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Comparative assessment of three sources of crude cassava water extract as bio-herbicide

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Abstract

Two experiments were conducted at Owode- Ijako in Ogun State, Nigeria between September 2006 and April 2007 to investigate the efficacy of three sources of Crude Cassava Water Extract (CCWE) as post emergence herbicide on weeds of cowpea. The trials were arranged in randomized complete block design and replicated three times. The treatments were 25% and 50% of Bulk sample, MS6 and TMS extracts respectively, and two controls; unweeded and handweeded in each trial. Herbicidal efficacies of CCWE in controlling cowpea weeds were evaluated using phytotoxicity, weed biomass and density. The results showed that spraying CCWE of Bulk and MS6 at 50% on cowpea weed caused 40 and 50% phytotoxicity respectively. There was no significant difference in weed biomass (65.3% and 74.5%) and weed density (79.92 and 80.33) of CCWE of bulk sample and MS6 respectively. Whereas handweeded achieved 98.68% and 96.65% weed biomass and density respectively. The growth attributes such as plant height, number of leaves and leaf area differed significantly due to different treatments. Grain yield and yield components of cowpea were significantly influenced by the application of CCWE from the three sources. Highest grain yield (540kg/ha) was recorded in handweeded plots but was comparable to plots sprayed with 50% CCWE of bulk samples (450kg/ha) and MS6 (430kg/ha) while least grain yield was recorded in unweeded plots.

Key words: Cowpea**,** crude cassava water extract, phytotoxicity, post-emergence herbicide, weed density, weed biomass.

1. Introduction

Cowpea is an important crop for farmers in the West African region, particularly in the dry savannas. It is a short duration crop and therefore highly susceptible to early weed interference of weeds such as *Eleusine indica, Talinum fruticosurps (*Jacq.*)* Wild*, Euphorbia* heterophylla, *Cynodon dactylon, Commelina spp, Aspilia Africana, Imperita cylindrical Chromoleana odorata, Rottboellia cochichinensis, Calopogonium mucunoides* (Akobundu, 1987, Lagoke *et al*., 1994, and Dugje *et al*., 2009). Others are *Portulaca oleracea, Schwenkia americana, Phyllantus amarus and Spigelia anthemia* (Fayinminnu 2010).

The first 3 – 4 weeks of cowpea early growth are critical for weed competition. (Dugje *et al*., 2009). The crop competes with weeds effectively for essential environmental resources, especially nutrients, moisture or water, light and space (Ayeni *et al.,* 1984). Remison (1978) showed that yield components of cowpea were reduced as density of the weed increased. However, several approaches exist for weed control include use of chemicals, cultural (hand weeding), mechanical and biological, land management, use of resistant crop varieties, crop rotation, (Dugje *et al*., 2009) following use of botanicals and allelochemicals.

Crude cassava water extract (CCWE) from processed cassava varieties had been reported by Fayinminnu (1999) to possess phytotoxic activity on weed flora/ vegetation. This is possibly due to the presence of hydrocyanic acid (HCN) in the extract as confirmed by the research work of Fayinminnu (2010). It is however not clear if crude cassava water extracts would be able to suppress/control growth of weeds associated with cowpea. This study therefore was carried out to investigate the effect of crude cassava water extracts in the management of cowpea weeds as a post emergence herbicide.

2. Materials and Methods

2.1. Field experiment

The study was carried out at Ijako – Owode on latitudes $6^0 35^1$N - $6^0 45^1$N and longitudes $2^0 55^1$E - $3^0 15^1$E. It is located in Ado - Odo Ota Local Government Area of Ogun State, a tropical rain forest zone of south west, Nigeria. The experiment was conducted between September 2006 and April 2007. The cowpea seeds were grown at spacing of 30x60cm for 12weeks in each year. The area of land used for the experiment was 540m^2, which was prepared manually. Each experimental plot measured 3m x 3m with 1m and 2m alleys between plots and replicates respectively. Experimental design was a randomized complete block design (RCBD) and replicated three times with eight treatments. The treatments comprised of Bulk, MS6 and TMS at 25 and 50%, of CCWE respectively, a hand weeded and unweeded. Three cowpea seeds of Ife brown variety were sown per hole

but later thinned to one seedling per stand at 2 weeks after sowing (WAS). Insect pests were controlled using Cypermethrin at 1 L/ha beginning from 2 WAS and sprayed at 10 days interval. Crude cassava water extract was applied on the cowpea weeds weekly from 3 - 7 WAS according to Fayinminnu (1999; 2010) using knapsack sprayer CP 15 while hand weeding was done at 3 and 5 WAP.

