Allelopathic Effect of Eucalyptus Roots Extract on Germination and Seedling Growth of Selected Varieties of Cowpea (*Vigna Unguiculata)* (L.) Walp)

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Abstract
Allelopathic effect of eucalyptus root extract on germination and growth of some varieties of cowpea (vigna unguiculata (L.) Walp) was investigated. The experiment was conducted at the Botanical garden Federal University Dutse, Jigawa state (latitude 11.00˚N to 13.00˚N and longitude 8.00˚E to 10.15˚E). Two cowpea varieties; Dankaka, a local cowpea variety and IT08-150-12 an improved variety were collected from IITA, Kano station. The experimental design used was completely randomized block design. There were twelve replications per treatment. The treatments used consist of four different concentrations of eucalyptus root extract; 25%, 50%, 75%, 100% and then the control. About 200mls of the different extracts concentrations were applied to the soil before sowing the seeds. The duration of the study was between June 6th- August 9th 2018. Data was collected on Germination and seedling growth namely; Plant height, Number of leaves, Plant fresh weight and Plant dry weight. Data was analyzed using analysis of variance at 5% significance level. The result showed that the germination rate and growth decreased with increasing concentration of the treatments. The overall germination and growth rate of seedlings were reduced with 100% eucalyptus root extract concentration treatment followed by 75% then 50%, the least was 25%. The cowpea variety dankaka was most susceptible to the allelophatic effect of eucalyptus extract with respect to germination, and IT08-150-12 was most susceptible with respect to seedling growth.

Key word: *Allelophatic, cowpea, eucalyptus, dankaka, IT08k-150-12*

1. Introduction

Cowpea is an economically important legume as it is a high-protein food and animal feed crop grown in the semi-arid tropics by small scale farmers. It is usually intercropped and increases soil fertility and reduces soil erosion, however, it is susceptible to attack by pests and diseases at all stages of its growth.

Cowpea (*Vignaunguiculata (L*) Walp.) is one of several species of the widely cultivated genus Vigna. Cowpea are one of the most important food legume crops in the semi-arid tropics covering, Asia, Africa, Southern Europe, central and South America. Cowpeas are well-adapted to the drier region of the tropics, where other food legumes do not perform well. It also has the ability to fix atmospheric nitrogen through its root nodules and it grows well in relatively poor soils with more than 85% sand and with less than 0.2% organic matter and low levels of phosphorus. Cowpea is well known and appreciated for its many useful values includes It provides a rich source of proteins and calories, as well as minerals and vitamin C. A cowpea seed can consist of 25% protein and is low in anti-nutritional factors (Range, *et al*, 2003). It is an important of traditional intercropping system because it is compatible as an intercrop with maize, millet, sorghum, sugarcane and cotton (Singh, 1997). The plants tolerate drought, performs well in a wide variety of soils and being a legume Replenished low soil fertility when the root are left to decay. Because of its adaptability to different types of soil and intercropping system, its resistance to drought and its ability to improve soil fertility and prevent erosion makes it an important economic crop in many developing regions, also the sale of the stems and leaves as feed during dry season also provides vital income for farmers.
Allelopathy is a biological phenomenon where one plant inhibits the growth of another through the release of allelochemicals; certain plants can greatly affect the growth of other plants either in a good or bad way by leaching, decomposition, etc. In essence, plant allelopathy is used as a means of survival in nature, reducing competition from plants nearby.
Allelopathy is existent in the natural ecosystem and it occurs widely in the natural plant communities. Allelopathy is possibly a significant factor maintaining the present balance among the various plant communities.

2. Materials and Method

Experimental Site

The experiment was conducted at Botanical garden Federal University Dutse Jigawa state found in Sudan savannah ecological zone and lie between latitude 11.00˚ N to 13.00˚ N and longitude 8.00˚ E to 10.15˚ E. Jigawa is characterized by two seasons, the rainy and the dry seasons. The rainy season usually begins from May and ends in September with heavier rainfall in July and August, October to May marks the dry season with little or no rainfall. Mean temperature during the study period was around 35ºC maximum temperature and 28ºC minimum temperature.

