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Efficacy of Three Botanicals in Cowpea Field, Oyo State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Authors NCI, O. O. Fadina, O. O. Fayinminnu and OSO designed the study, performed the statistical analysis, wrote the protocol, wrote the first draft of the manuscript and managed the analyses of the study. Author NCI managed the field work and literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To evaluate the effects of different concentrations of the plant extracts of *Eucalyptus camaldulensis* (EU), *Eucalyptus torreliana* (ET) and *Leucaena leucocephala* (LL) on seed-germination, seedling-growth, weed flora and yield performance of cowpea.
Study Design: The study was laid out in a completely randomized design (CRD) with eighteen ttreatments replicated three (3) times, totaling fifty-four (54) experimental samples. The whole experiments were repeated in two trials.
Place and Duration of the Study: This study was carried out on the roof top garden of department of Crop Protection and Environmental Biology, University of Ibadan, Nigeria from 2015 to 2017.
Methodology: Leaves of EU, ET and LL were harvested, air-dried, milled and assayed for phytochemicals (mg/g) following standard-procedures. Milled samples (144, 108, 72, 36 and 0 g) of each botanical were dissolved in 1 L distilled-water to obtain Aqueous-Leaf-Extracts (ALE) of 100, 75, 50, 25 and 0% (control) concentrations. Ten seeds of cowpea-Ife brown in petri dishes were treated with the different concentrations. Data were collected on Seed Germination-SG (%). In pots containing 10 kg soil, cowpea-seeds (2 plants/pot) were sown. Each botanical-extract at different concentrations and paraquat (5 mL/L/ha) were applied, before and five Weeks-After-Sowing (WAS).

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Data were collected on Plant height-PH (cm) at 3,5,7,9 and 11 WAS, while Grain Yield-GY (g/pot) was determined at maturity. Relative Importance Values (RIVs) were determined following standard-procedures. Data were analysed with descriptive-statistics and ANOVA at $\alpha_{0.05}$.

Results: Total phenols (32.04±0.10), tannins (27.40±0.04) and saponins (20.15±0.03) were significantly higher in EU than in ET and LL. Cowpea SG ranged from 80.0±0.5 (50% LL) to 100.0±1.2 (100% LL). Cowpea PH ranged from 18.2±2.0 (100% ET) to 48.5±3.2 (100% EU) both at 9-WAS. Cowpea GY ranged from 0.1±0.1 (25% LL) to 4.2±0.5 (50% LL). *Mitracarpus villosus* had highest RIV of 52.3 (100% EU at 3-WAS) but reduced to 28.5 (100% EU at 9-WAS). Aqueous-leaf-extract of *Eucalyptus camaldulensis* at 100% reduced *Mitracarpus villosus* populations, while *Leucaena leucocephala* at 50% improved grain yields.

Keywords: Bio-herbicide; Eucalyptus torreliana; Eucalyptus camaldulensis; Leucaena leucocephala; cowpea.

1. INTRODUCTION

Cowpea is one of the foremost food crops widely produced and consumed in Nigeria due to their high protein contents. Their production are constrained by weed interference, diseases and pest infestations Asiwe [1]. Weeds are a major hazard to agricultural systems causing productivity failure. Modern agricultural practices use large amounts of chemicals to combat weeds and other pests. But the adverse effect of the agrochemicals on the environment including food safety and human heath has prompted urgent need to search for alternative weed management methods Farooq et al. [2]. Plants produce through their secondary metabolism, chemical substances called allelochemicals, which may be harmful or beneficialto other plant species around them, such phenomena is called allelopathy Silva et al. [3]. Rodrigues et al. [4] reviewed that the leaves and fruits of Guapira graciliflora have allelochemicals in their constituents that affect the growth of the two weed species under study. Leandro et al. [5] reported that *Libidibia ferrea* extracts had a high allelopathic effect on two weeds (*Cenchrus echinatus* and *Calotropis procera)*. The use of plant products with biological active substances such as terpenoids, tannins, saponins, etc have potential weed control in modern agriculture Khan et al. [6], Araniti et al. [7]. Similary, Bulegon et al. [8] and Leandro et al. [5] also reviewed that allelopathic effects are arbitrated by chemical substances belonging to different secondary metabolite such as tannins, alkaloids, terpenoids, steroids, phenols, coumarins, flavonoids, glycosides, cyanogenics, derived from benzoic acid, fatty acids and quinones, among others. It has been shown that Eucalyptus species have strong allelopathic activity on plant Gliessman, [9]. They belong to the family of Myrtaceae and indigenous to Australia and are distributed worldwide McDonald, et al. [10]. Some species of Eucalyptus includes: *E. globulus, E. grandis*, *E. robusta*, *E. torelliana*, *E. camaldulensis*. Extract from *E. camaldulensis* on tomato significantly inhibited growth Fikreyesus et al. [11]. *Leucaena leucocephala* is a leguminious tree that has a tolerance to drought and is distributed widely in subtropical and tropical zones. Xuan et al. [12]; Aganga and Tshwenyane, [13]. It has multiple uses, such as soil erosion prevention and soil improvement. Meena et al. [14], Xuan, et al., [12]. Phytotoxic allelochemicals, such as mimosine was identified in the leaves of *Leucaena leucocephala* and also reported to be responsible for the allelopathic activity in the plant Xuan et al. [12], John and Narwal [15]. Tannins was reported by Silva et al. [3] to be involved in the plant defense mechanism against attacks of herbivores, fungi, bacteria and viruses, which is the compounds with allelopathic properties found in plant extracts. Therefore, herbicidal potential of *Eucalyptus camaldulensis, Eucalyptus torelliana* and *Leucaena leucocephala* extracts in cowpea production were assessed in Oyo State; to evaluate the effects of different concentrations of the plant extracts of *Eucalyptus camaldulensis*, *Eucalyptus torreliana* and *Leucaena leucocephala* on seed germination, seedling growth, weed flora and yield of cowpea.

