

INFLUENCE OF LAND USE INTENSITY AND WEED MANAGEMENT PRACTICE ON FIELD EMERGENCE, CHARACTERIZATION AND GROWTH OF WEEDS IN SOUTHERN GUINEA SAVANNA OF NIGERIA

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Abstract

The effects of land use intensity and weed management practice on weed seedling emergence, growth and characterization of weed species were examined at Ilorin, in the southern Guinea savanna of Nigeria. The study was conducted on three pieces of land with known cropping history, laid out as randomized complete block design with split-plot arrangement and three replicates. The main plots consisted of two cropping systems (sole maize and no cropping in continuously cultivated maize field, sole cowpea and no cropping in continuously cultivated cowpea field and sole maize, sole cowpea and no cropping in natural fallow field) while the sub plots consisted of three weed control methods (chemical weed control, hand hoeing at 3 and 6 weeks after planting and no weed control). Annual broadleaf weeds were most prevalent across the trial fields and constituted above 60 % of the total weed population. *Cleome vicosa* L., *Euphorbia heterophylla* L., *Passiflora foetida* L., *Tridax procumbens* L., *Fimbristylis littoralis* Gaudet and *Rottboellia cochinchinensis* (Lour.) Clayton were prevalent at continuously cultivated fields, *Pycereus lanceolatus* (poir) C.B.Cl, *Phyllanthus amarus* Schum & Thonn. and *Mariscus alternifolus* Vahl had high frequency of occurrence at the natural fallow fields while *Cyprus tuberosus* Roth was prevalent in all the sampled fields. In all, the frequency of occurrence of weeds was high at the continuously cultivated fields. Land use showed a pattern of increasing weed density in response to increasing land use intensity. These results show that intensive land use increases weed problems on farmers' fields. The implication of the result on weed management is discussed.

Keywords: Land use, weed emergence, sole maize, sole cowpea, follow

Introduction

In the West African savanna, the bulk of crop production is undertaken by small-scale farmers whose labour force, management practice and capital input originate from the household. Farmers in this region are faced with problems of increased land use and reduced fallow periods as a result of increased human population (Fadayomi *et al.*, 2005; Ekeleme *et al.*, 2003) resulting in negative consequences such as soil degradation, loss of soil nutrients (Kang *et al.*, 1997) and high weed pressure (Roder *et al.*, 1997).

The traditional shifting cultivation where farmers slash-down and burn the fallow vegetation, cultivate the land for a few years and then abandon the site for 5 to 7 years to allow the vegetation to regenerate and aid to keep pest population at low levels (De Rouw, 1995) is no longer sustainable (Ekeleme and Chikoye, 2003). Instead, continuous cropping with little or no fallowing period is gradually replacing the age-long traditional mode of farming (Ajiboye *et al.*, 2002). This has resulted in systematic degradation of arable land and the accompanying decline in the productive capacities of such land, and low crop yields.

The adaptation of weed populations to continuous cropping is due to a consistently hospitable environment for weeds that have phenological and physiological similarities to the crop. The continuous cropping sequences in the mid-western U.S.A. for instance, select for these annual weeds as the length of the growing season of these crops allows these weeds to avoid control measures and complete their life cycle (Murphy and Lemerle, 2006). This study is aim to examine the impact of previous land use intensity on characterization of weed infestation.

Materials and Methods

This study was conducted during the 2009 and 2010 growing seasons at the Institute of Agricultural Research & Training, Obafemi Awolowo University, Ile Ife, southern Guinea savanna substation, Ballah, Nigeria.

The study was conducted on three pieces of land with known cropping history, which had been under continuous cropping of either sole maize, sole cowpea or had been under natural fallow for at least 5 years. The study was laid out as randomized complete block design with split-plot arrangement. The experiment was designed as a randomized complete block with a split-plot arrangement and three replicates. The main plots consisted of seven cropping systems (sole maize and no cropping in continuously cultivated maize field, sole cowpea and no cropping in continuously cultivated cowpea field and sole maize, sole cowpea and no cropping in natural fallow field) while the sub plots consisted of three weed control methods {chemical weed control: pre-emergence application of Primextra Gold^(R) [a proprietary mixture of metolachlor (2-chloro-N-(2-ethyl-6-methylphenyl)-N-(2-methoxy-1-methyl-ethyl)acetamide) (290g/L) and atrazine (6-chloro-N-ethyl-N9-(1-methylethyl)-1,3,5-triazine-2,4-diamine) (370g/L)] at 2.5 kg ai/ha to the sole maize and pre emergence application of pendimethalin [N-(1-ethylpropyl)-3,4-dimethyl-2,6-dinitrobenzenamine] at 1.5 kg ai/ha to sole cowpea, hand hoeing at 3 and 6 weeks after planting and no weed control}.

Weed seedling emergence was assessed continuously at 3, 6, 9, and 12 WAP from two permanent quadrats measuring 0.5 m², established in each plot immediately after planting the crops. On each sampling date, weed types were identified to species level, counted and pulled out after enumeration for biomass determination.

Data collected on weed seedling emergence (density) and weed dry matter production were subjected to ANOVA using Gen Stat statistical package (Discovery Edition 3) and where F-ratios were significant ($P \leq 0.05$), means were separated using the Least Significant Difference.

Frequency of occurrence for weed species was calculated as the percentage of plots where a certain weed species was present (Weber *et al.*, 1995).

Results

Weed species composition

Forty weed species belonging to 35 genera within 15 families were enumerated during the 2009 and 2010 cropping seasons on the experimental sites (Table 1). Annual weed species accounted for 60 % of the weed flora, 32.5 % were perennials and 7.5% were annuals/ perennials. The weed spectrum encountered, consisted of 62.5 % broadleaves, 27.5 % grasses and 10 % sedges.

