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 treatments 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).
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 health 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 beneficial to 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 gracilliflora 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], Arantli 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 leguminous 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 torelliana 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.

\[
\text{Percentage Germination} = \left(\frac{\text{No of germinated seeds}}{\text{Total No of seeds plated}}\right) \times 100
\]

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. Weefindbs and their Relative Important Values (RIV) were also determined using standard procedures Akobundu et al. [17]. Relative Importance Value (RIV)

\[
\text{RIV} = \frac{\text{Relative frequency} + \text{Relative Density}}{2}
\]

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 which is 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. *Larplotea austean*a 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, 38.2, 35.7, 35.4 at 50%, 0% and 75%, 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 lanceifolia* 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 *Larplotea austean*a (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 *Larplotea austean*a as shown in Table 4.

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

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

*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 extract 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±0.2ab | 3.09±0.4d | 1.94±0.1f | 93.33±1.0ab | 3.36±0.2d | 2.14±0.1ef |
|     |         | 75        | 96.67±0.3a | 3.21±0.2d | 2.69±0.4de | 96.67±0.4a | 3.36±0.3d | 2.52±0.2ef |
|     |         | 50        | 96.67±0.3a | 4.78±0.4e | 3.4±0.3de | 96.67±0.4a | 4.3±0.3cd | 3.03±0.2de |
|     |         | 25        | 90.00±0.3abc | 9.17±0.6e | 5.08±0.6bc | 96.67±0.5a | 5.44±0.3bc | 4.49±0.3bc |
|     |         | 0         | 96.67±0.3a | 17.64±2.0a | 6.21±0.4c | 100.0±1.6a | 10.56±0.9a | 5.03±0.2bc |
| EU   | 100     | 100.0±0.5a | 4.68±0.3cd | 2.49±0.2ae | 83.33±0.4c | 2.61±0.3a | 1.13±0.1 |
|     |         | 75        | 93.33±0.4ab | 3.68±0.3cd | 5.03±0.6bc | 93.33±1.0a | 3.26±0.4cd | 1.44±0.11 |
|     |         | 50        | 96.67±0.2a | 5.0±0.3cd | 3.26±0.3de | 97.78±1.2a | 3.58±0.4d | 1.46±0.1f |
|     |         | 25        | 93.33±0.4ab | 6.74±0.4bc | 5.03±0.3bc | 100.0±0.8a | 3.47±0.3a | 1.82±0.2ef |
|     |         | 0         | 96.67±0.3a | 17.64±2.0a | 6.21±0.4d | 100.0±1.6a | 10.56±0.9a | 5.03±0.2bc |
|     |         | 100       | 96.67±0.3a | 3.67±0.2cd | 1.97±0.2e | 100.0±1.2a | 5.59±0.4c | 3.89±0.3cd |
|     |         | 75        | 83.33±0.6bc | 5.73±0.5cd | 3.97±0.3cd | 98.90±1.4c | 4.14±0.2cd | 4.80±0.2bc |
| LL   | 50      | 80.0±0.4cd | 6.84±0.8cd | 3.80±0.4cd | 96.67±1.2cd | 5.53±0.4c | 5.91±0.2ab |
|     |         | 25        | 96.67±0.3a | 15.96±0.7a | 11.24±1.2b | 97.78±1.3a | 8.26±0.6b | 6.53±0.4a |
|     |         | 0         | 96.67±0.3a | 17.64±2.0a | 6.21±0.4b | 100.0±1.6a | 10.56±0.9a | 5.03±0.2bc |

*ET - Eucalyptus torelliana, EU - Eucalyptus camaldulensis, LL - Leuecana 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.*