2. MATERIALS AND METHODS

2.1 Study Area

Between 2015 and 2017, this study was carried out at the Ecology Research Laboratory, Roof top, Bacteriology and Virology Research Laboratory, Toxicology Research Laboratory and the Crop Garden of the Department of Crop Protection and Environmental Biology, University of Ibadan, Oyo state, Nigeria. Crop Protection

and Environmental Biology Department lies between Latitude 7°27'0"N and 3°53'0"E.

2.2 Sample Collection and Preparation

Top soil was collected from the Crop Protection and Environmental Biology (CPEB) Crop Garden, University of Ibadan (UI) into 10 kg pot. Homogenized soil sample was air-dried for seven days in Ecology Laboratory of CPEB and later taken to Department of Bioscience, Forestry Research Institute of Nigeria (FRIN) for physico-chemical analysis using standard procedures AOAC, [16]. Cowpea seeds (Ife brown) were collected from Institute of Agricultural Research and Training (IAR&T). Botanicals were sourced from FRIN premises and identified in FRIN Herbarium with 111806, 111807 and 111808 for *Eucalyptus torreliana*, *Eucalyptus camaldulensis* and *Leucaena leucocephala,* respectively. They were air dried for 4 weeks, milled and soaked for 48 hours. The extract was stored in refrigerator prior to use.

Phytochemical analysis were carried out on air dried leaves of the plant species using standard procedures at International Institute for Tropical Agriculture (IITA). Petri- dishes experiment was done in Ecology laboratory of CPEB, the phytotoxic effects of *Eucalyptus torreliana* (ET), *Eucalyptus camaldulensis* (EU) and *Leucaena leucocephala* (LL) each by adding 2 mL of 100%, 75%, 50%, 25% for 7 days on cowpea (Ife brown) seed germination were evaluated in Complete Randomized Design (CRD) with three replicates, distilled water served as control (0%). Data on Percentage Seed Germination-SG (%), Plumule length -PL (cm) and Radicle Length-RL (cm) were assessed.

Percentage Germination = (No of germinated seeds)/ (Total No of seeds plated) × 100

The pot trials were arranged in CRD with three replicates, treatments: 200 mL of 100%, 75%, 50%, 25%, 0% of ET, EU and LL with Paraquat-P (5mL in 1 L/ ha) were applied before and five Weeks After Sowing (WAS) to examine pre-emergence and post-emergence potentials of the botanicals. At 3, 5, 7, 9 and 11 WAS Plant height-PH (cm) and Grain yield-GY (g/pot) were assessed. Weefindbcs and their Relative Important Values (RIV) were also determined using standard procedures Akobundu et al. [17].

$$\text{Relative Importance Value (RIV)} = \frac{(\text{Relative frequency} + \text{Relative Density})}{2}$$

Data were analysed using descriptive statistics and ANOVA α0.05.

3. RESULTS AND DISCUSSION

Our findings showed the presence of phytochemical contents; Tannins, Saponins, mimosine and Total phenols in *Eucalyptus torreliana* (ET), *Eucalyptus camaldulensis* (EU) and *Leucaena leucocephala* (LL) which is in support of Ayepola and Adeniyi [18,19]. The phytochemical contents in EU were higher in total phenols, tannins and saponins (32.04±0.10, 27.40±0.04 and 20.15±0.03 mg/g, respectively) as in Table 1.