Twenty-two weed species that had frequency of occurrence of 5 % and above were identified and thereafter referred to as prevalent weed species on the experimental fields during the two years (Table 2). Thirteen of the prevalent weed species were broadleaves, 5 were grasses while 4 were sedges. Although the broadleaved weeds were the most diverse, belonging to 7 families and 11 genera, they had moderate abundance and were all annuals except *Diodia scandens* and *Boerhevia diffusa* that are perennials. The grasses, which had the lowest abundance belonged to 5 genera/species and were made up 3 annuals and 2 perennials. Four species of sedges, belonging to the family of Cyperaceae were enumerated. The sedges were all perennials, except *Fimbristylis littoralis*, and had they had a relatively high occurrence on the natural fallow fields. In the continuously cultivated maize fields, three annual weed species (*Euphorbia heterophylla*, *Tridax procumbens* and *Cleome viscosa*) dominated the weed flora while *Euphorbia heterophylla*, *Passiflora foetida* and *Cleome viscosa* were more in abundance under the continuously cultivated cowpea fields in both years.

The natural fallow plots were dominated by perennial weed species. The sole maize plots on the natural fallow field had *Cyperus tuberosus*, *Diodia scandens*, and *Mariscus alternifolus* as the three most abundant weed species in 2009 while in 2010, the sedges (*Cyperus tuberosus*, *Mariscus alternifolus* and *Pycnus lanceolatus*) dominated the field. The sole cowpea plots cultivated on the natural fallow field had *Euphorbia hirta*, *Cleome viscosa* and *Boerhevia diffusa* as the three most abundant weed species in 2009 while *Cyperus tuberosus*, *Mariscus alternifolus* and *Croton lobatus* were most abundant in the 2010 growing season.

Weed seedling population.

The emergence of weed seedling was significantly affected by current cropping system on different land use intensity at all sampling periods in both years (Table 3). The natural fallow fields had

significantly lower weed population. There were similar with maize plots under continuous maize field except at 9 and 12WAP, in 2009 growing season. The cowpea plots in the continuous cowpea field had significantly higher emerged weed seedlings in both years. Similarly, weed management practice significantly influenced emergence of weed seedling except at 12 WAP in 2010. Herbicide treated plots had significantly lower emerged weed seedlings in both years except at 9 WAP in the 2009 season. Hand weeded plots were similar to herbicide treated plots at 6 and 12 WAP in 2009 while in 2010, those plots had similar weed population with unweeded control plots. The latter plots had significantly higher emerged weed

Seedlings in both years except at 3 WAP in the 2009 growing season. The interaction effects between cropping system and weed management practice were significant at 9 and 12 WAP in 2009 growing season (Fig. 1).

Significant higher weed seedling population was observed under unweeded control in the continuously cultivated cowpea field while significantly lower weed density were obtained in the natural fallow fields.

Weed morphological groups

The emergence of broadleaved weed seedlings was significantly by the current cropping system established on different land use intensity (Table 4). In 2009, natural fallow fields had significantly lower broadleaves population at 3 and 6 WAP compared to the continuously cultivated fields but at 9 and 12 WAP, a similar population of broadleaf seedlings were obtained under sole maize in the continuous maize fields and the natural fallow fields while the sole cowpea in the continuous fields had significantly higher broadleaved weed population. Significant interactions were observed between cropping system and weed control at 9 and 12 WAP (Fig. 2). Significant higher broadleaf weed seedling population was observed under unweeded control in the continuously cultivated cowpea field while significantly lower weed density were obtained in the natural fallow fields. In the 2010 growing season, sole maize in the natural fallow fields had significantly lower broadleaved weed density at 3 and 6 WAP while other cultivated plots in the natural fallow field had similar broadleaved seedling as in sole maize in the continuous maize fields but at 9 and 12 WAP, similar population of broadleaved weed seedlings were obtained under the natural fallow fields and continuously cultivated maize fields. The continuously cultivated cowpea fields had significantly higher broadleaved seedlings at all sampling periods. Conversely, weed management practice did not significantly affected emergence of broadleaves except in all sampling periods in 2009 and at 9 WAP in the 2010

growing season. Herbicide treated plots had significantly lower broadleaved weeds, similar to unweeded control plots at 6 WAP in both years and, hand weeded plots at 9 and 12 WAP.

The emergence of grass weed seedlings was significantly influenced by current cropping system established on different land use intensity (Table 5). In 2009, continuously cultivated cowpea fields had significantly lower population of grasses that were similar to the natural fallow fields except at 6 WAP where a relatively higher grasses emerged on the former fields. Continuously cultivated maize fields had significantly higher population of grasses at 3 and 12 WAP while at 9 WAP, the

natural fallow field had relatively higher grass seedlings. Significant interactions were observed between cropping system and weed control treatment in all sampling periods (Fig. 3). The continuously cultivated fields had significantly higher grass seedling population while natural fallow fields had relatively lower grass population across weed control practices. In 2010, significantly higher grass seedlings emerged from continuously cultivated maize fields, similar to sole maize in the natural fallow fields at 3 WAP and uncropped continuously cultivated cowpea fields, sole maize and uncropped natural fallow fields at 9 WAP. At 12 WAP, continuously cultivated maize fields and the natural fallow fields had similar grass density and was significantly lower compared to grass population obtained under the continuously cultivated cowpea fields. The effect of weed management practice on emergence of grass seedlings was significant in all sampling periods in 2010 except at 3WAP and at 9 and 12 WAP when the two year data were combined. In all cases where significant differences were observed, herbicide treated plots had significantly lower population of grasses compared to other two plots that had similar grass seedlings population. The interaction between cropping system and weed control was significant at 6WAP (Fig. 3) where continuously cultivated fields had significantly higher grass seedling population while natural fallow fields had relatively lower grass population across weed control practices.

Emergence of sedge weed seedlings was significantly affected by current cropping system established on different land use intensity except at 6 WAP in 2009 and 6 and 9 WAP in 2010 (Table 6). The continuously cultivated maize fields had relatively lower population of emerged sedge seedlings in both years except at 12 WAP in 2010 where continuously cultivated cowpea fields had significantly lower sedge seedling although similar to what was obtained under continuously cultivated maize fields. The sole maize and uncropped natural fallow fields had similar and significantly higher sedge seedlings compared to other plots. The effect of cropping system when the two year data were combined was only significant at 3 WAP and a similar pattern was observed as in 2010 at the same sampling period.

The effect of weed management practice on emergence of grass seedlings was significant in all sampling periods except at 9 WAP in 2010. Herbicide treated plots had significantly lower population of grasses similar to what was obtained in hand weeded plots in 2009 except at 3WAP while the unweeded control plots had significantly higher sedge seedlings population that was similar to hand weeded plots in 2010 except at 6 WAP. No significant interaction was observed in both years.