2.2. Laboratory experiment

Physical and chemical of soil were analysed according to the method of IITA (1982). Crude cassava water extract used for this study was obtained from freshly prepared extracts of two cassava varieties (MS6 and TMS 30555) while Bulk CCWE was obtained from cassava processing sites in Ijako –Owode near the experimental study area. Extraction of crude cassava water extract was prepared by grate-press method and the chemical composition as described by Fayinminnu (2010). Matured fresh cassava tubers were washed peeled and blended into pulp (mashed) within 24 hours in order to prevent denaturing of cassava tubers. The mashed pulp was put in a sterilized muslin sack and placed under a presser, with a bowl placed underneath to collect the water extract from the cassava pulp intermittently for 5 hours. The water extract from the bowl was poured into a calibrated black plastic keg and was tightly closed to prevent volatilization of hydrocyanic acid in the cassava water extract. Sample of serial dilutions of the crude water extract was taken to the Analytical laboratory of Institute of Agricultural Research and Training (IAR&T) Moor Plantation Apata, Ibadan, Nigeria to determine the elemental constituents.

2.3. Data collection

Data collection commenced at three weeks after planting (3WAS) until 12WAS. These sampling periods covered the active vegetative development in cowpea. Growth parameters taken were plant height (cm), number of leaves produced and leaf area (cm^2) at 8WAS.Yield components taken were numbers of pods, pod weight (g), seeds per pod and grain yield (kg/ha) which were obtained from the matured pods from the net plots harvested at 12 WAS. Phytotoxicity on weeds was carried out as visual toxicity rating which was determined using a scale of 0 -10, where `0` indicates no toxicity on weeds and `10` indicates excellent toxicity at 4, 6 and 8 WAS according to criteria developed by Clay and Davison (1978).

Weed control parameters were carried out in a $1.0m^2$ quadrant placed randomly two times at 5m intervals along transects. Samples of weeds within the quadrant were collected, identified and classified based on floral morphology (broad and narrow) prior to crude cassava water extract treatments. The fresh and dry matter production of the weeds was determined at 3, 6, 9 and 12 WAS. The weeds were uprooted and washed thoroughly with clean water. The weeds were dried under natural conditions in the open air for 2 hours. The fresh weight (g/m^2) was taken and the weeds were packed in paper envelope and oven dried at 70^0C until they have attained constant weight. Weed density was also determined at 3, 6, 9 and 12 WAS by counting the number of weeds (no/m^2) in $1.0m^2$ quadrant.

2.4. Statistical analysis

The data collected were analyzed using analysis of variance (ANOVA). Test of significance of the means was by the Duncan Multiple Range Test (DMRT), $P<0.05$ was the criterion for significance.

3. Results

The weeds associated with cowpea production in 2006 and 2007 experiments were shown in Table 1.The weed species in this study were ephemerals which showed that broad leafed constituted about 70% while grasses was 30%. About two different weed species were observed in 2007. This may be due to the seed hibernation of these species from CCWE which later resurged in 2007, this also suggests that CCWE may not be effective as pre emergence herbicide. Phytotoxicity on weeds revealed significant differences ($p<0.05$) between all crude cassava water extract (CCWE) of Bulk, MS and TMS in 2006 and 2007 as shown in Table 2. The phytotoxicity showed the same trend in both experiments, with crude cassava water extract of Bulk and MS at 50% recording the highest toxicity over TMS treatments. This may be due to the presence of high hydrocyanic acid content in both CCWE which showed herbicidal properties as reported by Rice (1984), Putnam (1989) & Fayinminnu (2010). This might probably have affected the biological and cellular systems of the weed species as reported by Keilin (1966) and resulted to decolorisation (yellowing) and wilting (Fayinminnu 2010).

Weed biomass of broad leafed and grasses and weed density across the crude cassava water extract of Bulk, MS and TMS treatments in 2006 and 2007 showed significant differences ($p<0.05$) in Table 2. The effect of CCWE of Bulk, MS and TMS at 25 and 50% on weed biomass of broadleaf and weed density in 2007 was reduced when compared with 2006. This is probably because there was no increase in the dose (amount) of CCWE applied on the weed species which had also increased in numbers. However, reduction of weed biomass

and density was achieved through CCWE by suppressing the weed species when compared with the unweeded treatment. The weed suppression enhanced the vegetative growth and reduction in yield loss in accordance to Tijani- Eniola (2001). Hand weeded treatment recorded lowest weed biomass and density over other treatments in the study (Table 2).

