Volume 3 Number 1 March 2013 ISSN 1681 - 5734

Special Edition of The Lesotho Journal of Agricultural Sciences

Published by the Faculty of Agriculture, The National University of Lesotho

EFFICACY STUDY OF BULK SOURCE OF CRUDE CASSAVA WATER EXTRACT AS A POST EMERGENCE HERBICIDE IN COWPEA (*Vigna unguiculata* (L) Walp) PRODUCTION

***Fayinminnu, O.O.,[1] Fadina, O.O[1] and Adedapo, A.A[2]**

1. *Department of Crop Protection and Environmental Biology, University of Ibadan, Ibadan Nigeria.*
2. *Department of Veterinary Physiology, Biochemistry and Pharmacology University of Ibadan, Ibadan Nigeria.*

Abstract

Weed interference remains a major cause of low productivity of cowpea and concern over synthetic herbicides has led to an increased interest in natural crop protection, in order to achieve more environmentally safe methods of reducing weed pests damage in cowpea production in Nigeria. Two field trials were conducted in 2006 and 2007 at Ijako –Owode in Ogun State, Nigeria. The treatments were Bulk crude cassava water extract (CCWE from different cassava varieties) at the rates of 25 and 50%, paraquat at 0.50 and 1.00kg ai/ha and two controls: handweeded and unweeded. The experiments were laid out in a randomized complete block design (RCBD) with three replications. Data collected were analyzed and significant means were seperated using analysis of variance (ANOVA) and Duncan multiple range test (DMRT) at p< 0.05. At commencement of the trial, the relative abundance of weed species was 81% broadleafed and 19% grasses. Results showed that Bulk CCWE at 50% showed significant difference (p<0.05) from paraquat at 1.00kgai/ha on phytotoxicity effects, while weed biomass and density recorded no significant difference (p>0.05). Higher leaf area (LA) was recorded from Bulk CCWE with a significant difference (p<0.05) from LA of paraquat. However all the yield components: number of pods, pod weight, seeds/pod and grain yield of Bulk CCWE were significantly higher (p<0.05) from paraquat treatments and comparable to handweeded while the least were obtained with unweeded. Attributes of Bulk CCWE as a post- emergence herbicide candidate are discussed.

Key words: Sole cropping, crude cassava water extract, weeds, post- emergence herbicide.

INTRODUCTION

Cowpea, *Vigna unguiculata* (L) Walp is one of the most economically and nutritionally important indigenous African grain legumes produced throughout the tropical and sub-tropical areas of the world (Ibro *et al.*, 2006). Again, cowpea has the ability to fix nitrogen into the soil (Tarawali *et al.*, 2000, Dugje *et al.*, 2009).

*E mail: olorijkb2008@yahoo.co.uk ; fk_ojo@yahoo.com

Cowpea constitutes the principal source of plant protein in human diets (Quin, 1997), its grains are milled into flour which is later processed by cooking. Cowpea leaves and stems are valued for livestock feed (Tarawali *et al.*, 2000). The problems of cowpea production in Nigeria include insect pests, disease pathogens, inappropriate production practices pest control tactics (particularly herbicides) and weed interference (Alonge and Lagoke, 2002; Dugje *et al.*, 2008). Cowpea being a short duration crop is therefore highly susceptible to early weed interference such as itchgrass, *Rottboellia cochichinensis* (Louis Clayton), milkweed, *Euphorbia heterophylla* (Desv) and cowitch, *Calopogonium mucunoides, Eleusine indica, Talinum fruticosurp, Euphorbia heterophylla, Cynodon dactylon, Commelina spp., Aspillia africana, Imperata cylindrical and Chromolaena odorata* (Akobundu, 1987; Okafor and Adegbite, 1991; Lagoke *et al.*, 1994;) *Portulaca oleracea, Schwenkia americana, Phyllantus amarus and Spigelia anthemia* (Fayinminnu, 2010). Weeds compete with cultivated crops for valuable nutrients such as light, water and space and also cause reduction in yield and quality of produce (Dugje *et al.*, 2009). Cowpea performance depends much on spraying with appropriate herbicides. However, it should be noted that many problems are associated with chemical weed control in developing countries. These chemicals are expensive, toxic to plants and farmers and are not environmentally- friendly. Also the high costs of these inputs are serious constraints to cowpea production in Nigeria (Kormawa *et al.*, 2000).