The phytotoxic effects of botanical extracts on cowpea seed germination depended on their concentrations, the inhibition was stronger at the higher concentrations as shown in Table 1, which is in line with the report of Ataollahi, et al. [20] *Eucalyptus species* extracts inhibited more than *Leucaena leucocephala* whichis in support of Ayepola and Adeniyi [18], Adeniyi and Ayepola [19]. According to Rice [21] allelochemicals are not always proficient of affecting seed germination, because seeds need few external resources to promote germination, since their reserves are contained internally. Thus, not all allelochemicals can prevent seed germination.The Seed Germination of cowpea ranged from 80.0±0.4 to 100.0±0.5 across the treatments (Table 2).Cowpea had significantly higher PL (16.0±0.7) and RL (11.2±1.2) with LL under 25% than other extracts (Table 2).

In the pot experiment as shown in Table 3, phytotoxic effect on PH of cowpea (48.5±3.2) under 100% EU at 9 Weeks After Sowing were significantly higher, while PH (7.8±0.8) were least at 5 weeks after sowing under Paraquat for cowpea. Significantly higher GY (4.2±0.5) of cowpea was obtained at 50% LL followed by 100% ET (3.0±0.2) with the least value (0.1±0.1) at Paraquat.

The data in Table 4, revealed that there were 14 weed species belonging to eight families enumerated in all the pots sampled at three weeks after sowing in the first trial with *Eucalyptus camaldulensis* treatment. The highest relative importance values obtained

(52.3, 37.0, 35.7 and 32.2) were for *Mitracarpus vilosus* at 100%, 75%, 0% and 25%, respectively. *Larpotea austeans* had the lowest relative importance value of 4.2 at 50%, as shown in Table 4. In the second trial, a total of seven weed species belonging to six families were enumerated in all the pots with *Eucalyptus camaldulensis* treatment at three weeks after sowing. *Cyperus esculentus* dominated with the highest relative importance values of 52.1, 44. 4, 41.1, 37.0 at 100%, 75%, 50% and 25%, respectively, while the lowest relative importance value of 3.7 at 50% for both *Ageratum conyzoides* and *Aspillia africana* was obtained as shown in Table 4.

A total of 15 weed species belonging to nine families were enumerated in all the pots sampled at three weeks after sowing in the first trial with *Eucalyptus torelliana* treatment. The relative importance values obtained as highest among all the species encountered, *Oldenlandia lancifolia* had the highest RIV (39.3) at 75% followed with 38.2, 35.7, 35.4 at 50%, 0% and 75%, respectively for *Mitracarpus vilosus* in the first trial. The lowest RIV was 4.5 at 100% for both *Cyperus rotundus* and *Larpotea austeans* (Table 4).

In the second trial, eight weed species belonging to seven families, were enumerated in all the pots sampled at three weeks after sowing. The relative importance values obtained were highest for *Cyperus esculentus* at 41.2, 40.4, 39.8, 39.1 and 32.2 at 25%, 100%, 50%, 75%, and 0% respectively, while the lowest relative importance value obtained was 4.3 at 25% for *Larpotea austeans* as shown in Table 4.

Table 1. Quantitative determination of the phytochemicals in the extracts of *Eucalyptus torelliana, E. camaldulensis* and *L. leucocephala*

Phytochemicals	Plant species		
	***Eucalyptus torelliana* (mg/g)**	***Eucalyptus camaldulensis* (mg/g)**	***Leuceana leucocephala* (mg/g)**
Alkaloids	2.55±0.07^{c}	4.83±0.04^{b}	11.40±0.15^{a}
Flavonoids	0.29±0.01^{b}	1.42±0.01^{a}	0.17±0.00^{c}
Mimosine	0.27±0.01^{b}	0.34\±0.01^{b}	5.09±0.05^{a}
Saponins	14.18±0.06^{b}	20.15±0.03^{a}	6.30±0.14^{c}
Tannins	17.91±0.09^{b}	27.40±0.04^{a}	8.55±0.19^{c}
Total phenols	21.78±0.08^{b}	32.04±0.10^{a}	9.47±0.08^{c}

Means ± standard errors along a row having the same letter(s) as superscript are not significantly different at 5% probability

Table 2. Effects of different aqueous plant extrpot on percentage seed germination, plumule and radicle length of cowpea *Vigna unguiculata* (L.)