Weed biomass

Weed dry matter production was significantly affected by the current cropping system as influenced by land use intensity in both years (Table 7). Uncropped plots in the continuously cultivated cowpea fields had significantly higher weed dry matter although similar at 3 WAP in both years with what was obtained under the sole cowpea plots in the continuously cultivated cowpea fields. The continuously cultivated maize fields had significantly lower weed biomass similar to natural fallow fields in both years except at 3 WAP in 2009.

In like manner, weed management practice significantly affected production of weed dry matter. Herbicide treated plots had significantly lower weed biomass in both years except at 9 and 12 WAP in 2009 where hand weeded plots had relatively lower weed biomass compared to the other two plots. The unweeded control plots had significantly higher weed biomass in both years followed by hand weeded plots except at 3WAP in 2009 where the two plots had similar weed dry matter.

The interactions between cropping system and weed control practice were significant in all sampling periods in both years except at 6 WAP in 2009 (Fig. 4 and 5). The unweeded control in the continuously cultivated cowpea fields had significantly higher weed biomass in both years which was similar to the hoe weeded plots in the same land use intensity. The natural fallow fields and continuously cultivated maize field had similar weed biomass across the weed control practices.

Discussion

Weed species composition differed with year, greatly and closely linked to the cropping history of the fields. *Cleome vicosa*, *Euphorbia heterophylla*, *Passiflora foetida*, *Tridax procumbens*, *Fimbristylis littoralis* and *Rottboellia cochinchinensis* occurred in continuously cultivated fields, *Pycereus lanceolatus* and *Phyllanthus amarus* were enumerated in maize plots in natural fallow field, *Mariscus alternifolus* specifically adapted to natural fallow fields in respective of the cultivated crop while *Cyprus tuberosus* was prevalent in all the sampled fields. These observation confirm earlier reports by Zimdahl *et al.* (1988) and Ekeleme *et al.* (2004) that tropical soils contain high population of weed seeds that are composed of a few dominant species and many other minor species present in low numbers.

Annual broadleaf weeds were most prevalent across the trial fields and constituted above 60 % of the total weed population. This is in agreement with the findings of Sibuga and Nzuku (2007) in Tanzania who reported 71 % population of broadleaf weed composition under continuously cultivated and natural fallow lands. Rahman *et al.* (2004) also reported that, broadleaf weeds dominated 20 of the 30 maize fields enumerated in Palmer stun North, New Zealand while Ekeleme *et al.* (2004) reported that 53 % of the total seedling density per plot were annual broadleaf weeds enumerated over 6 years. Annual weed species dominated the continuously cultivated fields while greater percentage of perennial weed species were encountered in the natural fallow field as compared to the former fields. Annual weeds, according to Clements *et al.* (1996) are adapted to succeed in highly unstable and unpredictable environments brought about by frequent tillage, drought or other disturbances. These weed types put much of their life cycle into making seeds for the next generation. This survival strategy serves annual weeds well in the disturbed environment, since their environment is likely to be disturbed again (Becker, 1996). The perennial weed species in the other hand, prosper on less-disturbed and more stable environments. They are more common under no-till cropping system (Clements *et al.*, 1996).

Overall, the frequency of occurrence of weeds was high at the continuously cultivated fields. This could be due to the influence of farming practices on quantity of seeds removed and returned to

the soil. The frequency of soil disturbance through tillage operations, hoe weeding and environmental factors might explain the variation in weed dominance (Mulegeta and Stoltenberg, 1997).

At the initiation of the study, 2009, the seedling community was dominated by annual weeds across the land use intensities while the second cropping season showed a substantial increase in perennial weed seedlings especially under the natural fallow fields and significant increase in total weed population. The increasing weed population in the continuously cultivated fields may be attributed to higher seedbank and seed return at the end of each cropping year while the cultivation activities in the natural fallow fields disrupted weed seed dormancy induced by the long fallow period, this could be the reason for increased weed seedling population in the 2010 growing season in the natural fallow fields. Ekeleme *et al.* (2000) found that weed seed rain was more in continuous cropping than in crop-fallow rotations while Szott *et al.* (1991) and later Ekeleme *et al.* (2004), reported that weed seedbank is usually low in the season after opening field that has been under long fallow and this could translate into low weed density in that season.

Land use showed a pattern of increasing weed density in response to increasing land use intensity. Continuously cultivated monoculture fields showed more annual weeds especially broadleaves, but perennial grass weeds were more abundant in long natural fallow fields. Cereal crops grown continuously for several years, select for grass weeds and broadleaf weeds tend to increase in continuous broadleaf crops such as legume crop (Blackshaw, 1994). Owen (1998) reported that, continuous maize or maize-soybean intercropping resulted in the proliferation of aggressive annual weeds.

Conclusion

These results show that intensive land use increases weed problems on farmers' fields. Long and diverse cropping with careful weed control systems could be fundamental strategy in sustainable and ecological crop production systems. Therefore, both cropping system and land use strategies are fundamentally significant considerations in the development of sustainable and environmentally safe strategies for weed control.

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Table 1 **Effect of previous land use intensity and current cropping system on the occurrence of weed species**

Frequency of Occurrence (%) under different land use										
Weed Species			CSMZ		CSCP		FSMZ		FSCP	
Family	Species	LC/M	2009	2010	2009	2010	2009	2010	2009	2010
Asteraceae	<i>Ageratum conyzoides</i> L.	AB	-	-	-	-	0.61	-	-	-
	<i>Aspilia africana</i> pers C.D.Adams	PB	-	1.14	-	-	7.07	1.44	3.36	1.15
	<i>Tridax procumbens</i> L.	AB	13.58	9.91	6.31	7.27	2.16	-	2.16	-
	<i>Chromoleana odorata</i> (L.) R.M.King	PB	0.73	-	-	-	0.19	-	-	-
Cleomaceae	<i>Cleome rutidosperma</i> DC	AB	-	0.83	-	-	-	2.94	1.46	2.04
	<i>C. viscosa</i> L.	AB	6.81	5.84	22.18	9.46	1.63	1.82	16.77	2.78
Commelinaceae	<i>Commelina benghalensis</i> L.	APB	1.69	1.22	-	2.46	0.98	1.82	5.43	1.51
Convovulaceae	<i>Ipomoea involucrata</i> P. Beauv	APB	-	0.87	-	-	-	-	2.19	-
	<i>I. vagans</i> Bak	AB	-	-	-	-	-	-	-	1.14
Cyperaceae	<i>Cyperus tuberosus</i> Rotth	PS	9.32	8.46	4.97	5.08	10.07	21.62	-	29.09
	<i>Fimbristylis littoralis</i> Gaudet	AS	5.24	-	5.12	1.99	-	-	-	-
	<i>Mariscus alternifolus</i> Vahl	PS	-	8.29	-	2.40	9.54	19.29	6.56	16.24
	<i>Pycereus lanceolatus</i> (poir) C.B.Cl	PS	1.74	-	-	1.86	8.73	15.66	-	-

