of irrigation water from a natural source that might be contaminated with weeds. The observed high density of grasses and high species diversity may be due to high tillering ability of grasses and the wide edaphic adaptability of broadleaf weeds (Akobundu 1997). Broadleaf weeds are easier to control through cultural practices than grasses and sedges that possess adaptive features for vegetative propagation, which facilitate their regeneration in subsequent years without changes in species (Ekeleme *et al*., 2004).

There was a decrease in number of tillers with an increase in weed population which resulted in reduction in cane weight. Reduction in cane yield ranging from 80.51% to 97.55% was due to weed crop competition which prolonged from 4 to 20 WAP/weedy check. These results are supported by Fadayomi and Abayomi, (1988), Kolo *et al*. (1999) in Nigeria who concluded that uncontrolled weed interference in the crop has been reported to cause between 12 and 78% reductions in cane yield depending on weed species, weed density and the sugarcane crop cycle. Chauhan and Srivastava (2002) in India reported 32.0 to 45.45% yield losses due to weed-crop competition. Similarly, Singh and Tomar (2003) in India reported 20.5 and 74.5% reduction in cane yield because of weed-crop competition. Muhammad et al. (2010) reported a decrease of 9.84 to 56.89% in stripped cane yield in Pakistan. In U.S.A. weed crop competition of 3, 6 and 9 WAP reduced yield of sugarcane, 77.6, 50.6 and 41.7% respectively (Zimdahl, 1980). Khan *et al*. (2004) reported that cane yield of sugarcane crop is affected more than 20-25% due to weeds while Nayyar (1994) and Patel et al. (2007) concluded that zero weed-crop competition gave higher cane yield than different weed-crop competition periods.

Increase in weed population with an increase in weed-crop competition period could be due to more time availed for weed seeds to germinate, whereas increase in weed biomass with time was due to utilization of environmental resources by weeds for a longer period of time compared with monthly hoe weeded.

Coefficient of correlation of weed density and weed biomass with cane yield showed that the increase in these weed parameters will result in decrease in cane yield whereas tiller count was positively and highly significant, an increase in tillering ability resulted in simultaneously increase in cane yield. Ramdoyal (1999) in Mauritius and Abdul Fatah et al. (2006) Thatta, Pakistan reported similar results between number of tillers and cane yield.

Conclusion

The yield of sugarcane was linearly decreased with increasing weed-crop competition duration with maximum decrease in weedy plot. Weeds should be removed immediately after the emergence to get maximum cane yield. Growth parameters that are negatively and significantly correlated with weed parameters should be used for selection of weed tolerance sugarcane variety(s) for commercial sugar production.

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Table 1 Mean relative abundance (%) of weed species encountered in sugarcane fields

Weed Species	LC	MG	PC 2009	PC 2010	PC 2011	Ratoon 2011
Trianthema portulacastrum L.	A	B	0.891	0.510	0.153	0.554
Achyranthes aspera L.	A	B	-	-	0.382	-
Celosia leptostachya Benth.	A	B	2.836	1.8718	1.147	2.215
Ageratum conyzoides L	A	B	1.378	2.041	1.651	-
Aspilia africana pers C.D Adams	P	B	1.702	1.8718	0.917	1.177
Chromolaena odorata L. (RM) king	P	B	2.998	2.211	0.765	1.107
Tridax procumbens L.	A	B	1.702	1.786	1.606	1.038
Cleome viscosa L.	A	B	2.431	2.466	-	1.523
Commelina diffusa Burn.	P	S	-	-	1.682	-
Cyperus esculentus L.	P	S	4.863	4.931	2.982	2.629
Cyperus rotundus L.	P	S	4.943	6.037	3.058	4.498
Mariscus alternifolius Vahl	P	S	2.512	2.721	3.669	2.7682
Croton lobatus L.	A	B	-	-	0.994	1.107
Euphorbia heterophylla L.	A	B	1.054	1.020	2.141	1.524
Phyllanthus amarus Schum & Thonn	A	S	2.998	1.871	2.446	-
Desmodium salicifolium (Poir) DC	A	B	1.216	-	1.529	-
Tephrosia bracheolata Guill	A	S	2.836	2.551	1.376	1.384
Sida acuta Burm.	P	B	1.539	1.701	-	1.107
Sida rhombifolia L.	P	B	0.729	-	1.452	1.384
Boerhavia coccinea Mill	P	B	-	-	-	0.692
Boerhavia diffusa L.	P	B	2.188	2.126	0.841	2.007
Andropogon gayanus Kunth	P	G	4.619	6.463	6.269	8.374
Axonopus compresus Sw. P. Beauv	P	G	5.835	2.806	0.917	1.176
Bracharia lata (Schumach) C.E	A	G	1.458	1.361	1.147	1.868
Cynodon dactylon L.	P	G	7.050	5.528	8.104	5.952
Eleusine indica Gaertn	A	G	7.050	4.762	8.180	3.806
Imperata cylindrica L.	P	G	4.943	12.245	10.092	6.575
Panicum maximum Jacq	P	G	13.047	10.034	8.563	5.952
Panicum repens L.	P	G	6.321	5.017	10.168	9.481
Paspalum scrobiculatum L.	P	G	-	2.721	-	3.253
Pennisetum polystachion L	A	G		0.255	0.535	6.298
Pennisetum violaceum Lam.	A	G		0.425	0.382	7.889
Rottboellia cochinchinensis (Lour)	A	G	8.833	10.119	15.367	9.343
Mitracarpus villosus Sw. DC.	A	B	2.026	1.871	1.376	1.107
Physalis angulata L	A	B	0	0.680	0.153	2.215