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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 villosus*, but relative importance values of 29.1 at 100% was the same for both *Mitracarpus villosus and Mariscus alternifolius*. The lowest relative importance values was 4.2 at 25% for *Amaranthus spinosus*, *Oldenlandia lancifolia* and *Syledrella 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 brasiliiana* 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 *Syledrella nodiflora* was highest among all the species encountered in the first trial. The lowest relative importance value was 5.0 for *Mitracarpus villosus* in the first trial as shown in Table 4 also. In the second trial, there was only one weed species 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, Paraquat*—P, 0%, distilled water, 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.*

| Trt | First trial | | Second trial | |
|-----|-------------|-------------|-------------|-------------|
| 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 | 42.09±4.1 | 0.37±0.1 | 7.8±0.8 | 15.43±1.8 | 0.37±0.1 |
| ET | 100 | 13.17±2.2 | 18.15±2.0 | 3.07±0.2 | 11.90±1.5 | 25.80±2.8 | 3.04±0.2 |
| 75 | 23.10±2.8 | 35.41±2.8 | 1.00±0.1 | 19.17±2.0 | 34.80±4.2 | 1.01±0.1 |
| 50 | 19.00±2.4 | 37.67±4.6 | 1.12±0.1 | 18.07±1.9 | 40.33±5.1 | 1.10±0.1 |
| 25 | 18.60±1.8 | 41.56±3.8 | 1.7±0.1 | 25.0±2.7 | 43.43±4.4 | 1.70±0.2 |
| 0 | 16.73±1.8 | 38.11±4.2 | 0.97±0.1 | 20.60±3.2 | 41.67±4.5 | 0.97±0.2 |
| EU | 100 | 15.27±1.4 | 48.46±3.2 | 0.63±0.2 | 25.57±3.0 | 46.33±3.8 | 0.52±0.1 |
| 75 | 26.20±2.4 | 44.58±5.2 | 0.73±0.1 | 19.40±2.0 | 44.20±5.0 | 0.93±0.2 |
| 50 | 26.70±2.2 | 40.43±2.9 | 0.50±0.1 | 17.13±1.9 | 35.17±4.1 | 0.50±0.1 |
| 25 | 23.30±2.6 | 36.67±3.2 | 0.37±0.1 | 20.33±1.5 | 20.57±3.6 | 0.42±0.1 |
| 0 | 16.73±1.8 | 42.00±4.2 | 0.97±0.1 | 20.60±3.2 | 41.67±4.5 | 0.97±0.2 |
| LL | 100 | 15.57±1.0 | 39.60±2.8 | 0.43±0.2 | 20.77±2.1 | 41.13±3.2 | 0.48±0.1 |
| 75 | 16.77±1.2 | 37.71±2.2 | 0.53±0.2 | 19.67±1.9 | 37.67±3.5 | 0.43±0.1 |
| 50 | 18.33±1.2 | 39.10±3.2 | 0.38±0.4 | 21.50±2.5 | 42.97±4.0 | 4.23±0.5 |
| 25 | 20.20±1.6 | 37.00±2.4 | 0.13±0.1 | 19.77±2.0 | 37.67±2.8 | 0.10±0.1 |
| 0 | 16.73±1.8 | 40.45±3.2 | 0.97±0.1 | 20.60±3.2 | 41.67±4.5 | 0.97±0.2 |

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

Table 3. Phytotoxic effects of different aqueous botanical extracts and paraquat on plant height and grain yield of *Vigna unguiculata* (Cowpea)
Table 4. Species composition and Relative Importance Value (RIV) of weeds at 3 weeks after sowing