Euphorbiaceae	<i>Euphorbia heterophylla</i> L.	AB	13.94	15.41	15.32	21.89	-	-	-	-
	<i>E. hirta</i> L.	AB	-	-	2.30	2.22	0.58	2.41	18.01	-
	<i>E. hyssopifolia</i> L.	AB	0.83	-	5.55	7.27	-	2.58	2.01	5.59
	<i>Croton lobatus</i> L.	AB	2.81	1.83	-	2.35	0.51	4.46	1.98	11.67
	<i>Phyllanthus amarus</i> Schum & Thonn.	AB	2.62	1.16	2.56	2.15	9.39	6.21	4.51	5.23
Fabaceae	<i>Tephrosia bracteolata</i> Guill. & Perr.	AB	1.50	1.26	0.89	-	0.25	0.69	-	1.04
Malvaceae	<i>Sida rhombifolia</i> L.	PB	-	-	-	-	-	0.38	-	0.38
Nyctaginaceae	<i>Boerhevia coccinea</i> Mill	PB	-	1.67	0.99	-	0.61	-	10.22	-
	<i>B. diffusa</i> L.	PB	0.47	2.66	4.63	3.13	-	-	-	-
Passifloraceae	<i>Passiflora foetida</i> L.	AB	7.89	6.18	13.72	18.90	4.95	-	1.74	-
Poaceae	<i>Brachiaria deflexa</i> (Schumach)	AG	3.17	2.27	-	1.34	-	-	-	-
	C.E.Hubbard ex Robyns									
	<i>Cynodon dactylon</i> (L.) Pers.	PG	-	-	-	1.29	4.00	2.17	-	5.36
	<i>Dactyloctenium aegyptum</i> (L.)	APG	3.66	-	4.66	-	-	-	-	-
	<i>Digitaria horizontalis</i> Willd.	AG	2.93	4.75	-	0.56	-	-	-	-
	<i>Eleusine indica</i> Gaertn	AG	3.79	4.21	5.80	1.77	-	2.58	-	2.88

	<i>Hypparhenia involucrata</i> Stapf	AG	-	3.22	-	-	9.08	1.18		
	<i>Imperata cylindrica</i> (Anderss.) C.E. Hubbard ex Robyns	PG	2.01	1.49	-	0.72	6.99	0.26	2.99	0.24
	<i>Panicum maximum</i> Jacq	PG	0.05	-	-	-	-	2.09	-	2.11
	<i>Paspalum orbiculare</i> Forst	PG	-	-	-	-	-	1.53	-	1.31
	<i>Rottboellia cochinchinensis</i> (Lour.) Clayton	AG	5.60	5.54	2.50	2.15	8.57	4.19	8.57	4.19
	<i>Seteria barbata</i> (Lam) Kunth	AG		-	2.76	-	-	-	-	-
Portulacaceae	<i>Portulaca oleracea</i> L.	AB	2.32	4.79	2.50	2.15	0.08	1.14	0.08	1.65
Rubiaceae	<i>Diodia scandens</i> SW	PB	-	1.84	-	-	9.60	3.51	2.60	3.21
	<i>Mitracarpus villosus</i> (SW) DC	AB	3.42	1.88	-	1.59	4.07	-	8.48	-
	<i>Oldenlandia corymbosa</i> L.	AB	1.03	1.24	-	-	-	-	-	-
Solanaceae	<i>Physalis angulata</i> L.	AB	1.87	-	-	-	-	-	-	-
Verbenaceae	<i>Vernonia galamensis</i> (Cass.) Less	AB	-	-	-	-	0.35	-	-	-

CSMZ= maize plots in continuous maize field, CSCP= cowpea plots in continuous cowpea field, FSMZ= maize plots in natural fallow field, FSCP = cowpea plots in natural fallow field, CRP = cropped plots, LC = life cycle, M = morphological group, A = annual, P= perennial, B= broadleaved, S= sedge, G= grass

Table 2. Prevalent weed species encountered under various land use intensities in 2009 and 2010.

Weed species		CSMZ		CSCP		FSMZ		FSCP	
Broadleaves	LC/M	2009	2010	2009	2010	2009	2010	2009	2010
<i>Aspilia Africana</i>	PB	-	-	-	-	7.07	-	-	-
<i>Boerhevia diffusa</i>	PB	-	-	-	-	-	-	10.22	-
<i>Cleome viscosa</i>	AB	13.56	9.19	22.18	9.46	-	-	16.77	-
<i>Commelina benghalensis</i>	APB	-	-	-	-	-	-	5.43	-
<i>Croton lobatus</i>	AB	-	-	-	-	-	-	-	11.67
<i>Diodia scadens</i>	PB	-	-	-	-	9.60	-	-	-
<i>Euphorbia heterophylla</i>	AB	13.94	15.41	15.32	21.89	-	-	-	-
<i>E. hirta</i>	AB	-	-	-	-	-	-	18.01	-
<i>E. hyssopifolia</i>	AB	-	-	5.55	7.27	-	-	-	5.59
<i>Mitracarpus villosus</i>	AB	-	-	-	-	-	-	8.48	-
<i>Passiflora foetida</i>	AB	7.89	6.18	13.72	18.90	-	-	-	-
<i>Phyllantus amarus</i>	AB	-	-	-	-	9.39	6.24	-	5.23
<i>Tridax procumbens</i>	AB	13.56	9.19	6.31	7.27	-	-	-	-
Grasses									
<i>Cynodon dactylon</i>	PG	-	-	-	-	-	-	-	5.36
<i>Eleusine indica</i>	AG	-	-	5.80	-	-	-	-	-
<i>Hypparhenia involucrata</i>	AG	-	-	-	-	9.08	-	-	-
<i>Impereta cylindrica</i>	PG	-	-	-	-	6.92	-	-	-
<i>Rottboellia cochinchinensis</i>	AG	5.60	5.54	-	-	8.57	-	8.51	-