LC=life cycle, MG= morphological group, A = annual weed species, P = perennial weed species, B= broadleaf, G= grass, S = sedge, PC = plant crop.

Table 2: Ten worst weed species identified in different sugarcane cultivation sites

			Relative Abundance (%)				Mean Rel. Abundance
			Plant Crop			Ratoon Crop	
Weed Species	MG	LC	2009	2010	2011	2011	(%)
Panicum maximum Jacq	G	P	13.047	10.034	8.563	5.952	9.399
Rottboellia cochinchinensis (Lour)	G	A	8.833	10.119	15.367	9.343	10.916
Cynodon dactylon L	G	P	7.050	5.528	8.104	5.952	6.659
Eleusine indica Gaertru	G	A	7.050	4.762	8.180	3.806	5.949
Imperata cylindrica L	G	P	4.943	12.245	10.092	6.575	8.644
Panicum repens L	G	P	6.321	5.017	10.168	9.481	7.747
Cyperus esculentus L	S	P	4.863	4.931	2.982	-	3.194
Cyperus rotundus L	S	P	4.943	6.037	3.058	4.498	4.634
Mariscus alternifolius Vahl	S	P	-	2.721	3.669	-	1.598
Andropogon gayanus Kunth	G	P	4.619	6.463	6.269	8.374	6.431
Chromolaena odorata L. (RM) king	B	P	2.998	-	-	-	0.749
Pennisetum polystachion L	G	A	-	-	-	6.298	1.575
Pennisetum violaceum Lam	G	A				7.889	1.972

LC=life cycle, MG= morphological group, A = annual weed species, P = perennial weed species, B= broadleaf, G= grass, S = sedge

Table 3: Influence of sugarcane variety and weeding regime on mean weed density (no/m^2)

Treatment	Plant crop, 2009	Plant crop, 2010	Ratoon crop, 2011	Plant crop, 2011
Variety				
B47419	129c	23a	243	84c
Co 62175	111ab	26a	236	76b
Co 957	107a	41b	209	70a
ILS-001	105a	27a	236	82c
ILS-002	121bc	26a	251	73ab
Sed	6.45	2.38	22.76	2.77
Weeding Regime				
NHW	149c	52c	300c	88c
MHW	25a	13a	45a	46a
HW4	138c	21b	307c	87bc
HW8	141c	28b	300c	80bc
HW12	135c	25b	214b	85bc
HW20	98b	31b	244b	174b
Sed	10.25	3.44	31.24	6.83
ANOVA				
Replication	366.9	138.3	45848	1802.1
Variety	1799.8*	900.4**	4637	656.1*
Residual	982.7	50.9	4661	204.4
Weeding Regime	33540.0**	2657.3**	150923**	3766.9**
Interaction	894.0	1078.3**	6802	529.9
Residual	788.3	88.9	7320	350.2

NHW =no hoe weeding, MHW= monthly hoe weeding, HW4= hoe weeding at 4 WAP, HW8= hoe weeding at 8 WAP, HW12= hoe weeding at 12 WAP, HW20= hoe weeding at 20 WAP

Table 4: Interaction between sugarcane varieties with weeding regime on mean weed density at 2010