Collection of Seeds

Dankaka, a local cowpea variety and IT08-150-12 an improved variety were collected from IITA, Kano station. A brief description of the seeds used is given below:

Dankaka

This is a local variety that originated from Kano in the northern part of Nigeria. It is strongly photosensitive and mature after raining season (kaka) that is why the variety name after the season called Dankaka it take about 45 days to flower when the minimum and maximum temperature are between 20 and 33.5^0c, respectively and day length from 13.6 to12.9h day^{-1}. It has an indeterminate growth habit with lateral branches growth up to 2.5m long during dry

season. However, the maturity occur early (takes about 40-45 from sowing to flowering) they have green leaves and white flower the seeds are large with kidney shape.

IT08-150-12

IT08-150-12 is an improved variety that takes about 94 days to mature, is tolerant of drought, leaf spot, and bacterial diseases, and has a white-colored seed with brown eye. Its yield potential is 1460 kg/ha.

Collection of Soil Sample

The soil was collected at 0-15 and 15-30cm depth from Federal University Dutse Agricultural farm the texture of the soil is sandy loam.

Soil Analysis

Analysis of the soil used for this experiment was carried out before planting. The parameters determine were as follows: PH, electrical conductivity, sodium, potassium, calcium, magnesium, total nitrogen, %sand, %silt and clay (Appendix 1).

Preparation of Aqueous Extracts

Mature Root of eucalyptus was collected and was air dried at room temperature for two weeks. The dried root was ground into fine powder using a mortar and pestle. 40 g of the powder was weighed and soaked in 1000 ml of distilled water for 24 hours. The solution was filtered through double layer of muslin cloth followed by No.1 Whatman filter paper. Five concentration levels were prepared i.e 25%, 50%, 75%, and 100% from the root extract and stored separately in conical flasks. Distilled water was used as control (0 %) as described by Jafari *et al* (2007).

Planting

Polythene bags were used in this experiment. The size of the polythene bag used has a length of 48cm and diameter of 38mm.The collected soil sample was air dried under the sun and mixed with cow dung in 3:1 ratio and each of the polythene bags was filled with the soil and watered well for two days before planting. There were twelve replications per treatment. The treatment used consists of four different concentrations of eucalyptus root extract (Allelochemical) at 25%, 50%, 75%, 100% and then the control. Planting was done on 6th June 2018. The Seeds were directly sown on the prepared pots at 2 seeds per pot. Later they were labeled and placed in completely randomized block design and labeled appropriately according to the plant treatment applied.

Experimental Treatment

The experimental treatment used was the extract of eucalyptus root at 25%, 50%, 75% and 100% concentrations level. About 200mls of the different extracts was applied to the soil before sowing the seeds. For the control, no root extract was added to the soil. However, all the necessary nutrients for the growth of cowpea were added to the soil.

Data Collection

Data was collected on germination and seedling growth. The description of the procedure for each is given below:

Germination percentage rate: This was calculated by counting the number seeds that germinated divided by the number of seeds planted multiply by 100 for each of the treated and the control plants.

Germination Percentage rate = Number of germinated seeds/ total number of seeds planted x 100

Seedling Growth parameters: These parameters are as follows:

Plant height in (cm)

The height of the control and treated plants were measured from the ground level to the tip of the stem or terminal bud with the aid of a meter rule and thread and the measurements were recorded.

Number of leaves

The total number of leaves on each of the treated and control plants were counted and the mean was recorded for each treatment

Plant fresh weight: Here the weights of the plants were recorded immediately after they were harvested.

Plant dry weight: Here the weight was recorded after drying the plant at temperature higher than the ambient air temperature (around 65-100^{0}c) to drive off the water.

Statistical Analysis

The data collected was subjected to one-way analysis of variance (ANOVA) and significant differences were further treated to a least significant difference test at P = 0.