Trt.	Conc.	1st trial			2nd trial		
	(%)	SG (%)	PL (cm)	RL (cm)	% SG	PL (cm)	RL (cm)
ET	100	93.33±0.2^{ab}	3.09±0.4^{d}	1.94±0.1^{e}	93.33±1.0^{ab}	3.36±0.2^{d}	2.14±0.1^{ef}
	75	96.67±0.3^{a}	3.21±0.2^{d}	2.69±0.4^{de}	96.67±0.4^{a}	3.36±0.3^{d}	2.52±0.2^{ef}
	50	96.67±0.3^{a}	4.78±0.4^{cd}	3.4±0.3^{de}	96.67±0.4^{a}	4.3±0.3^{cd}	3.03±0.2^{de}
	25	90.00±0.3^{abc}	9.17±0.6^{b}	5.08±0.8^{bc}	96.67±0.5^{a}	5.44±0.3^{c}	4.49±0.3^{bc}
	0	96.67±0.3^{a}	17.64±2.0^{a}	6.21±0.4^{b}	100.0±1.6^{a}	10.56±0.9^{a}	5.03±0.2^{bc}
EU	100	100.0±0.5^{a}	4.68±0.3^{cd}	2.49±0.2^{de}	83.33±0.4^{b}	2.61±0.3^{d}	1.13±0.1^{f}
	75	93.33±0.4^{ab}	3.68±0.3^{cd}	5.03±0.6^{bc}	93.33±1.0^{a}	3.26±0.4^{d}	1.44±0.1^{f}
	50	96.67±0.2^{a}	5.0±0.3^{cd}	3.26±0.3^{de}	97.78±1.2^{a}	3.58±0.4^{d}	1.46±0.1^{f}
	25	93.33±0.4^{ab}	6.74±0.4^{bc}	5.03±0.3^{bc}	100.0±0.8^{a}	3.47±0.3^{d}	1.82±0.2^{ef}
	0	96.67±0.3^{a}	17.64±2.0^{a}	6.21±0.4^{b}	100.0±1.6^{a}	10.56±0.9^{a}	5.03±0.2^{bc}
	100	96.67±0.3^{a}	3.67±0.2^{cd}	1.97±0.2e	100.0±1.2^{a}	5.59±0.4c	3.89±0.3^{cd}
	75	83.33±0.6^{bc}	5.73±0.5^{cd}	3.97±0.3^{cd}	98.90±1.4^{a}	4.14±0.2^{cd}	4.80±0.2^{bc}
LL	50	80.0±0.4^{c}	6.84±0.6^{bc}	3.80±0.4 ^{cd}	96.67±1.2^{ab}	5.53±0.4^{c}	5.91±0.2^{ab}
	25	96.67±0.3^{a}	15.96±0.7^{a}	11.24±1.2^{b}	97.78±1.3^{a}	8.26±0.6^{b}	6.53±0.4^{a}
	0	96.67±0.3^{a}	17.64±2.0^{a}	6.21±0.4b	100.0±1.6^{a}	10.56±0.9^{a}	5.03±0.2^{bc}

ET - Eucalyptus torelliana, EU - Eucalyptus camaldulensis, LL – Leucaena leucocephala , Conc.-concentration, distilled water (0),SG- % Seed Germination, Plumule length –PL, Radicle Lenght- RL. Means ± standard errors within a column followed by the same letter(s) are not significantly different at 5% probability level DMRT

Table 3. Phytotoxic effects of different aqueous botanical extracts and paraquat on plant height and grain yield of *Vigna unguiculata* (Cowpea)