	Weeding Regime					
Variety	HW12	HW20	HW4	HW8	MHW	NHW
B47419	31.44	22.78	16.44	27.00	9.89	30.33
Co61275	31.89	27.89	28.11	25.67	14.44	23.67
Co957	35.22	19.89	18.67	25.33	13.22	132.11
ILS 001	32.33	25.44	19.33	32.78	15.22	34.67
ILS 002	22.78	30.11	20.11	28.67	13.22	41.33
	Sed	7.423		7.702		

NHW =no hoe weeding, MHW= monthly hoe weeding, HW4= hoe weeding at 4 WAP, HW8= hoe weeding at 8 WAP, HW12= hoe weeding at 12 WAP, HW20= hoe weeding at 20 WAP

Table 5: Influence of sugarcane variety and weeding regime on mean weed biomass (kg/m^2)

Treatment	Plant crop, 2009	Plant crop, 2010	Ratoon crop, 2011	Plant crop, 2011
Variety				
B47419	0.401c	1.128a	1.186d	0.784
Co 62175	0.316ab	0.783b	0.850a	0.830
Co 957	0.289a	0.193a	0.952c	0.744
ILS-001	0.370bc	0.497b	0.896b	0.911
ILS-002	0.389bc	0.522b	0.902b	0.877
Sed	0.039	0.081	0.112	0.126
Weeding Regime				
NHW	0.387	0.762d	1.198b	1.061b
MHW	0.325	0.391a	0.592a	0.074a
HW4	0.384	0.678b	1.091b	0.879b
HW8	0.342	0.665a	1.063b	1.052
HW12	0.331	0.549b	0.788ab	0.989b
HW20	0.349	0.703c	1.012b	0.921b
Sed	0.036	0.073	0.117	0.131
ANOVA				
Replication	0.154	0.134	0.008	2.245
Variety	0.042*	0.215**	0.319*	0.082
Residual	0.014	0.059	0.094	0.144
Weeding Regime	0.011	0.270**	0.757*	2.129**
Interaction	0.025*	0.141**	0.139	0.135
Residual	0.009	0.039	0.103	0.129

NHW =no hoe weeding, MHW= monthly hoe weeding, HW4= hoe weeding at 4 WAP, HW8= hoe weeding at 8 WAP, HW12= hoe weeding at 12 WAP, HW20= hoe weeding at 20 WAP

Table 6 Interaction between sugarcane variety with weeding regime on mean weed biomass in 2009 and 2010

	Weeding Regime at 2009					
VARIETY	HW12	HW20	HW4	HW8	MHW	NHW
B47419	0.390	0.364	0.353	0.390	0.501	0.407
Co61275	0.330	0.283	0.376	0.376	0.194	0.337
Co957	0.288	0.354	0.359	0.306	0.077	0.349
ILS 001	0.316	0.428	0.418	0.349	0.261	0.449
ILS 002	0.329	0.317	0.417	0.288	0.593	0.392
	Sed	0.0831	0.0803			
	Weeding Regime at 2009					
B47419	0.051	0.109	0.188	0.162	0.400	0.246
Co61275	0.648	0.898	0.846	0.772	0.558	0.976
Co957	0.973	1.495	1.148	1.277	0.353	1.524
ILS 001	0.405	0.468	0.740	0.430	0.471	0.470
ILS 002	0.667	0.547	0.467	0.686	0.171	0.594
	Sed	0.1686	0.1621			

NHW =no hoe weeding, MHW= monthly hoe weeding, HW4= hoe weeding at 4 WAP, HW8= hoe weeding at 8 WAP, HW12= hoe weeding at 12 WAP, HW20= hoe weeding at 20 WAP

Table 7: Effect of weeds infestation on sugarcane tillering ability (tillers/plot)

Treatment	Plant crop, 2009	Plant crop, 2010	Ratoon crop, 2011	Plant crop, 2011
Variety				
B47419	139	61	101	57
Co 62175	112	56	78	58
Co 957	148	59	118	51
ILS-001	131	56	90	85
ILS-002	178	46	91	62
Sed	25.52	6.61	24.28	12.36
Weeding Regime				
NHW	56d	37d	68b	17c
MHW	259a	93a	169a	145a
HW4	202b	60b	101b	61b
HW8	135c	48c	84b	52b
HW12	142c	48c	72b	52b
HW20	56d	49c	80b	49b
Sed	22.14	4.79	24.20	11.73
ANOVA				
Replication	135902	204	11179	6489
Variety	10428	597	3454	2987
Residual	5862	393	4074	1375
Weeding Regime	96611**	5661*	21239*	27937*
Interaction	2193	511	5048	1460
Residual	3677	185	4392	1032