3. Results and Discussions

Germination Percentage Rate

Comparison between the treatments on germination percentage rate

The result of the effect of the various treatments on germination percentage rate is shown in Table 1. The treatments induced different responses in the number of days taken to germinate. The control had the highest germination rate with 83.3% and 75.1% in IT08-150-12 and Dankaka respectively this was followed by 25% treatment with 80.2% and 70.3% followed by 50% treatment (75.0% and 68.2%) then 75% treatment (75.0% and 56.5%). The least in germination percentage rate was in 100% concentration treatment with 56.7% and 50.6% in IT08-150-12 and Dankaka respectively.

Comparison between the varieties on germination percentage rate

The result of the different varieties on germination percentage rate is shown in Table 2 comparison of the varieties showed that there was significant difference ($P \leq 0.05$) between the two varieties.IT08-150-12 had 89% germination rate while dankaka had 80% germination rate.

Table 1: Effect of different treatments concentrations (%) of *Eucalyptus camaldulensis* extract on germination percentage rate

Treatment	IT08-150-12	DANKAKA
A-0	83.3^a	75.1^a
B-25	80.2^b	70.3^b
C-50	75.6^c	68.2^c
D-75	75.0^c	56.5^d
E-100	56.7^d	50.6^e
LSD (0.05%)	1.0	0.9

Source: Field Survey, 2018

Table .2: Comparison of the cowpea varieties on germination percentage rate

Variety	germination percentage rate (%)
A-IT08-150-12	89[a]
B-DANKAKA	80[b]
LSD (0.05%)	0.9

Source: Field Survey, 2018

Plant Height

Comparison between the treatments on plant height

Comparison between the treatments showed that the control plants had the highest plant height in all the weeks' i.e. at 2,3,4,5 and 6 weeks after planting with 16.2 cm, 22.8cm, 21.2cm, 26.0cm and 29.3cm respectively. Followed by those plants treated with 25% concentration extract with12.7cm, 18.2cm, 19.5cm, 24.4cm and 26.7cm at 2,3,4,5 and 6 weeks after planting respectively, this was followed by 50% treatment (11.1cm, 15.3cm, 14.1cm, 22.0cm,and 25.0cm) then 75% treatment (10.1 cm, 14.0cm,10.1cm, 17.0cm and 19.2cm) the least in plant height were those plants treated with 100% concentration extract with 8.0cm, 10.8cm, 12.6cm, 12.1 cm and 12.2cm at 2,3,4,5 and 6 weeks after planting respectively. The difference between all the treatments was significant (Table 3).

Comparison between the varieties on plant height

The result on plant height of the two cowpea varieties are presented in Table 4 There was significant difference between the varieties, IT08-150-12 and Dankaka. At 2,3 and 4 weeks after planting IT08-150-12 recorded the highest plant height with 14.8cm, 19.8cm and 16.5cm in contrast to dankaka that had 8.4cm, 12.7cm and 14.5cm at 2,3 and 4 weeks respectively. But at 5 and 6 weeks after planting Dankaka had the highest plant height (24.1cm and 26.8cm) when compared with IT08-150-12 that had 16.5cm and 18.3cm.

Table 3: Effect of different treatments concentrations (%) of *Eucalyptus camaldulensis* extract on plant height (cm) at different weeks after sowing

Treatment	2weeks	3weeks	4weeks	5weeks	6weeks
A-100	8.0[c]	10.8[d]	12.6[c]	12.1[e]	12.2[c]
B-75	10.1[c]	14.0[c]	10.1[c]	17.0[d]	19.2[b]
C-50	11.1[b]	15.3[c]	14.1[b]	22.0[c]	25.2[a]
D-25	12.7[b]	18.2[b]	19.5[a]	24.4[b]	26.7[a]
E-0	16.02[a]	22.8[a]	21.2[a]	26.0[a]	29.3[a]
LSD (0.05%)	2.2	0.5	3.1	1.0	4.5

Source: Field Survey, 2018

Table 4: Comparison of cow pea varieties on plant height at different weeks after sowing