Trt		First trail			Second trail		
	Conc. (%)	5 WAS PH (cm)	9 WAS PH (cm)	Grain yield (g)	5 WAS PH (cm)	9 WAS PH (cm)	Grain yield (g)
P		22.53±2.5^{ab}	42.09±4.1^{bc}	0.37±0.1^{ab}	7.8±0.8^{c}	15.43±1.8^{de}	0.37±0.1^{ab}
ET	100	13.17±2.2^{abc}	18.15±2.0^{cd}	3.07±0.2^{a}	11.90±1.5^{bc}	25.80±2.8^{abcd}	3.04±0.2^{a}
	75	23.10±2.8^{ab}	35.41±2.8^{cd}	1.00±0.1^{ab}	19.17±2.0^{ab}	34.80±4.2^{abcd}	1.01±0.1^{ab}
	50	19.00±2.4^{abc}	37.67±4.6^{bcd}	1.12±0.1^{ab}	18.07±1.9^{ab}	40.33±5.1^{abc}	1.10±0.1^{ab}
	25	18.60±1.8^{abc}	41.56±3.8^{bcd}	1.7±0.1^{ab}	25.0±2.7^{a}	43.43±4.4^{abc}	1.70±0.2^{ab}
	0	16.73±1.8^{abc}	38.11±4.2^{bcd}	0.97±0.1^{ab}	20.60±3.2^{ab}	41.67±4.5^{abc}	0.97±0.2^{ab}
EU	100	15.27±1.4^{abc}	48.46±3.2^{c}	0.63±0.2^{ab}	25.57±3.0^{a}	46.33±3.8^{a}	0.52±0.1^{ab}
	75	26.20±2.4^{a}	44.58±5.2^{ab}	0.73±0.1^{ab}	19.40±2.0^{ab}	44.20±5.0^{abc}	0.93±0.2^{ab}
	50	26.70±2.2^{a}	40.43±4.2^{a}	0.50±0.1^{ab}	17.13±1.9^{ab}	35.17±4.1^{abcd}	0.50±0.1^{ab}
	25	23.30±2.5^{ab}	36.67±3.2^{abc}	0.37±0.1^{ab}	20.33±1.5^{ab}	20.57±3.6^{bcde}	0.42±0.1^{ab}
	0	16.73±1.8^{abc}	42.00±4.2^{ab}	0.97±0.1^{ab}	20.60±3.2^{ab}	41.67±4.5^{abc}	0.97±0.2^{ab}
LL	100	15.57±1.0^{abc}	39.60±2.8^{a}	0.43±0.2^{ab}	20.77±2.1^{ab}	41.13±3.2^{abc}	0.48±0.1^{ab}
	75	16.77±1.2^{abc}	37.71±2.2^{cd}	0.53±0.2^{ab}	19.67±1.9^{ab}	37.67±3.5^{abcd}	0.43±0.1^{ab}
	50	18.83±1.2^{abc}	39.10±3.2^{a}	3.83±0.4^{a}	21.50±2.5^{ab}	42.97±4.0^{abc}	4.23±0.5^{a}
	25	20.20±1.8^{abc}	37.0±2.4^{cd}	0.13±0.1^{ab}	19.77±2.0^{ab}	37.67±2.8^{abcd}	0.10±0.1^{ab}
	0	16.73±1.8^{abc}	40.45±3.2^{a}	0.97±0.1^{ab}	20.60±3.2^{ab}	41.67±4.5^{abc}	0.97±0.2^{ab}

ET - Eucalyptus torelliana, EU - Eucalyptus camaldulensis, LL – Leucaena leucocephala, Paraquat– P, 0%, distresultswater, WAS- Weeks after Sowing, PH- Plant Height.

Means ± standard errors within a column followed by the same letter(s) are not significantly different at 5% probability level DMRT

There were 14 weed species belonging to eight families enumerated in all the pots treated with *Leucaena leucocephala* at three weeks after sowing in the first trial. The relative importance values obtained as highest among all the species encountered were 43.0, 42.9, 35.7 and 29.1 at 25%, 50%, 0% and 100% respectively for *Mitracarpus vilosus*, but relative importance values of 29.1 at 100% was the same for both *Mitracapus vilosus* and *Mariscus alternifolius*. The lowest relative importance values was 4.2 at 25% for *Amaranthus spinosus, Oldenlandia lancifolia* and *Synedrella nodiflora* (Table 4).

In the second trial, a total of nine weed species belonging to seven families were enumerated in all the pots treated with *Leucaena leucocephala*. The relative importance values obtained were highest for *Cyperus esculentus* at 34.8, 32.2, 30.3 and 30.1 23.8 at 100%, 0%, 50% and 25% respectively, while the lowest relative importance value obtained was 3.3 at 100% for *Alternanthera brasiliana* and *Amaranthus spinosus* as shown in Table 4.

There were six weed species belonging to four families enumerated in all the pots treated with Paraquat at three weeks after sowing in the first trial. The relative importance values of 14.0 for *Syndedralla nodiflora* was highest among all the species encountered in the first trial. The lowest relative importance value was 5.0 for *Mitracarpus vilosus* in the first trial as shown in Table 4 also. In the second trial, there was only one weed specie enumerated in all the pots sampled at three weeks after sowing with relative importance values of 10.0 (Table 4).

In summary, it was observed that inhibitory/phytotoxic attribute of *Eucalyptus camaldulensis* (EU) were higher compared to that of *Eucalyptus torelliana* (ET) and *Leucaena leucocephala* (LL). The Relative Importance Value of *Mitracarpus villosus* (52.3) were higher at 3 Weeks After Sowing (WAS) under 100% EU (Table 4), but reduced to 28.5 (100% EU at 9-WAS) as shown in Table 5. Concentrations of *Eucalyptus torelliana* at 100% and *Leucaena leucocephala* at 50% enhanced the grain yield of cowpea. Herbicidal effect of *Eucalyptus torelliana* at 50 to 100% concentrations reduced Relative Important Value of *Mitracarpus villosus* at 9 weeks after sowing.