NHW =no hoe weeding, MHW= monthly hoe weeding, HW4= hoe weeding at 4 WAP, HW8= hoe weeding at 8 WAP, HW12= hoe weeding at 12 WAP, HW20= hoe weeding at 20 WAP

Table 8: Interaction between sugarcane variety with weeding regime on mean cane yield (t/ha)

	Weeding Regime						
VARIETY	HW12	HW20	HW4	HW8	MHW	NHW	
			Plant Crop of 2009				
B47419	0.93	0.49	1.11	2.69	39.98	0.24	
Co61275		0.53	0.82	1.74	1.78	34.93	0.42
Co957	0.92	0.42	1.36	3.03	60.32	0.25	
ILS 001	0.99	0.61	0.34	0.97	41.50	0.00	
ILS 002	1.83	0.67	0.90	3.90	36.61	0.67	
	Sed					3.59	
			Plant Crop of 2010				
B47419	0.54	0.60	0.98	1.36	34.62	0.49	
Co61275		0.56	0.92	0.88	0.66	48.81	0.20
Co957	0.93	0.13	0.82	2.22	72.54	0.18	
ILS 001	0.88	0.53	1.71	1.81	50.70	0.78	
ILS 002	0.75	0.46	1.62	1.64	55.14	0.51	
Sed			4.60				
			Plant Crop of 2011				
B47419	1.03	0.88	1.85	4.74	32.85	2.27	
Co61275		1.00	0.56	2.94	5.96	22.61	0.07
Co957	1.21	0.98	1.23	6.07	63.07	0.15	
ILS 001	1.93	1.15	1.39	2.15	34.07	0.99	
ILS 002	1.99	0.06	1.37	2.17	42.72	0.72	
	Sed					7.79	
			Ratoon Crop of 2011				
B47419	1.07	1.51	3.54	3.05	34.37	0.19	
Co61275		0.48	1.79	4.16	7.09	26.37	0.31
Co957	1.07	1.96	2.90	2.63	48.12	0.68	
ILS 001	1.14	1.34	1.52	3.28	47.19	0.29	
ILS 002	0.82	1.01	1.43	2.09	36.45	0.29	
	Sed					4.24	

NHW =no hoe weeding, MHW= monthly hoe weeding, HW4= hoe weeding at 4 WAP, HW8= hoe weeding at 8 WAP, HW12= hoe weeding at 12 WAP, HW20= hoe weeding at 20 WAP

Table 9: Coefficient of correlation for weed parameters and tiller count with cane yield

	Dependent variable (Cane Yield t/ha)			
Independent variables	2009 cane yield	2010 cane yield	2011 Ration cane yield	2011 Cana yield
Weed density @16 WAP	-0.1456ns(7.89)	-0.2827*(5.20)	-0.3852*(11.8)	-0.2876**(10.0)
Weed density@20 WAP	-0.6235**(6.23)	-0.3165*(5.14)	-0.4272ns(12.3)	-0.0147**(9.83)
Weed density@40 WAP	-0.6337**(6.17)	-0.2143*(5.29)	-0.5015**(11.4)	-0.3793**(9.40)
Weed biomass@12 WAP	0.5463**(6.68)	0.5014**(4.69)	-0.2886*(11.9)	-0.2512* (10.4)
Weed biomass@16 WAP	-0.0768ns(7.95)	-0.1897ns(5.32)	-0.3266ns(12.3)	-0.0416ns (10.3)
Weed biomass@20 WAP	0.2701*(7.67)	-0.1258ns(5.38)	-0.5587ns(12.2)	-0.1485**(10.1)
Weed biomass@30 WAP	-0.1971*(7.81)	-0.2815*(5.20)	-0.4487**(10.7)	-0.4960**(9.71)
Weed biomass@40 WAP	-0.4930**(6.93)	-0.3113*(5.15)	-0.4732ns(12.2)	-0.1517**(9.58)
Tiller count @12 WAP	0.4502**(7.12)	0.6884**(3.93)	0.5147*(11.9)	0.2504**(9.32)
Tiller count @16 WAP	-	0.6786**(3.98)	0.5221**(11.3)	0.3876**(9.27)
Tiller count @30 WAP	-	0.6884**(3.93)	0.6218**(11.5)	0.3569**(8.51)
Tiller count @40 WAP	0.5738**(6.53)	0.7200**(3.76)	0.6252**(8.06)	0.7552**(8.48)

*significant at 0.05, **significant at 0.01, ns = non-significant, standard error in parenthesis, - missing data