Variety	2weeks	3weeks	4weeks	5weeks	6week
A-IT 08-150-12	14.8^{a}	19.8^{a}	16.5^{a}	16.5^{a}	18.3^{a}
B-Dankaka	8.4^{b}	12.7^{b}	14.5^{a}	24.1^{a}	26.8^{a}
LSD (0.05%)	3.1	0.8	4.1	8.6	9.5

Source: Field Survey, 2018

Number of Leaves

Comparison between the treatments on number of leaves

Comparison between the treatments showed that the control plants had the highest number of leaves in all the weeks' i.e. at 2,3,4,5 and 6 weeks after planting with 9, 16, 15, 17 and 17 respectively. Followed by those plants treated with 25% concentration extract with 8, 14, 13, 16 and 17 at 2,3,4,5 and 6 weeks after planting respectively, this was followed by 50% treatment (7, 13, 10, 15 and 11) then 75% treatment (5, 11, 7, 10 and 11) the least in number of leaves were those plants treated with 100% concentration extract with 4, 9, 10, 12 and 15 at 2,3,4,5 and 6 weeks after planting respectively. The difference between all the treatments was significant (Table 5).

Comparison between the varieties on number of leaves

The result on number of leave in the two cowpea varieties is presented in Table 6. There was significant difference between the varieties, IT08-150-12 and Dankaka. At 3 and 4 weeks after planting IT08-150-12 record the highest number of leave with7 and 11 in contrast to dankaka that had 6 and 10 at 2,3 and 4 weeks respectively. But at 3, 5and6 weeks after planting Dankaka had the highest number of leave (13, 16 and 18) when compared with IT08-150-12 that had 12, 12 and10.8.

Table 5: Effect of different treatments concentrations (%) of *Eucalyptus camaldulensis* extract on number of leaves at different weeks after sowing

Treatment	2weeks	3weeks	4weeks	5weeks	6weeks
A-100	4^{e}	9^{e}	10^{b}	12^{a}	15^{a}
B-75	5^{d}	11^{d}	7^{c}	10^{a}	10^{a}
C-50	7^{c}	13^{c}	10^{b}	15^{a}	11^{a}
D-25	8^{b}	14^{b}	13^{b}	16^{a}	17^{a}
E-0	9^{a}	16^{a}	15^{a}	17^{a}	17^{a}
LSD (0.05%)	0.9	0.9	4.1	9.3	8.6

Source: Field Survey, 2018

Table 6: Comparison between the varieties on number of leaves

Variety	2weeks	3weeks	4weeks	5weeks	6weeks
A-IT08-150-12	7^a	12^a	10^a	12^b	10^b
B-Dankaka	6^b	13^b	11^b	16^a	18a
LSD (0.05%)	0.03	0.01	0.006	0.35	0.62

Source: Field Survey, 2018

Plant Fresh Weight

Comparison between the treatments on plant fresh weight

Comparison between the treatments showed that the control plants had the highest plant fresh weight in all the weeks i.e. at 2,3,4,5 and 6 weeks after planting with 2.2g, 4.5g, 5.0g, 5.8g and 7.1 respectively. Followed by those plants treated with 25% concentration extract with 2.1g, 3.6g, 5.0g, 5.7g and6.1g at 2,3,4,5 and 6 weeks after planting respectively, this was followed by 50% treatment (1.4g, 1.7g, 3.7g, 6.3g and 5.0) then 75% treatment (0.6g, 1.6g, 1.5g, 3.8g and 4.5) the least in plant fresh weight were those plants treated with 100% concentration extract with 0.9g, 1.9g, 2.4g, 2.1g and3.0 at 2,3,4,5 and 6 weeks after planting respectively. The difference between all the treatments was significant (Table 7).