Sedges*Cyperus tuberosus*

PS	9.32	8.40	-	5.08	10.07	21.62	-	29.09
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*Fimbristylis**littoralis*

AS	5.24	-	5.12	-	-	-	-	-
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*Mariscus**alternifolus*

PS	-	8.29	-	-	9.54	19.29	6.56	16.24
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Pycnus lanceolatus

PS	-	-	-	-	8.73	15.66	-	-
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CSMZ= maize plots in continuous maize field, CSCP= cowpea plots in continuous cowpea field, FSMZ= maize plots in natural fallow field, FSCP = cowpea plots in natural fallow field, CRP = cropped plots, LC = life cycle, M = morphological group, A = annual, P= perennial, B= broadleaved, S= sedge, G= grass

Table 3. Effect of previously land use intensity, current cropping system and weed management practice on weed seedling population in 2009 and 2010.

Treatment	2009				2010			
	Weeks after planting (WAP)				Weeks after planting (WAP)			
Cropping system (CS)	3	6	9	12	3	6	9	12
	no/m ²				no/m ²			
SMZ in CSMZ	329	92	42	27	375	326	188	130
NCRP in CSMZ	275	92	41	28	407	347	212	133
SCP in CSCP	211	175	152	91	1217	590	386	330
NCRP in CSCP	198	157	143	83	979	540	490	341
SMZ in NFF	58	54	84	54	328	175	149	100
SCP in NFF	43	57	32	14	321	249	208	120
NCRP in NFF	62	60	70	38	352	239	214	124
Sed	47.72	22.91	11.73	5.24	131.33	64.52	59.63	41.44
LSD(0.05)	96.00	46.28	23.74	10.39	264.30	129.70	120.00	83.30
Weed control (WC)								
CWC	90	77	71	35	408	248	171	155
HWC	210	84	56	36	569	359	323	180
NWC	165	199	110	70	647	406	279	191
Sed	29.23	14.16	7.23	3.22	80.46	39.54	36.54	25.43
LSD(0.05)	58.80	28.34	14.54	6.36	161.90	79.50	73.50	NS
Interaction								
CS x WC	NS	NS	*	*	NS	NS	NS	NS

WAP = weeks after planting, SMZ = sole maize, CSMZ = continuously cultivated maize field, SCP = sole cowpea, CSCP = continuously cultivated cowpea field, NFF = natural fallow field, NCRP = no cropping (uncropped plot), CWC = chemical weed control, HWC = hand weeded control, NWC = no weed control.

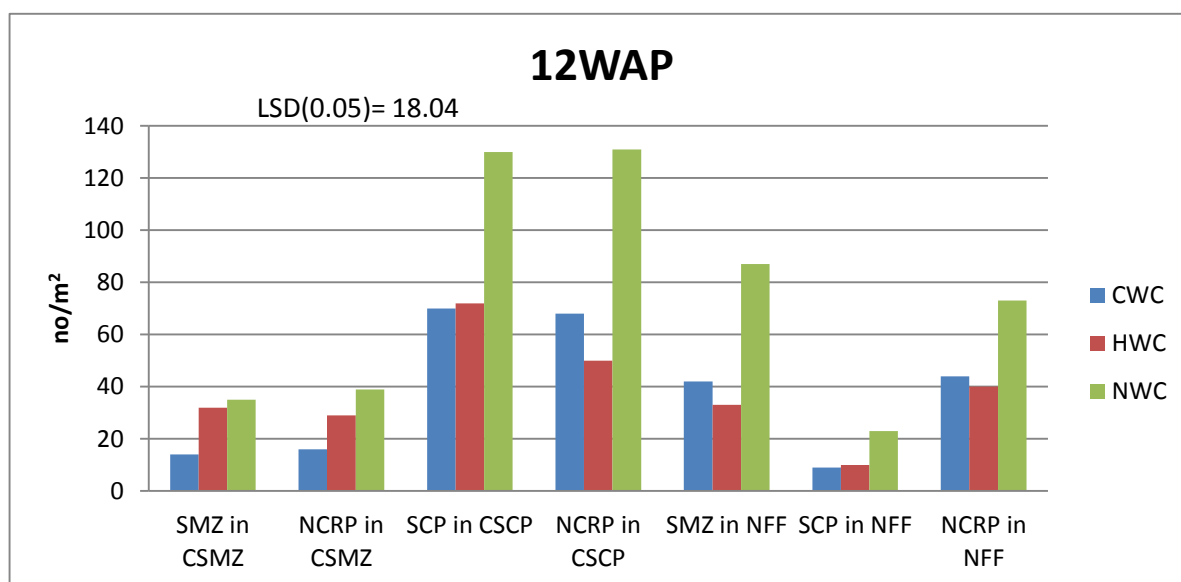
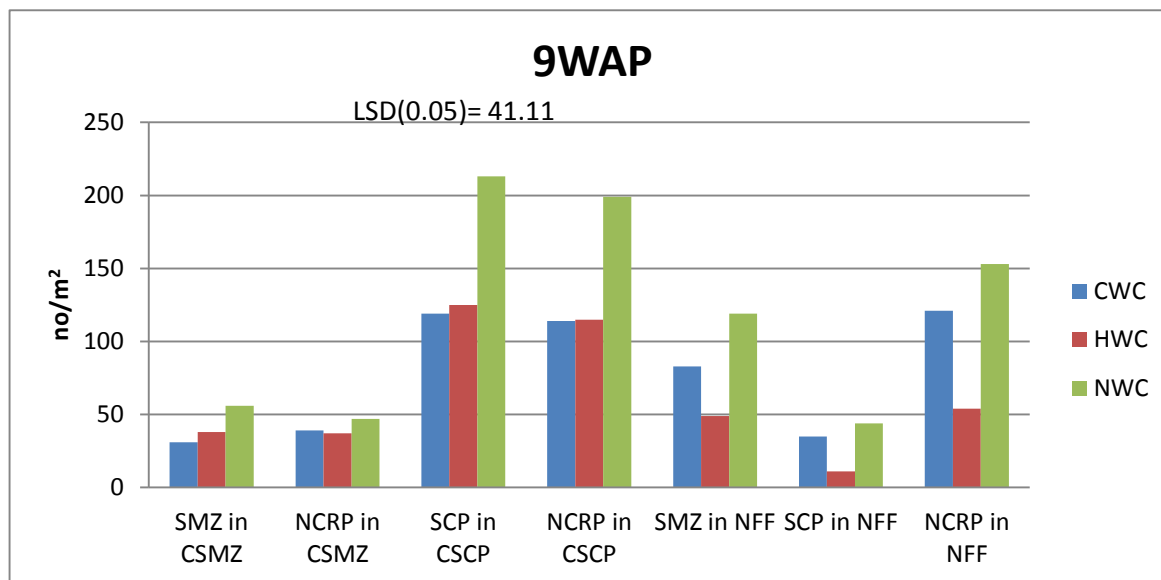