It was observed that vegetation scarcely grow at the cassava processing sites where the crude cassava water is discharged. Therefore, there is considerable interest in alternative methods of weed pest management as opposed to the use of synthetic herbicides. Any method that can replace synthetic herbicides usage, in efficiency, with low cash input, without appreciable yield reduction will be accepted by Nigerian poor farmers (Salako, 2002). The farmers therefore, need to make use of natural pesticides (herbicides) with low cash input, readily available, with a minimized environmental impact to manage weeds and protect their cowpea crop like crude cassava water extract .

The laboratory analyses from the previous work had revealed the chemical compositions of crude cassava water extracts (CCWE) from different cassava varieties. It showed that the hydrocyanic acid (HCN) from CCWE has phytotoxic effect on weeds/vegetation (Putnam 1988, Fayinminnu, 1999, 2010). The objective of this paper therefore, was to study the efficacy of Bulk source of crude cassava water extract (CCWE) as an herbicide candidate (post -emergence) in controlling weeds in cowpea production.

MATERIALS AND METHODS

Description of the study area

The study was carried out at Ijako – Owode in Sango Ota, Ado Odo –Ota Local Government Area, Ogun State, Nigeria. The site is located on latitude $6^0 35^1$N - $6^0 45^1$N and longitude $2^0 55^1$E - $3^0 15^1$E. The site is situated in the tropical rain forest zone of south west, Nigeria. The soil type at the study site is sandy clay, reddish brown in colour and slightly acidic. The site is mainly used for farming especially cassava, maize and vegetables. The experiments were conducted between 2006 and 2007 on an area of $375m^2$ respectively.

Field work

The experimental site was manually cleared. The soil samples (ten) were randomly collected across the experimental site using an auger at depths of 0 - 15 cm and 15 – 30cm and analysed for physico - chemical constituents. These samples were transported to the laboratory and air – dried and sieved using a 2.0mm and 0.5mm sieves. These following parameters were determined: pH, calcium and sodium, organic carbon and available micro nutrients and then analysed after the methods of the Analytical Service Laboratory of the IITA, Ibadan, Nigeria (IITA, 1982). Cation exchange capacity (CEC) was calculated from the sum of all exchangeable cations.

Preparation of Crude Cassava Water Extract (CCWE)

Extraction of Bulk crude cassava water extract was prepared by grate - press method described by Fayinminnu (2010). Series of cassava tubers from different farmers were washed, peeled and blended into pulp (mashed) within 24 hours in order to prevent rotting. The mashed pulp was put in a muslin sack and placed under a presser, with a bowl placed underneath to collect the water extract from the cassava pulp intermittently after 5 hours. The water extract from the bowl was poured into a calibrated black plastic keg intermittently and closed, so that the active ingredient (hydrocyanic acid) in the cassava water extract would not be lost. Sample of the crude cassava water extract was taken to the Analytical Laboratory of Institute of Agricultural Research and Training (IAR&T) Moor Plantation, Ibadan, Nigeria to determine the active ingredient and other minerals present in the extract.

Seeds of Ife brown variety were used as the planting crop. The experimental design was a Randomised Complete Block Design (RCBD) and replicated three times with six treatments in each experiment: CCWE at 25 and 50%, paraquat at 0.50 and 1.00kg/ha, handweeded and unweeded (controls). Three seeds were sown and later thinned to one seedling per stand at 2 weeks after sowing (WAS). The spacing was 60cm x 30cm between and within rows. Insect pests were controlled using Cypermethrin at 1 L/ha beginning from 2 WAP and sprayed at 10 days interval. Bulk crude cassava water extract was applied on the cowpea weeds from 3 - 7 WAS weekly using a knapsack sprayer CP15 while paraquat application and hand weeding were done at 3 and 5 WAS according to Fayinminnu (1999; 2010). A 0.25m^2 quadrant was 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 grasses) prior to crude cassava water extract, paraquat and handweeded treatments. The weed species in both experiments were looped together since there was no difference in the weed species.