Comparison between the varieties on plant fresh weight

The result on plant fresh weight of the two cowpea varieties is presented in Table 8. There was significant difference between the varieties, IT08-150-12 and Dankaka. At 2,3 and 5 weeks after planting IT08-150-12 recorded the highest plant fresh weight with 1.8g, 3.3g and 5.3in contrast to dankaka that had1.1g, 2.0g and 4.2g at 2,3 and 5 weeks respectively. But at 4and6 weeks after planting Dankaka had the highest plant fresh weight (3.6g and5.4) when compared with IT08-150-12 that had3.4g and4.9g.

Table 7: Effect of different treatments concentrations (%) of *Eucalyptus camaldulensis* extract on plant fresh weight (cm) at different weeks after sowing

Treatments	2weeks	3weeks	4weeks	5weeks	6weeks
A-100	0.9^c	1.9^b	2.4^b	2.1^a	3.0^a
B-75	0.6^b	1.6^b	1.5^c	3.8^a	4.5^a
C-50	1.4^b	1.7^b	3.7^b	6.3^a	5.0^a
D-25	2.1^a	3.6^a	5.0^a	5.7^a	6.1^a
E-0	2.2^a	4.5^a	5.0^a	5.8^a	7.1^a
LSD (0.05%)	0.62	1.0	1.2	3.7	4.2

Source: Field Survey, 2018

Table 8. Comparison between the varieties on plant fresh weight

Variety	2weeks	3weeks	4weeks	5weeks	6weeks
A-IT08-150-12	1.8[a]	3.3[a]	3.4[b]	5.3[b]	4.9[b]
B-Dankaka	1.1[b]	2.0[b]	3.6[a]	4.2[c]	5.4[a]
LSD (0.05%)	0.03	0.01	0.06	0.35	0.62

Source: Field survey, 2018

Plant Dry Weight

Comparison between the treatments on plant dry weight

Comparison between the treatments showed that the control plants had the highest plant dry weight in all the weeks i.e. at 2,3,4,5 and 6 weeks after planting with 0.7g, 0.7g, 1.0g, 1.3g and 0.9g respectively. Followed by those plants treated with 25% concentration extract with 0.5g, 0.6g, 0.8g, 1.2g and0.8g at 2,3,4,5 and 6 weeks after planting respectively, this was followed by 50% treatment (0.5g, 0.5g, 0.6g, 1.2g and0.7g) then 75% treatment (0.4g, 0.3g, 0.3g,0.7g and 0.4g) the least in plant dry weight were those plants treated with 100% concentration extract with 0.3g, 0.3g, 0.7g, 0.3g and 0.3g at 2,3,4,5 and 6 weeks after planting respectively. The difference between all the treatments was significant (Table 9).

Comparison between the varieties on plant dry weight

The result on plant dry weight of the two cowpea varieties are presented in table 10 There was significant difference between the varieties, IT08-150-12 and Dankaka. At 3 and4 weeks after planting IT08-150-12 recorded the highest plant dry weight with 0.6g and 0.7g in contrast to dankaka that had 0.3g and0.6g at 3 and4 weeks respectively. But at 2, 5 and 6 weeks after planting Dankaka had the highest plant dry weight (0.6g, 1.1g and0.9g) when compared with IT08-150-12 that had 0.3g, 0.8g and 0.3

Table 9: Effect of different treatments concentrations (%) of *Eucalyptus camaldulensis* extract on plant dry weight (cm) at different weeks after sowing

Treatments	2weeks	3weeks	4weeks	5weeks	6weeks
A-100	0.3[c]	0.3[c]	0.7[a]	0.3[b]	0.3[b]
B-75	0.4[b]	0.3[c]	0.3[b]	0.7[b]	0.4[b]
C-50	0.5[b]	0.5[b]	0.6[b]	1.2[a]	0.7[a]
D-25	0.5[b]	0.6[a]	0.8[a]	1.2[a]	0.8[a]
E-0	0.7[a]	0.7[a]	1.0[a]	1.3[a]	0.9[a]
LSD (0.05%)	0.13	0.11	0.22	0.65	0.36