Figure 1. Interaction effect between land use intensity/cropping system and weed management practice on weed seedling population in 2009.

Table 4. Effect of previously land use intensity, current cropping system and weed management practice on broadleaf weed seedling population (no/m²) in 2009 and 2010.

Treatment	2009				2010			
	Weeks after planting (WAP)				Weeks after planting (WAP)			
Cropping system(CS)	3	6	9	12	3	6	9	12
SMZ in CSMZ	174	145	30	15	232	146	112	89
NCRP in CSMZ	143	123	30	17	234	165	129	92
SCP in CSCP	166	141	136	84	1078	420	300	227
NCRP in CSCP	145	129	128	75	804	413	375	290
SMZ in NFF	15	16	62	37	76	32	69	44
SCP in NFF	17	27	17	7	228	123	124	78
NCRP in NFF	22	24	47	26	162	104	134	64
Sed	28.41	33.56	10.28	5.36	124.31	48.14	45.61	37.16
LSD(0.05)	57.23	67.52	20.71	10.86	250.11	96.94	91.83	74.79
Weed control (WC)								
CWC	54	48	58	29	306	161	123	128
HWC	111	105	42	26	376	208	209	120
NWC	99	82	84	54	434	196	169	127
Sed	17.40	20.55	6.30	3.28	76.12	29.54	27.94	22.75
LSD(0.05)	35.04	41.39	12.68	6.61	NS	NS	56.25	NS
Interaction								
CS x WC	NS	NS	*	*	NS	NS	NS	NS

WAP = weeks after planting, SMZ = sole maize, CSMZ = continuously cultivated maize field, SCP = sole cowpea, CSCP = continuously cultivated cowpea field, NFF = natural fallow field, NCRP = no cropping (uncropped plot), CWC = chemical weed control, HWC = hand weeded control, NWC – no weed control.



Figure 2. Interaction effect between land use intensity/cropping system and weed management practice on broadleaf weed seedling population in 2009.

Table 5. Effect of previously land use intensity, current cropping system and weed management practice on grass weed seedling population (no/m²) in 2009 and 2010.

Treatment	2009				2010			
	Weeks after planting (WAP)				Weeks after planting (WAP)			
Cropping system (CS)	3	6	9	12	3	6	9	12
SMZ in CSMZ	55	14	8	9	111	104	40	16
NCRP in CSMZ	56	18	7	10	136	112	45	25
SCP in CSCP	12	27	2	2	52	68	19	43
NCRP in CSCP	9	32	4	2	64	49	43	44
SMZ in NFF	10	13	11	9	98	26	24	15
SCP in NFF	14	13	8	3	53	17	12	7
NCRP in NFF	14	15	10	8	58	20	25	20
Sed	8.35	6.73	2.18	1.28	25.63	15.13	11.33	11.50
LSD(0.05)	16.83	13.55	4.38	2.57	51.58	30.46	22.81	23.14
Weed control (WC)								
CWC	19	17	7	3	58	35	14	12
HWC	16	16	8	7	97	65	38	25
NWC	34	22	7	8	82	57	37	32
LSD(0.05)	10.30	NS	NS	1.57	NS	18.65	13.97	14.17
Interaction								
CS x WC	*	*	*	*	NS	*	NS	NS

WAP = weeks after planting, SMZ = sole maize, CSMZ = continuously cultivated maize field, SCP = sole cowpea, CSCP = continuously cultivated cowpea field, NFF = natural fallow field, NCRP = no cropping (uncropped plot), CWC = chemical weed control, HWC = hand weeded control, NWC – no weed control.