Table 4. Species composition and Relative Importance Value (RIV) of weeds at 3 weeks after sowing

Trt	Species		First trial						Second trial					
		Family	CM	10%	75%	50%	25%	0%	CM	100%	75%	50%	25%	0%
EU	*Ageratum conyzoides* Linn.	Asteraceae	-	-	-	-	-	-	-	-	-	3.74	12.31	-
	Alternanthera brasilliana (L.) Kuntze	Amaranthaceae	-	-	-	-	-	-	-	-	4.72	4.14	-	3.76
	Amaranthus spinosus Linn.	Amaranthaceae	9.33	11.45	5.66	18.77	13.40	10.71	-	-	-	-	-	-
	Aspilia africana (Pers.) C.D. Adams	Asteraceae	-	-	-	-	-	-	-	-	-	3.74	-	8.38
	Cyperus rotundus Linn.	Cyperaceae	8.67	7.02	5.66	-	-	-	-	-	-	-	-	-
	Cyperus esculentus L.	Cyperaceae	-	-	-	-	-	-	-	52.08	44.37	41.05	37.50	32.22
	Larpotea austeans (Linn.) chew	Urticaceae	-	-	5.65	4.21	-	-	-	-	-	7.47	-	-
	Mariscus alternifolius Vahl	Cyperaceae	8.67	16.63	14.55	21.56	24.16	20.48	-	-	-	-	-	-
	Mitracarpus vilosus (Sw) DC.	Rubiaceae	5.00	52.27	36.98	22.47	32.22	35.71	-	-	-	-	-	-
	Oldenlandia lancifolia (Schumach.) DC.	Rubiaceae	12.00	19.34	24.75	11.05	20.93	11.91	-	-	-	-	-	-
	Oldenlandia corymbosa Linn	Rubiaceae	-	-	-	-	-	-	10.0	13.83	16.03	23.71	20.27	26.67
	Phyllantus amarus Schumach. &Thonn.	Phyllanthaceae		-	-	-	-	-	-	26.33	18.54	14.03	14.02	15.13
	Syndedralla nodiflora (Linn.) Gaertn.	Compositae	14.00	4.43	6.77	9.30	9.29	14.05	-	-	-	-	-	-
	Talinum fruticosum (L) Juss	Talinaceae	-	8.87	-	12.63	-	8.90	-	7.77	16.35	4.14	15.91	9.23
ET	*Ageratum conyzoides* L.	Asteraceae	-	-	-	-	-	-	-	6.82	14.93	-	18.04	-
	Alternanthera brasilliana (L.) Kuntze	Amaranthaceae	-	-	-	-	-	-	-	-	6.94	8.87	-	-
	*Amaranthus spinosus*Linn.	Amaranthaceae	9.33	9.97	9.95	7.49	5.43	10.71	-	-	-	-	-	-
	Aspilia Africana (Pers.) C.D. Adams	Asteraceae	-	-	-	-	-	-	-	5.49	5.97	8.87	-	-
	Cyperus rotundus Linn.	Cyperaceae	8.6	4.52	17.36	-	-	-	-	-	-	-	-	-
	Cyperus esculentus L.	Cyperaceae	-	-	-	-	-	-	-	40.38	39.05	39.78	41.21	32.22
	Larpotea austeans (Linn.) chew	Urticaceae	-	4.52	-	5.53	4.64	-	-	5.05	5.97	-	4.25	-
	Mariscus alternifolius Vahl	Cyperaceae	8.67	13.01	-	22.82	26.62	20.48	-	-	-	-	-	-
	Mitracarpus vilosus (Sw) DC.	Rubiaceae	5.0	27.70	35.42	38.15	34.55	35.71	-	-	-	-	-	-
	Oldenlandia lancifolia (Schumach.) DC.	Rubiaceae	12.00	25.81	39.27	7.49	14.84	11.91	-	-	-	-	-	-
	Oldenlandia corymbosa Linn.	Rubiaceae		-	-	-	-	-	10.0	25.33	9.85	19.46	18.67	26.67
	Phyllantus amarus Schumach. &Thonn.	Phyllanthaceae	-	-	-	-	-	-	-	16.93	13.33	11.22	9.32	15.13
	Setaria barbata (Lam.) Kunth	Poaceae	-	-	-	-	4.64	-	-	-	-	-	-	-
	Syndedralla nodiflora (Linn.) Gaertn.	Compositae	14.0	14.49	-	6.51	9.28	14.05	-	-	-	-	-	-
	Talinum fruticosum (L) Juss	Talinaceae	-	-	-	12.03	-	8.90	-	-	3.96	11.81	8.51	9.23