Agronomic parameters taken were plant height (cm) using a metre rule, number of leaves produced were counted visually, and leaf area (cm^2) using the method of Nangju and Wanki (1989). Yield parameters: numbers of pods, pod weight (g), seeds per pod and grain yield (kg/ha) were taken at harvest. Visual toxicity rating of the effect of CCWE and paraquat on weeds was adapted from Clay and Davison (1978) a scale of 0 -10, where `0` indicates no toxicity on weeds and `10` indicates full toxicity. Weed control parameters: the fresh and dry matter production of the weeds was determined at 8 WAP. The weeds were uprooted and washed thoroughly with clean water. The weeds were dried under natural conditions in the open air for two hours. The fresh weight (g/m^2) was taken and the weeds were packed in paper envelope and oven dried for dry weight at 70^{0}C for 48 hours until they have attained constant weight. Weed density was determined at 8WAP by counting the number of weeds (no/m^2) in 0.25m^2 quadrant.

The data collected were subjected to analysis of variance (ANOVA) and means were separated using the Duncan multiple range test (DMRT) at $p<0.05$.

RESULTS

The result of physico - chemical properties of soil before and after the experiments is presented in (Table 1). The textural classification showed that the experiment belongs to the sandy clay soil as in (Table 1). The fallow weed species for the experiments at Ijako-Owode is shown in (Table 2). Broad leaved weeds constituted about 81% and grasses 19% of the total weed population in the experimental field. Most of the weeds were annuals while a few were perennials.

The mean values of phytotoxicity on weeds in relation to Bulk CCWE and paraquat (herbicide treatments) produced a significant difference ($p<0.05$) as shown in (Table 3). The mean values of paraquat at 0.50 and 1.00kg ai/ha and Bulk CCWE at 25 and 50% showed no significant difference ($p<0.05$) in weed biomass and density as shown in (Table 3). The handweeded plots recorded significant reduction in weed biomass and density while the unweeded treatment was significantly different ($p<0.05$) from all other treatments in recording highest weed biomass and density.

Significant differences ($p<0.05$) were observed in the mean values of agronomic attributes: plant height, number of leaves, leaf area (LA) as shown in Table 4. The handweeded and paraquat at 1.00kg ai/ha recorded highest plant height and number of leaves while paraquat at 0.50kg ai/ha and Bulk CCWE at 25 and 50% recorded similar plant height. The mean values of number of cowpea leaves produced also showed similar trend, however, paraquat at 0.50kg ai/ha and Bulk CCWE at 25% recorded similar number of leaves while Bulk CCWE at 50% recorded higher number of leaves over them (Table 4). Leaf Area in (Table 4) showed significant differences ($p<0.05$) whereby Bulk CCWE at 50% recorded higher LA over paraquat at 1.00kg ai/ha with a significant difference ($p<0.05$) while handweeded recorded highest LA over other treatments.

Highest number of pods was recorded from paraquat at 1.00kgai/ha, Bulk CCWE at 50% and handweeded with no statistical difference among the treated plots (Table 5). Bulk CCWE at 25 and 50% and handweeded recorded the highest pod weight with significant difference ($p<0.05$) as shown in (Table 5). Handweeded and paraquat at 1.00kgai/ha recorded significant number of seeds/pod over other treatments (Table 5). As shown in (Table 5), handweeded recorded the highest grain yield followed closely by Bulk CCWE at 50% and 25% with no statistical difference but with significant difference ($p<0.05$) from other treatments (Table 5). Unweeded treatment recorded drastically reductions in all the growth and yield parameters in the experiment.