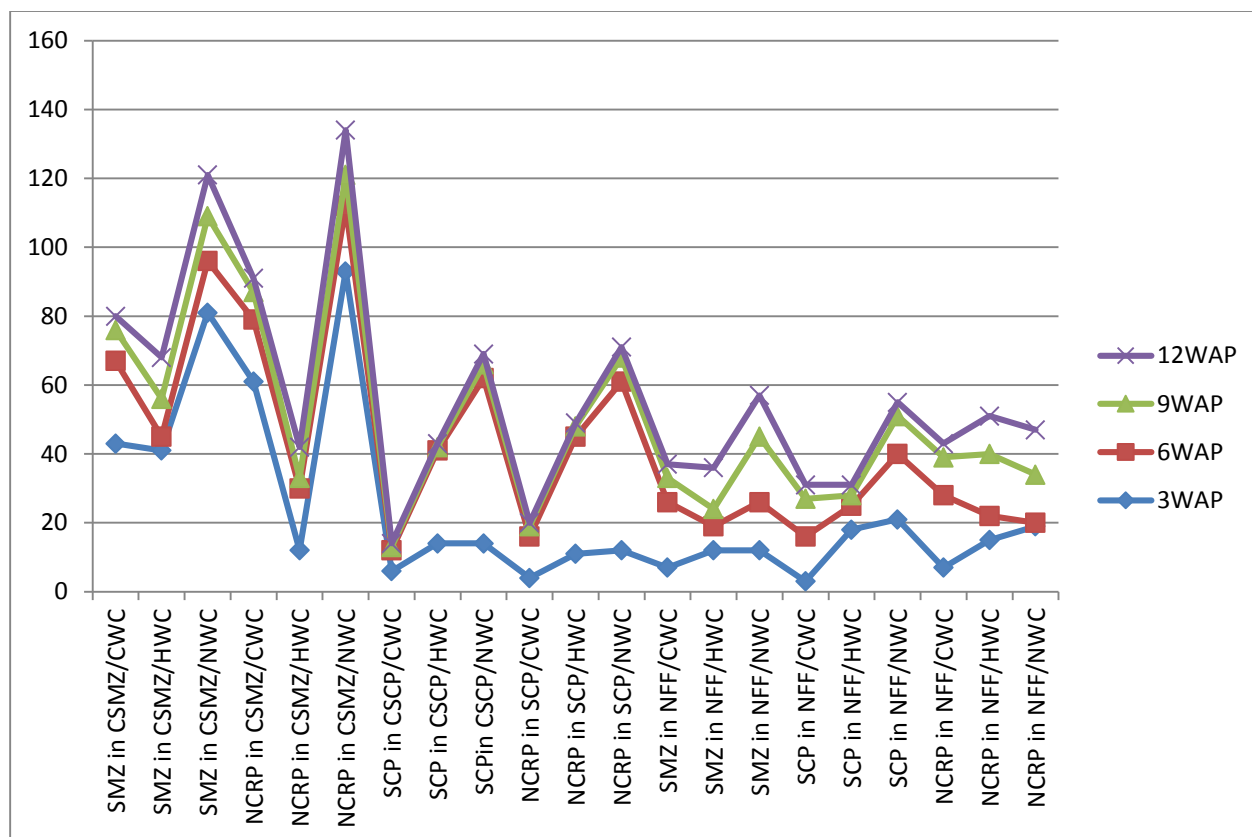


Figure 3. Interaction effect between land use intensity/cropping system and weed management practice on grass weed seedling population in 2009.

Table 6. Effect of previously land use intensity, current cropping system and weed management practice on sedge weed seedling population (no/m²) in 2009 and 2010.

Treatment	2009				2010			
	Weeks after planting (WAP)				Weeks after planting (WAP)			
Cropping system (CS)	3	6	9	12	3	6	9	12
SMZ in CSMZ	10	23	4	2	18	75	36	25
NCRP in CSMZ	9	19	4	2	43	120	38	17
SCP in CSCP	19	22	14	5	95	102	40	4
NCRP in CSCP	18	21	11	4	117	76	71	12
SMZ in NFF	29	24	12	6	161	116	55	41
SCP in NFF	14	14	5	3	54	109	88	36
NCRP in NFF	27	23	14	6	137	142	68	44
LSD(0.05)	17.47	NS	5.68	2.97	58.69	NS	NS	26.34
Weed control (WC)								
CWC	13	15	7	3	49	52	35	14
HWC	29	17	6	3	105	94	65	38
NWC	16	31	16	7	131	147	74	32
LSD(0.05)	10.70	10.30	3.48	1.82	35.94	42.18	28.75	16.13
Interaction								
CS x WC	NS	NS	NS	NS	NS	NS	NS	NS

WAP = weeks after planting, SMZ = sole maize, CSMZ = continuously cultivated maize field, SCP = sole cowpea, CSCP = continuously cultivated cowpea field, NFF = natural fallow field, NCRP = no cropping (uncropped plot), CWC = chemical weed control, HWC = hand weeded control, NWC – no weed control.

Table 7. Effect of previously land use intensity, current cropping system and weed management practice on weed biomass (g/m²) in 2009 and 2010.

Treatment	2009				2010			
	Sampling time (WAP)				Sampling time (WAP)			
Cropping system (CS)	3	6	9	12	3	6	9	12
SMZ in CSMZ	16.84	31.92	18.82	7.90	61.91	47.92	19.11	14.80
NCRP in CSMZ	17.61	34.21	20.20	11.60	117.32	107.10	61.00	22.81
SCP in CSCP	118.54	87.11	70.33	34.50	375.43	260.40	142.09	105.43
NCRP in CSCP	103.82	66.67	103.45	55.54	343.77	304.01	255.23	140.90
SMZ in NFF	29.73	18.80	19.11	13.42	91.32	138.54	24.23	16.57
SCP in NFF	27.73	26.78	15.82	6.38	116.23	74.82	28.83	8.80
NCRP in NFF	33.24	28.10	20.79	12.67	179.43	92.90	38.70	15.61
LSD(0.05)	19.31	20.14	16.20	5.89	74.49	63.94	33.02	18.72
Weed control (WC)								
CWC	10.34	25.73	37.89	17.32	43.90	28.23	16.54	12.36
HWC	69.35	30.20	20.81	12.67	190.67	144.34	80.92	40.24
NWC	63.09	64.65	49.86	28.09	315.56	247.09	130.65	75.11
LSD(0.05)	11.83	12.33	9.92	3.61	45.62	39.16	20.22	11.47
Interaction								
CS x WC	*	NS	*	*	*	*	*	*

WAP = weeks after planting, SMZ = sole maize, CSMZ = continuously cultivated maize field, SCP = sole cowpea, CSCP = continuously cultivated cowpea field, NFF = natural fallow field, NCRP = no cropping (uncropped plot), CWC = chemical weed control, HWC = hand weeded control, NWC – no weed control.