LL	*Ageratum conyzoides* Linn.	Asteraceae	-	-	-	-	-	-	-	-	-	5.51	8.28	-
	Alternanthera brasilliana (L.) Kuntze	Amaranthaceae	-	-	-	-	-	-	-	3.26	4.03	3.70	6.92	-
	Amaranthus spinosus Linn.	Amaranthaceae	9.33	15.09	15.54	13.60	4.17	10.71	-	3.26	-	-	-	-
	Aspilia africana (Pers.) C.D. Adams	Asteraceae	-	-	-	-	-	-	-	-	9.44	3.70	-	8.38
	Cyperus esculentus L.	Cyperaceae	-	-	-	-	-	-	-	34.78	23.80	30.29	30.10	32.22
	Cyperus rotundus Linn.	Cyperaceae	8.67	4.55	-	16.23	16.85	-	-	-	-	-	-	-
	Larpotea austeans (Linn.) chew	Urticaceae	-	-	-	5.25	-	-	-	6.52	-	-	6.92	-
	Mariscus alternifolius Vahl	Cyperaceae	8.67	29.09	7.69	-	22.46	20.48	-	-	-	-	-	-
	Mitracarpus vilosus (Sw) DC.	Rubiaceae	5.0	29.09	27.69	42.99	42.94	35.71	-	-	-	-	-	-
	Oldenlandia corymbosa Linn.	Rubiaceae	-	-	-	-	-	-	10.0.	12.29	23.56	27.75	26.70	26.67
	Oldenlandia lancifolia (Schumach.) DC.	Rubiaceae	12.0	4.55	23.54	13.60	4.17	11.91	-	-	-	-	-	-
	Phyllantus amarus Schumach. &Thonn.	Phyllanthaceae	-	-	-	-	-	-	-	12.18	6.78	9.57	7.26	15.13
	Syndedralla nodiflora (Linn.) Gaertn	Compositae	14.0	6.55	13.54	-	4.17	14.05	-	-	-	-	-	-
	Talinum fruticosum (L) Juss	Talinaceae	-	6.55	-	-	-	8.90	-	11.22	14.94	9.57	10.71	9.23

CM – Paraquat, ET - Eucalyptus torelliana, EU - Eucalyptus camudulensis, LL - Leucaenaleucocephala; Dw (0) – distilled water

Table 5. Species composition and relative importance value of weeds in cowpea at 9 weeks after sowing cowpea seed

Trt	Species	Family	First trial						Second trial					
			CM	100%	75%	50%	25%	0%	CM	100%	75%	50%	25%	0%
EU	*Ageratum conyzoides*L.	Asteraceae	-	-	-	-	-	-	16.12	7.05	7.55	12.93	24.44	5.11
	Alternanthera brasilliana (L.) Kuntze	Amaranthaceae	-	23.57	21.64	22.29	21.75	-	-	38.64	-	-	-	7.22
	Amaranthus spinosus Linn.	Amaranthaceae	-	5.72	10.03	10.83	8.60	-	-	-	-	-	-	-
	Aspilia Africana (Pers.) C.D. Adams	Asteraceae	-	-	-	-	-	-	10.17	-	4.77	-	-	9.72
	Cyperus esculentus L.	Cyperaceae	-	-	-	-	-	-	-	8.30	30.06	15.87	22.48	16.39
	Cyperus rotundus Linn.	Cyperaceae	5.60	7.14	11.91	4.38	14.70	10.27	-	-	-	-	-	-
	Larpote aausteans (Linn.) chew	Urticaceae	-	-	5.01	-	3.39	8.44	-	-	-	-	-	-
	Mariscus alternifolius Vahl	Cyperaceae	8.46	-	-	-	-	21.02	14.40	38.64	16.95	11.52	7.49	20.50
	Mimosa pudica L.	Fabaceae	-	-	-	-	-	-	-	-	7.55	-	-	-
	Mitracarpus vilosus (Sw) DC.	Rubiaceae	5.60	28.5	-	-	-	6.90	-	-	-	-	-	-
	Oldenlandia corymbosa Linn.	Rubiaceae	-	-	-	-	-		16.12	8.30	9.40	21.50	14.99	87.50
	Phyllantus amarus Schumach. &Thonn.	Phyllanthaceae	-	-	-	-	-	4.20		22.39	18.02	10.81	13.03	9.72
	Shrankia leptocarpa DC.	Fabaceae	-	-	-	-	-	-	14.40	7.05	5.70	9.40	12.05	16.67
	Syndedral lanodiflora (Linn.) Gaertn.	Compositae	11.19	-	-	-	-	18.90	-	-	-	-	-	-
	Talinum fruticosum (L) Juss	Talinaceae	12.62	33.58	30.14	29.79	24.80	10.65	-	8.30	-	5.76	5.53	4.44
	Tithonia diversifolia (Hemsl.) A. Gray.	Asteraceae		4.29	8.14	13.13	3.40			-	-	-	-	-
ET	*Ageratum conyzoides* Linn.	Asteraceae	-	-	-	-	-	-	16.12	-	-	-	-	5.11
	Aspilia africana (Pers.) C.D. Adams	Asteraceae	-	-	-	-	-	-	10.17	-	-	-	-	9.72
	Alternanthera brasilliana (L.) Kuntze	Amaranthaceae	-	-	-	-	-	-	-	-	5.83	7.59	-	7.22
	Cyperus esculentus L.	Cyperaceae	-	-	-	-	-	-	-	28.85	11.65	16.12	19.60	16.39
	Cyperus rotundus Linn.	Cyperaceae	5.60	-	-	-	-	-	10.27	-	-	-	-	-
	Larpotea austeans (Linn.) chew	Urticaceae	-	-	-	-	-	8.44	-	-	-	-	-	-
	Mariscus alternifolius Vahl	Cyperaceae	8.46	-	-	-	-	21.02	14.40	-	-	-	-	20.50
	Mitracarpus vilosus (Sw) DC.	Rubiaceae	5.60	28.53	28.76	42.52	34.15	6.90	-	-	-	-	-	-
	Oldenlandia corymbosa Linn.	Rubiaceae	-	-	-	-	-	-	16.12	-	-	-	-	87.50
	Oldenlandia lancifolia (Schumach.) DC.	Rubiaceae	-	10.47	19.83	14.05	16.18	33.15	33.15	-	-	-	-	-
	Phyllantus amarus Schumach. &Thonn.	Phyllanthaceae	-	-	-	-	-	4.20	-	12.50	18.44	5.09	-	9.72
	Shrankia leptocarpa DC.	Fabaceae	-	-	-	-	-	-	14.40	-	-	-	-	16.67
	Syndedralla nodiflora (Linn.) Gaertn.	Compositae	11.19	-	-	-	-	18.90	-	-	-	-	-	-
	Talinum fruticosum (L) Juss	Talinaceae	12.62	-	-	-	-	10.65	-	-	-	-	-	4.44