DISCUSSION

The physico-chemical of soil analysis after the experiment showed that, the Nitrogen (N) level increased which showed that cowpea, a nutrient fixing crop was able to fix N in the soil after cropping (Dugje 2009). Other essential mineral elements: Fe, Mn, Cu and Zn detected in crude cassava water extract were present in the soil due to the application of CCWE as reported by Fayinminnu (2010). All these elements contributed to the good growth of cowpea plants.

The presence of cyanide in the CCWE brought about the toxic effect on weeds which may be attributed to the binding of cytochrome oxidase as reported by Kaza and Jaiswa (1994). The inhibition of cytochrome oxidase enzyme which occupies a critical position in cellular metabolism may have been attributed to cyanide inhibiting biological systems. This may have led to a decrease in the tissue utilization of oxygen due to inhibition of cytochrome oxidase according to Kaza and Jaiswa (1994). This may also be responsible for the phytotoxic effects demonstrated by cyanide compounds. It has also shown that, cyanide compounds possess the actual or potential herbicidal properties which is in support of Putnam (1988). Decolorisation and wilting were observed as phytotoxic and herbicidal effects on some weeds as reported by Fayinminnu, (1999; 2010). This also confirmed the findings of earlier researchers (Putnam, 1988; Rice, 1984; Fayinminnu, 1999; Ogundola and Liasu 2007) that CCWE released during processing have phytotoxic effect because cyanide is poisonous even when it dissolves in water to form weak acid solution.

The cyanide toxicity from Bulk CCWE was more pronounced on the following weed species; *S. anthemia, E.heterophylla, P.amarus, S.americana, P.oleraceae, Tridax procumbens and C. odorata* at the rate of 50% by causing decoloration, leaf burn and finally wilting than *Cyanodon dactylon and Panicum maximum*. This is in accordance with Fayinminnu (1999; 2010). Fayinminnu (1999; 2010) also found out that, cassava water extract could control weeds effectively in cowpea during the growing periods of 3

– 5 WAP. The phytotoxic effects produced on the weeds by the herbicide treatments led to the reduction in weed biomass hence there was reduction in weed density. The significant lower weed density recorded by the treatments used in this study showed effectiveness of the natural herbicide in line with the report of Fayinminnu (2010).

Bulk CCWE at 50% produced higher LA which compared favourably with paraquat and handweeding may be due to low weed biomass in the treated plots, which resulted in little competition between cowpea crop and weed for growth resources such as nutrients, water and light. This also suggests that, there was no toxicity effect or crop injury on agronomic parameters by Bulk CCWE and hence high crop yield; this is in accordance with West Gate *et al.*, (1997).

The yield components viz: number of cowpea pods and weight, seeds/pod and grain yield revealed that Bulk CCWE at 50% compared favourably with handweeded and were higher than paraquat treatments. This may be due to absence of crop injury and was able to suppress the weeds of cowpea at the early critical growth 3 -5 WAP of the crop as a post emergence herbicide. Also bigger sizes of cowpea seeds were harvested from the plots treated with Bulk CCWE which might be responsible for higher grain yield. The presence of essential elements Fe, Mn, Cu and Zn detected in CCWE (Fayinminnu 2010) and were released might have contributed to the higher good growth and yield of cowpea treated with Bulk CCWE.

In this study, the hand weeding control plots gave superior cowpea growth, yield, reduced weed biomass and density than Bulk CCWE and paraquat. This was probably due to lower weeds in hand weeded plots, which resulted in little or no competition between the crop and weeds for growth resources such as light, nutrients, water and space. However unweeded control recorded the highest weed biomass and density, significant reduction in growth and yield parameters of cowpea plants.