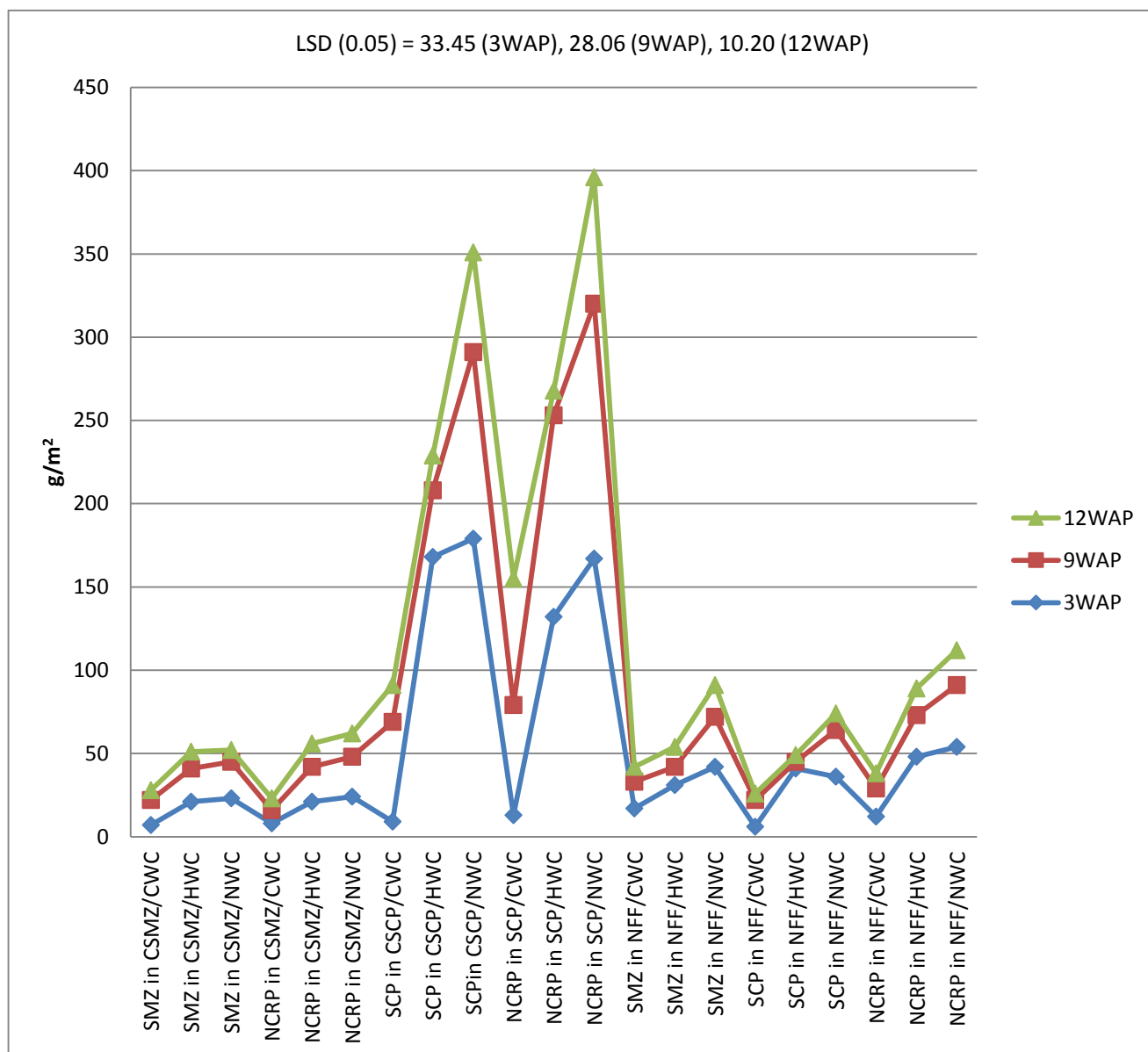


Figure 4. Interaction effect between land use intensity/cropping system and weed management practice on weed biomass in 2009.

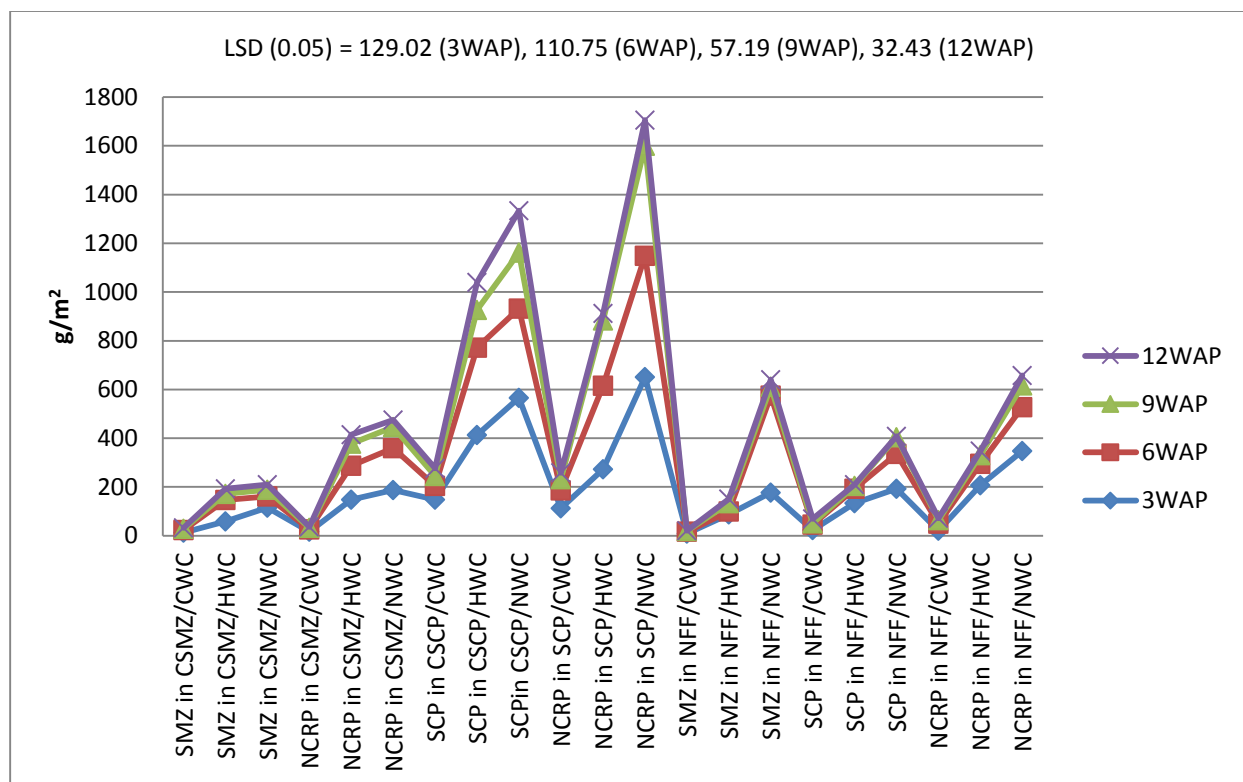


Figure 5. Interaction effect between land use intensity/cropping system and weed management practice on weed biomass in 2010.