| Trt       | Species                                      | Family         | First trial | Second trial |
|-----------|----------------------------------------------|----------------|-------------|--------------|
|           |                                              |                | CM 10% 75% 50% 25% 0% CM 100% 75% 50% 25% 0% |              |
| EU        | Ageratum conyzoides Linn.                    | Asteraceae     | -           | -            | 3.74 12.31 |
|           | Alternanthera brasiliana (L.) Kuntze         | Aamaranthaceae | -           | -            | 4.72 4.14 3.76 |
|           | Amaranthus spinosus Linn.                    | Aamaranthaceae | 9.33 11.45 5.66 18.77 13.40 10.71 | -            |
|           | Aspilia Africana (Pers.) C.D. Adams          | Aamaranthaceae | -           | -            | -    |
|           | Cyperus rotundus Linn.                       | Cyperaceae     | 8.67 7.02 5.66 - - - - - | 52.08 44.37 41.05 37.50 32.22 |
|           | Larpotea austeans (Linn.) chew               | Urticaceae     | -           | -            | 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 | -            |
|           | Phyllanthus 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                  | Compositae     | -           | -            | -    |
|           |                                              | Talinaceae     | 8.87 12.63 8.90 7.77 16.35 4.14 | 15.91 9.23  |
| ET        | Ageratum conyzoides L.                       | Asteraceae     | -           | -            | -    |
|           | Alternanthera brasiliana (L.) Kuntze         | Aamaranthaceae | -           | -            | 6.94 8.87 |
|           | Amaranthus spinosus Linn.                    | Aamaranthaceae | 9.33 9.97 9.95 7.49 5.43 10.71 | -            |
|           | Aspilia Africana (Pers.) C.D. Adams          | Aamaranthaceae | -           | -            | 5.49 5.97 8.87 |
|           | Cyperus rotundus Linn.                       | Cyperaceae     | 8.6 4.52 17.36 - - - - - | -            |
|           | Cyperus esculentus L.                        | Cyperaceae     | -           | -            | -    |
|           | Larpotea austeans (Linn.) chew               | Urticaceae     | -           | -            | 4.03 39.05 39.78 41.21 32.22 |
|           | Mariscus alternifolius Vahl                  | Cyperaceae     | 8.67 13.01 - 22.82 26.82 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 | -            |
|           | Phyllanthus amarus Schumach. &Thonn.         | Phyllanthaceae  | -           | -            | -    |
|           | 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     | -           | -            | 3.96 11.81 8.51 9.23  |

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| LL | Ageratum conyzoides Linn. | Asteraceae | - | - | - | - | - | - | 5.51 | 8.28 | - |
| Alternanthera brasiliiana (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 | - | - | - | - | - | - |
| Oldelandia corymbosa Linn. | Rubiaceae | - | - | - | - | - | 10.0. | 12.29 | 23.56 | 27.75 | 26.70 | 26.67 | - |
| Oldelandia lancifolia (Schumach.) DC. | Rubiaceae | 12.0 | 4.55 | 23.54 | 13.60 | 4.17 | 11.91 | - | - | - | - | - | - |
| Phyllanthus amarus Schumach. & Thonn. | Phyllanthaceae | - | - | - | - | 12.18 | 6.78 | 9.57 | 7.26 | 15.13 | - | - | - |
| Syndedrella 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 – Leucaena leucocephala, Dw (0) – distilled water
| Trt     | Species                    | Family       | First trial |                        | Second trial |
|---------|----------------------------|--------------|-------------|-------------------------|--------------|
|         |                            | CM           | 100%        | 75%                     | 50%          |
| EU      | Ageratum coryzoides L.     | Asteraceae   | -           | -                       | -            |
|         | Alternanthera brasiliana (L.) Kuntze | Amaranthaceae | 23.57       | 21.64                   | 22.29        |
|         | Aamaranthus spinosus Linn. | Amaranthaceae | 5.72        | 10.03                   | 10.83        |
|         | Aspilia Africana (Pers.) C.D. Adams | Asteraceae   | -           | -                       | -            |
|         | Cyperus esculentus L.      | Cyperaceae   | -           | -                       | -            |
|         | Cyperus rotundus Linn.     | Cyperaceae   | 5.60        | 7.14                    | 11.91        |
|         | Larpotea aausteans (Linn.) chew | Urticaceae   | -           | 5.01                    | 3.39         |
|         | Mariscus alternifolius Vahl | Cyperaceae   | 8.46        | -                       | -            |
|         | Mimosa pudica L.           | Fabaceae     | -           | -                       | -            |
|         | Mitracarpus vilosus (Sw) DC. | Rubiaceae    | 5.60        | 28.5                    | -            |
|         | Oldenlandia corymbosa Linn. | Rubiaceae    | -           | -                       | -            |
|         | Phyllanthus amarus Schumach. & Thonn. | Phyllanthaceae | -            | 4.20                    | -            |
|         | Shrankia leptocarpa DC.    | Fabaceae     | -           | -                       | -            |
|         | Syndedra lanodiflora (Linn.) Gaertn. | Compositae  | 11.19       | -                       | 18.90        |
|         | Talinum fruticosum (L.) Juss | Talinaceae   | 12.62       | 33.58                   | 30.14        |
|         | Tithonia diversifolia (Hemsl.) A. Gray. | Asteraceae | 4.29        | 8.14                    | 13.13        |
| ET      | Ageratum coryzoides Linn. | Asteraceae   | -           | -                       | -            |
|         | Aspilia africana (Pers.) C.D. Adams | Asteraceae   | -           | -                       | -            |
|         | Alternanthera brasiliana (L.) Kuntze | Amaranthaceae | -           | -                       | -            |
|         | Cyperus esculentus L.      | Cyperaceae   | 5.60        | -                       | -            |
|         | Cyperus rotundus Linn.     | Cyperaceae   | -           | -                       | -            |
|         | Larpotea aausteans (Linn.) chew | Urticaceae   | -           | -                       | -            |
|         | Mariscus alternifolius Vahl | Cyperaceae   | 8.46        | -                       | -            |
|         | Mitracarpus vilosus (Sw) DC. | Rubiaceae    | 5.60        | 28.53                   | 28.76        |
|         | Oldenlandia corymbosa Linn. | Rubiaceae    | -           | -                       | -            |
|         | Oldenlandia lancifolia (Schumach.) DC. | Rubiaceae    | 10.47       | 19.83                   | 14.05        |
|         | Phyllanthus amarus Schumach. & Thonn. | Phyllanthaceae | -            | 4.20                    | 12.50        |
|         | Shrankia leptocarpa DC.    | Fabaceae     | -           | -                       | -            |
|         | Syndedra lanodiflora (Linn.) Gaertn. | Compositae  | 11.19       | -                       | -            |
|         | Talinum fruticosum (L.) Juss | Talinaceae   | 12.62       | -                       | -            |