Growth parameters under the crude cassava water extract of Bulk, MS and TMS as post emergent herbicide were shown in (Table 3). Cowpea plant height and number of leaves produced followed the same trend whereby Bulk, MS and TMS at 25 and 50% concentrations were statistically different ($p<0.05$). Cowpea plant height in plots sprayed with TMS at 25 and 50% compared favourably with hand weeded in 2006 while MS at 50% compared favourably with hand weeded in 2007. Number of leaves recorded from Bulk and MS at 50% compared favourably with hand weeded in both years. Crude cassava water extract of Bulk, MS and TMS showed high leaf area. It also shown that the CCWE could reduce weed biomass at each growth stages of cowpea plants (3-7 WAS), as an early post emergent herbicide. This results obtained implies that growth resources such as nutrients, water and light would be less competed for between the weeds and cowpea plants.
The yield components of cowpea were significantly ($p<0.05$) affected by different crude cassava water extract as post emergent herbicide (Table 4). Crude cassava water extract of Bulk and MS at 50% compared favourably with hand weeded in cowpea number of pods in 2006. The least number of pods seeds/pod and grain yield were obtained from unweeded while hand weeded recorded the highest in 2006 and 2007. This is probably due to weed free situation in the hand weeded plots. Crude cassava water extracts from Bulk and MS at 25 and 50% in the experiments recorded higher yield parameters than all TMS treatments.

4. Discussion

Similar findings had been reported by West Gate *et al*., (1997) and Johnson *et al*., (1998). This suggests that the critical period at which cowpea plants could not tolerate weed competition falls within this range. The result from this research may be due to high potency of hydrocyanic acid in Bulk and MS crude cassava water extract which reduced weed biomass and density with herbicidal potentials and acted as early post emergent herbicides which brought about higher grain yield values as also reported by Olofintoye & Adesiyun (1989) and Dugje *et al*., (2009). This could also be attributed to adequate canopy formation, which made it easy for cowpea crop to intercept solar radiation better than the weeds, hence making the weed interference less effective on the yield components. Similar findings as reported by Oworu (1988) & O`Donovan *et al*., (1997). Drastically reduction in seed weight was recorded from unweeded treatment while hand weeded recorded the highest seed weight in the study.

4. Conclusion

The study concluded that Bulk and MS crude cassava water extract at 50% was able to effectively perform as post emergence herbicide with TMS during the critical early growth stage of cowpea (3-7WAP) against weeds. This study also showed that CCWE could be used as an alternative to synthetic herbicides because it is readily available and likely to easily biodegrade. This would be beneficial to the resources of poor small farm holders in developing economies of the world. Furthermore, CCWE may be proved suitable and be used as product of choice for organic food production.

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Table 1: Weeds associated with cowpea production in 2006 and 2007

2006				2007			
Family	**Weed Species**	**Morphology**	**Life Cycle**	**Family**	**Weed Species**	**Morphology**	**Life Cycle**
Asteraceae	*Ageratum conyzoides L.*	Broadleaf	A	Asteraceae	*Ageratum conyzoides L.*	Broadleaf	A
	Chromolaena odorata L.	Broadleaf	P		*Chromolaena odorata L.*	Broadleaf	P
	Tridax procumbens L.	Broadleaf	A		*Tridax procumbens L.*	Broadleaf	A
Commelinacea e	*Commelina benghalensis L.*	Broadleaf	A	Commelinacea e	*Commelina benghalensis L.*	Broadleaf	A
Euphorbiaceae	*Euphorbia heterophylla L.*	Broadleaf	A	Euphorbiaceae	*Euphorbia heterophylla L.*	Broadleaf	A
Malvaceae	*Sida acuta Burm.f.*	Broadleaf	P	Malvaceae	*Sida acuta Burm.f.*	Broadleaf	P
Portularaceae	*Portulaca olerace L.*	Broadleaf	A	Portulacaceae	*Portulaca olerace L.*	Broadleaf	A
Poaceae	*Seteria bartata(Lam.)Kunth*	Grass	A	Solanaceae	*Phyllantus amarus* Schum &Thonn	Broadleaf	A
	Bracharia deflexa (Schumach) C.E.Hubbard ex Robyns	Grass	A	Poaceae	*Seteria bartata(Lam.)Kunth*	Grass	A
	Paspalum scrobiculatum L.	Grass	P		*Bracharia deflexa (Schumach)* C.E.Hubbard ex Robyns	Grass	A
					Paspalum scrobiculatum L.	Grass	P
					Cyanodon dactylon L.	Grass	P

A = Annual, P =Perennial

Means in the same column followed by the same letter are not significantly different at $p<0.05$

CCWE = Crude Cassava Water Extract; WAS =Weeks After Sowing; SE = Standard Error

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Table 2: Efficacy of Three Sources of Crude Cassava Water Extract on Weed Species in cowpea production in 2006and 2007 Experiments