CONCLUSION AND RECOMMENDATIONS

The Bulk CCWE investigated as a potential herbicide (post emergence) showed that cowpea plants treated with this natural herbicide (biocide) recorded good performance on cowpea growth and yield components even at the lowest rate of 25 and 50%. This showed that crude water extract from cassava could produce allelochemicals that can promote growth in plants at 50% due to its suppression of weeds during the early growth of cowpea crop. This study also revealed that it would result into waste and increase in cost for the farmers to continue applying the natural (CCWE) and synthetic (paraquat) herbicides at different rates and application after 6 WAP. Farmers should not classify CCWE as a waste but should be making use of it as an environmental friendly biocide with no crop injury or toxicity on cowpea crop. This would be beneficial to resources poor small farm holders who dominated the farming enterprise in Nigeria. Crude cassava water extract at 50% is hereby recommended as a natural post emergence herbicide as the world is tending towards organic agriculture.

REFERENCES

Akobundu, I. O. 1987. Weed Science in the tropics Principles and Practices. U.S.A John Wiley and Sons publication 522pp.

Akobundu, I. O. 1997. Weed science development in Nigeria: Yesterday, Today and Tomorrow. *Nigerian Journal of Weed Science 10*: 61-70.

Alonge, S.O. and Lagoke, S.T.O.. 2002. Parasitism of cowpea varieties by *Alectra vogelli* and *Striga gesneriodes. Nigeria Journal of Weed Science* 15: 39-51.

Dugje, I.Y., F.Ekeleme, A.Y. Kamara, A. Tegbaru, L.O.Omoigui, J.E.Onyibe, and I.A.Teli 2008. Guide on pesticide use for crop production in Borno State, Nigeria. 15pp.

Dugje, I.Y., L.O. Omoigui, F. Ekeleme, A.Y. Kamara, and H. Ajeigbe. 2009. Farmers' Guide to Cowpea Production in West Africa. International Institute of Tropical Agriculture (IITA), Ibadan Nigeria. 20pp.

Fayinminnu, O.O. 1999. Comparative Toxicological Effect of a Post Emergence Herbicide, paraquat (gramoxone) and cassava waste water on the growth characteristics, food components and yield of cowpea (*Vigna unguiculata* (L) Walp). Unpublished MSc Thesis, Department of Crop Protection and Environmental Biology University of Ibadan, 50pp.

Fayinminnu, O.O. 2010. Crude cassava water extract as a natural post emergent herbicide and effects on growth, yield and food components of cowpea (*Vigna unguiculata* (L) Walp). Unpublished Ph.D Thesis. Department of Crop Protection and Environmental Biology University of Ibadan. 225pp.

Ibro, G., J. Fulton, and J. Lowenberg-DeBoer.2006. Factors Affecting Success for Women Entrepreneurs in West Africa: The Case of Kosaï, a Value-Added

Cowpea Product. Selected paper at the American Agricultural Economics Association annual meeting, July 23-26, 2006, in Long Beach, California (http://agecon.lib.umn.edu/cgi- bin/pdf_view.pl?paperid=21781&ftype=.pdf).

IITA 1982: Selected Methods for plant and soil analysis Manual Series No.7 International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria.

Kaza, S.K and Jaiswal, D.K. 1995: Mechanism of Cyanide Toxicity and Efficacy of its Antidotes. *Defence Science Journal* 44 (4) pp331-340.

Kormawa, P. M, J. N. Chianu, and V. M Manyong 2000. Cowpea demand and supply patterns in West Africa: the case of Nigeria. **In:** Challenges and Opportunities for Enhancing Sustainable Cowpea Production. (Eds) Fatokun, C.A., Tarawali, S.A., Singh, B. B., Kormawa, P. M, and Tamo, M 2002, 433pp.