Source: Field Survey, 2018

Table 10: Comparison between the varieties on plant dry weight

Variety	2weeks	3weeks	4weeks	5weeks	6weeks
A-IT08-150-12	0.3^{b}	0.6^{a}	0.7^{a}	0.8^{b}	0.3^{b}
B-Dankaka	0.6^{a}	0.3^{b}	0.6^{b}	1.1^{a}	0.9
LSD (0.05%)	0.007	0.01	0.007	0.73	0.60

Source: Field Survey, 2018

Discussion

Germination percentage rate

The allelopathic effect of eucalyptus root extract was tested using five different treatment concentrations (100%, 75%, 50%, 25% and 0%) on two varieties of cowpea (IT08-150-12 and Dankaka). From the result obtained 100% concentration reduced the germination more than any of the treatments when compared with the control that did not reduced germination in any way. This was followed by 75% then 50% and the least in terms of allelophatic effect was 25% concentration. This showed that the higher the extract concentration the more the allelophatic effect and vice versa. Eucalyptus species may have variable effects, as Anwar (1991) observed greater allelopathic effects of the fresh leaves extract of *Eucalyptus alba* than that of *E. deglupta and E. robusta* on the growth of maize seedlings. Similarly Sanginga and Switt (1992) proved reduction in germination of maize seeds when soaked for 48 hours in different proportions of the extract of Eucalyptus camaldulensis on comparing with water, Bisal *et al*. (1992) reported that Eucalyptus has harmful effects on germination and seedling growth of wheat, barley, lentil, chickpeas and mustard.

Between the 2 varieties IT08-150-12 had the highest germination rate percentage when compared with dankaka and the work was similar to the work of Sazada *et, al*. (2009) where he used been extract on different varieties of maize and he reported that allellochemical is a toxic substances that inhibit the growth and germination of crops,

Seedling growth

The seedling growth parameters on two cowpea varieties were also obtained i.e plant height, number of leaves, plant fresh weight and plant dry weight on each treatment at 2,3,4,5 and 6 weeks after planting, the result showed that the allelopathic effect of eucalyptus affected the growth of cowpea.

The treatments induced different responses for Plant height, Number of leaves, Plant fresh weight and Plant dry weight. All the parameters were significantly reduced with 100% and 75% eucalyptus extracts and insignificantly and slightly reduced with 50% and 25% when compared with the control. The result showed that the seedling growth decreased with increasing concentration of the treatments. Comparison between the varieties showed that the variety IT08-150-12 had the highest seedling growth than Dankaka and the difference was significant ($P \leq 0.05$). Sharma *et al.*, (1987) studied the effect of leachates from 4 commonly grown tree species (*Acacia nilotica, E. tereticornis, Dalbergiasissoo* and *Morusalba*) on growth parameters of 4 crops *viz.*, wheat (*Triticumaestivum*), raya (*Brassica juncea*), field pea (*Pisumsativum*) and lentil (*Lens esculenta*). Growth of raya was reduced by all leachates; that of other crops was not much affected. Anwar (1991) tested the effect of extracts of fresh leaves and leaf litter, and of stem flow water from 3 *Eucalyptus* spp. (*E. alba, E. deglupta* and *E. robusta*) on growth of maize seedlings and found that *E. alba* was the most allelopathic species and fresh leaves were the most allelopathic 'extract'.

Bisla *et al.,* (1992) also studied the inhibitory effects of aqueous extracts of dried leaves of *Eucalyptus tereticornis* and *Populusdeltoides* on the seed germination and seedling growth of 5 winter crops: *Triticumaestivum*, *Hordeumvulgare*, *Lens esculenta*, *Cicerarietinum* and *Brassica juncea*. Activity varied with extract concentration, and, in some cases, initial stimulatory effects were obtained.

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Appendix 1: Physicochemical Properties of the Soil Used In the Research Work.

Soil parameter	Physico-chemical parameter
PH	6.2
Organic carbon	0.147% low O.C
Total Nitrogen Na	2.40
EC value	0.24
Calcium	2.35
Sodium Na	0.08
Potassium K	0.01
Magnesium g	S0.66
Soil type	Sandy Loam

Source: Field Survey, 2018