LL	*Ageratum conyzoides* L.	Asteraceae	-	-	-	-	-	-	16.12	11.68	16.67	19.90	13.66	5.11
	Alternanthera brasilliana (L.) Kuntze	Amaranthaceae	-	-	-	-	-			-	-	4.00	10.42	7.22
	Amaranthus spinosus Linn.	Amaranthaceae	-	13.21	10.51	-	6.19	-	-	-	-	-	4.05	-
	Aspilia Africana (Pers.) C.D. Adams	Asteraceae	-	-	-	-	-	-	10.17	-	-	-	-	9.72
	Cyperus esculentus L.	Cyperaceae		-	4.30	-	-	-	-	19.56	12.22	18.15	20.49	-
	Cyperus rotundus Linn.	Cyperaceae	5.60	-	-	-	-	10.27	-	-	-	-	-	-
	Larpotea austeans (Linn.) chew	Urticaceae	-	-	-	10.47	3.13	8.44	-	-	-	-	-	-
	Mariscus alternifolius Vahl	Cyperaceae	8.46	27.31	18.21	26.79	27.57	21.02	14.40	6.86	26.67	11.51	14.58	20.50
	Mitracarpus vilosus (Sw) DC.	Rubiaceae	5.60	29.23	28.27	19.64	41.51	6.90	-	-	-	-	-	-
	*Oldenlandia corymbosa*Linn.	Rubiaceae	-	-	-	-	-	-	16.12	-	4.44	26.04	17.36	87.50
	Oldenlandia lancifolia (Schumach.) DC.	Rubiaceae	-	11.03	21.54	53.58	19.37	6.90	-	-	-	-	-	-
	Phyllantus amarus Schumach. &Thonn.	Phyllanthaceae	-	-	-	-	-	4.20	-	14.46	12.22	4.88	4.98	9.72
	Shrankia leptocarpa DC.	Fabaceae	-	-	-	-	-	-	14.40	4.82	10.00	9.76	15.86	16.67
	Syndedralla nodiflora (Linn.) Gaertn.	Compositae	11.19	7.95	12.89	-	-	18.90	-	-	-	-	-	-
	Talinum fruticosum (L) Juss	Talinaceae	12.62	7.95	-	-	5.37	10.65	-	9.64	12.22	5.76	4.98	4.44

Trt. – Treatment, CM – Paraquat, ET - Eucalyptus torelliana, EU - Eucalyptus camudulensis, LL - Leucaenaleucocephal

4. CONCLUSION

This study was designed to assess the efficacy of *Eucalyptus torelliana*, *Eucalyptus camaldulensis* and *Leucaena leucocephala* extracts in cowpea field as a bio-herbicide, our results have shown that the botanicals used were capable of inhibiting the weeds and enhancing the grain yield. Our research therefore, has thrown up many questions in need of further investigation. Further work needs to be done to establish whether botanical extracts can be effective as bio-herbicide in crop production in both small and large scale farming towards enhancement of environmental sustainability and food safety.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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