Lagoke, S.T.O., J. Y., Shebayan, G., Weber, O. K., Olufajo, K., Elemo, J.K., Adu, A. M, Emechebe, B. B., Singh, A., Zaria, A., Awad, L. Ngawa, G. O., Olaniyan, Olafare, S. O. Olafare and A. A. Adeoti. 1994. Survey of *Striga* problems and evaluation of *Striga* control methods and packages in crops in the Nigerian savanna. Pp 91-120. **In:** Improving *Srtiga* management in Africa.*Proceedings, Second General Workshop of Pan –African Striga Control Network* (PASCON), edited by Lagoke, S. T. O., Hoevers, R., and Boob, S. S. M and Traboulsi, R. N 23-29 June 1991, Nairobi, Kenya, FAO/ PASCON, Accra, Ghana.

Nangju, D. J. and Wanki, (1989) Determination of leaf area index in cowpea and soybean. *Experimental Agric.* 16: 149 – 151.

Ogundola, A.F and Liasu, M.O. 2007. Herbicidal effects of effluent from processed cassava on growth performances of *Chromoleana odorata* weeds population.

Okafor, I. I. and Adegbite, A.A. 1991. Predominant weeds of Cowpea (*Vigna unguiculata*) in Bauchi State. Nigeria Journal of Weed Science. Vol. 13: 9- 13.

Putnam, A. R. 1988. Use of allelochemicals as natural herbicides or pesticides. Weed Tech.2:510-518. **In:** M An, J.Pratley and T.Haig (eds.) Allelopathy: from concept to reality. Environmental and Analytical Laboratries and Farrer Centre for Conservation Farming, Charles Sturt University, Wagga Wagga, NSW Pp 2650.

Quin, F. M 1997. Introduction: Advances in Cowpea Research – co-publication of IITA and JIIRC on Cowpea. 1998 edition. Pp ix - xv.

Rice, E.L. 1984. ``Allelopathy.`` 2nd Ed. Academic Press, New York. 421pp.

Salako, E.A. 2002. Plant protein for the Resources poor farmers. Symposium paper Presented at the 30th Annual Conference of the Nigeria Society for Plant

Protection (NSPP) Sept. 1-4, 2002. UNAAB, Abeokuta Ogun State Nigeria.

Tarawali, S.A., S., Larhi, Fernandez –Rivera, and A. Bationo. 2000. The role of livestock in the maintenance and improvement of soil fertility. Pp 281-304 *In*: Sustaining soil fertility in West Africa, SSSA Special Publication No. 58. Soil Society of America and American Society of Agronomy, Madison, USA.

Table 1: Physico - Chemical properties of the soil (Mean values for two years)

Characteristics	Pre planting	Post planting
pH H20	5.92	6.06
pH KCl 1:1	Nil	5.05
Total N g kg-1	1.96	2.02
Organic C g kg-1	24.70	19.01
Avail. P mg kg-1	61.88	81.24
Ca Cmol kg-1	3.98	4.90
Mg Cmol kg-1	3.39	4.01
K Cmol kg-1	1.01	0.07
Na Cmol kg-1	1.13	0.63
Al Cmol kg-1	Nil	Nil
Mn mg kg-1	Nil	330.97
Fe mg kg-1	Nil	210.90
Cu mg kg-1	Nil	18.49
Zn mg kg-1	Nil	93.59
Cyanide (CN) mg/kg	Nil	0.040
Exchangeable acidity C mol kg-1	0.20	0.20
ECEC Cmol kg-1	9.51	9.043
% Sand	72.20	79.00
% Clay	7.40	15.80
% Silt	13.40	5.20
Bulk density g/cm3	1.095	1.28

ECEC = Exchangeable Cation Exchange Capacity

Table 2: Weed species at the experimental site for two years

Family	Weed species	Morphology	Life cycle
Amaranthaceae	*Amarantus spinosus* L	Broadleaf	A
Asteraceae	*Agerantum coryzoides* L.	Broadleaf	A
	Chromolaena odorata L.	Broadleaf	P
	Tridax procumbens L.	Broadleaf	A
Commelinaceae	*Commelina benghalensis* L.	Broadleaf	A
Cyperaceae	*Cyperus rotundus* L.	Grass	P
Euphorbiaceae	*Euphorbia heterophylla* L.	Broadleaf	A
Loganiaceae	*Spigelia anthemia* L.	Broadleaf	A
Poaceae	*Cyanodon dactylon* L.	Grass	P
	Panicum maximum L.	Grass	P
Portulacaceae	*Portulaca oleracea* L.	Broadleaf	A
	Talinium fruticosum (Jacq) Wild	Broadleaf	A
Solanaceae	*Schwenkia americana* L.	Broadleaf	A
	Aspigilia africana L.	Broadleaf	A
	Phyllantus amarus Schum & Thonn	Broadleaf	A