Herbicide Treatments	Rates	Phytotoxicity 2006	Phytotoxicity 2007	Weed Biomass Broadleaf (g/m^2) 2006	Weed Biomass Broadleaf (g/m^2) 2007	Weed Biomass Grasses (g/m^2) 2006	Weed Biomass Grasses (g/m^2) 2007	Weed Density (No/m^2) 2006	Weed Density (No/m^2) 2007
Bulk CCWE	25%	3.16b	3.00b	10.53b	10.20bc	6.68b	7.00b	19.56b	21.22b
Bulk CCWE	50%	4.67a	4.29a	6.45b	4.62b	4.85b	5.63b	12.92b	16.81b
MS CCWE	25%	3.05b	2.83b	10.53b	10.11bc	6.79b	7.02b	20.08b	21.11b
MS CCWE	50%	4.52a	4.08a	6.53b	5.67b	4.94b	5.86b	15.03b	17.05b
TMS CCWE	25%	2.12bc	2.12c	10.76b	10.75c	4.10bc	8.02b	27.30bc	25.32b
TMS CCWE	50%	3.05b	3.54b	7.53b	8.84c	3.43bc	5.06b	22.14b	20.17b
Handweeding	0%	0.00d	0.00d	1.32a	1.00a	0.50a	1.66a	2.00a	1.85a
Unweeded	0%	0.00d	0.00d	47.66c	45.41	17.00c	33.21c	65.84c	57.33c
Mean		2.57	2.12	12.69	12.08	6.04	9.18	23.11	22.61
SE(±)		0.63	0.82	5.12	4.91	1.72	3.50	6.66	5.54

Table 3: Effect of Crude cassava water extracts as post emergent herbicide on growth of cowpea

Herbicide Treatments	**Rates**	**Plant Height ((cm) 2006**	**Plant Height (cm) 2007**	**No. of Leaves 2006**	**No. of Leaves 2007**	**Leaf Area(cm^2) 2006**	**Leaf Area (cm^2) 2007**
Bulk CCWE	25%	15.50ab	11.00b	18.10bc	12.47c	17.99b	12.29d
Bulk CCWE	50%	14.00ab	13.50b	23.77a	18.10a	19.54b	17.73bc
MS CCWE	25%	9.73b	10.00b	21.15b	14.60b	18.11b	12.03d
MSCCWE	50%	10.59b	14.53a	23.80a	18.00a	21.82ab	18.63b
TMS CCWE	25%	18.95a	8.50c	11.22c	11.25c	19.89b	10.44d
TMS CCWE	50%	19.44a	10.57b	20.22b	15.00b	18.18b	15.02c
Handweeding	0%	21.61	15.00a	25.11a	17.00a	27.37a	21.73a
Unweeded	0%	4.09c	3.00d	3.21d	5.00d	7.55c	5.70e
Mean		14.24	10.76	18.32	13.93	18.81	13.12
SE(±)		2.08	1.18	2.66	1.55	1.95	1.69

Means in the same column followed by the same letter are not significantly different at $p<0.05$
CCWE = Crude Cassava Water Extract
WAS =Weeks After Sowing
SE = Standard Error

Table 4: Effect of Crude Cassava Water Extracts as natural post emergence herbicide on yield characteristics of cowpea in 2006 and 2007 Experiments

Herbicide Treatments	Rates	No.of Pods 2006	No. of Pods 2007	Seeds/Pods 2006	Seeds/Pods 2007	GrainYield (kg/ha) 2006	Grain Yield (kg/ha) 2007
Bulk CCWE	25%	14.06b	5.00d	10.12c	7.10d	365c	255b
Bulk CCWE	50%	17.94a	8.00c	12.19b	10.40b	450b	280b
MS CCWE	25%	14.19b	7.00c	10.19c	7.00d	360c	250b
MS CCWE	50%	18.38a	10.00b	12.38b	10.00b	430b	265b
TMS CCWE	25%	12.40b	7.40c	8.46d	7.00d	350d	230c
TMS CCWE	50%	14.35b	8.65b	10.12c	8.40c	390c	255b
Handweeding	0%	17.60a	15.60a	15.93a	13.50a	540a	370a
Unweeded	0%	3.25c	3.00e	2.25e	1.70e	180e	110d
Mean		14.27	13.33	9.39	8.14	383.13	251.86
SE(±)		1.74	1.68	1.29	1.21	36.49	31.56

Means in the same column followed by the same letter are not significantly different at p<0.05
CCWE = Crude Cassava Water Extract
WAS =Weeks After Sowing
SE = Standard Error