Table 5. Species composition and relative importance value of weeds in cowpea at 9 weeks after sowing cowpea seed.
| Plant Name                           | Family     | Trt. 1 | Trt. 2 | Trt. 3 | Trt. 4 | Trt. 5 | Trt. 6 |
|-------------------------------------|------------|--------|--------|--------|--------|--------|--------|
| Ageratum conyzoides L.              | Asteraceae | -      | -      | -      | -      | -      | -      |
| Alternanthera brasiliana (L.) Kuntze | Amaranthaceae | -    | -      | -      | -      | -      | -      |
| Amaranthus spinosus Linn.           | Amaranthaceae | -    | 13.21  | 10.51  | -      | 6.19   | -      |
| Aspilia Africana (Pers.) C.D. Adams | Asteraceae | -     | -      | -      | -      | -      | -      |
| Cyperus esculentus L.               | Cyperaceae | 5.60   | -      | -      | -      | -      | 10.27  |
| Cyperus rotundus Linn.              | Cyperaceae | -     | 4.30   | -      | -      | -      | -      |
| 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  |
| Mitracarpus vilosus (Sw) DC.        | Rubiaceae | 5.60   | 29.23  | 28.27  | 19.64  | 41.51  | 6.90   |
| Oldenlandia corymbosaLinn.          | Rubiaceae | -     | -      | -      | -      | 16.12  | 4.44   |
| Oldenlandia lancifolia (Schumach.)  | Rubiaceae | -     | 11.03  | 21.54  | 53.58  | 19.37  | 6.90   |
| Phyllantus amarus Schumach. &Thonn. | Phyllanthaceae | - | - | - | - | 4.20 | - |
| Shrankia leptocarpa DC.             | Fabaceae   | -     | -      | -      | -      | -      | -      |
| Syndedrella 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  | -      |

Trt. – Treatment, CM – Paraquat, ET - Eucalyptus torelliana, EU - Eucalyptus camudulensis, LL - Leucaena leucocephal
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-herbicde, 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-herbicde 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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