A=Annual; P=Perennial

Table 3: Effects of Crude cassava water extract (CCWE) and paraquat on weeds of cowpea (Mean values for two years)

Herbicide treatments	Rates	Phyto 6WAP	Phyto 8WAP	WB Broad 8WAP	WB Grasses 8WAP	WD 8WAP (no/m^2)
Paraquat	1.00kgai/ha	6.20a	5.21a	5.35b	5.00b	13.50b
Paraquat	0.50kgai/ha	5.13a	3.62b	10.46b	7.16b	19.56b
Bulk CCWE	50%	4.78ab	3.22b	9.85b	7.00b	19.19b
Bulk CCWE	25%	3.00b	2.25b	13.00b	8.67b	23.00c
Unweeded	-	0.00c	0.00c	72.00c	40.05c	88.00d
HDW	-	0.00c	0.00c	2.00a	1.05a	3.66a
Mean		3.19	2.38	18.78	11.49	27.82
SE±		1.09	0.85	10.77	5.81	12.35

Means in the same column followed by the same letter are not significantly different at DMRT ($P<0.05$)
CCWE=Crude cassava water extract, Phyto =Phytotoxicity, WB =Weed biomass (g/m^2), WD=Weed density, HDW=Handweeding; WAP=Weeks After Planting;
SE=Standard Error Mean (±)

Table 4: Effects of crude cassava water extract and paraquat on growth parameters of cowpea (Mean values for two years)

Herbicide treatments	Rates	PH(cm) 6WAP	NOL 6WAP	LA(cm^2) 6WAP
Paraquat	1.00kgai/ha	19.83a	17.16a	25.73c
Paraquat	0.50kgai/ha	17.16b	11.41c	23.62c
Bulk CCWE	50%	16..81b	13.75b	29.35b
Bulk CCWE	25%	16.81b	10.83c	20.71bc
Unweeded	-	13.00c	6.35d	9.41d
HDW	-	19.37a	18.41a	34.89a
Mean		17.16	12.99	21.76
SE±		0.99	1.81	3.39

Means in the same column followed by the same letter are not significantly different at DMRT ($P<0.05$)
CCWE = Bulk crude cassava water extract; PH=Plant Height, NOL=Number of Leaves LA=Leaf Area, HDW=Handweeding; WAP=Weeks After Planting;
SE=Standard Error Mean (±)

Table 5: Effects of crude cassava water extract and paraquat on yield parameters of cowpea (Mean values for two years)

Herbicide treatments	Rates	NOP	PW(g)	NOSP	Yield (kg/ha)
Paraquat	1.00kgai/ha	16.85a	12.00b	6.78b	306a
Paraquat	0.50kgai/ha	14.26ab	12.00b	5.04c	209b
Bulk CCWE	50%	16.43a	14.35a	5.16c	319a
Bulk CCWE	25%	15.48a	14.35a	5.33c	316a
Unweeded	-	3.99c	7.35c	4.30c	140c
HDW	-	16.15a	14.35a	7.10a	320a
Mean		13.86	12.40	5.62	268
SE±		2.00	1.11	0.44	31.05

Means in the same column followed by the same letter are not significantly different at DMRT ($P<0.05$)
CCWE=Bulk crude cassava water extract; NOP=Number of pods, PW=Pod weight
NOSP=Number of seeds per pod HDW=Handweeding;
WAP=Weeks After Planting; SE=Standard Error Mean (±)