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Comparative Allelopathic Effects of Four Native Weeds on the Growth of Common Beans (*Phaseolus vulgaris* L.) in Nigeria Police Academy, Wudil

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Abstract

The presence of allelochemicals in the soil affects the growth, survival, and reproduction of neighbouring plants. This phenomenon influences crop yield and the dynamics of weed-crop interactions. This study was conducted with the aim of comparing the allelopathic effects of four plant species collected from Nigeria Police Academy, Wudil against the growth of beans (*Phaseolus vulgaris* l.). Results revealed that, comparing the concentrations of the extracts used, 20 mg/l had the greatest effect on the research materials. *Euphorbia hirta* was observed to create the highest inhibition on shoot and root lengths (25.98 and 38.49 %) respectively. Similarly, *Tridax procumbens* produced the highest inhibition on germination percentage (17.19 %) while, *Cynodon dactylon* and *Euphorbia hirta* had the highest inhibiton on seedling vigour (20.03 and 19.78 %) respectively. Based on the results obtained from this study, it can be concluded that all the tested weeds had an effect on the growth of beans. The greatest inhibitory effect was observed when the extracts of *E. hirta* was used. It was also observed that 20 mg/l of the extracts had the highest effect.

Introduction

Allelopathy is a phenomenon where plants release chemicals into the environment that have harmful effects on other plants (Zhang et al. 2021). The presence of allelochemicals in the soil affects the growth, survival, and reproduction of neighbouring plants. This phenomenon influences crop yield and the dynamics of weed-crop interactions (Singh et al., 2021). The production of these allelochemicals depends on the genetic make-up of the plant and environmental condition under which it grows (Singh et al., 2022). They can be released directly or indirectly from live plants, dead plants, or organic wastes. Their release is possible under dry and semi-arid conditions as a result of volatilization, (Kassam et al. 2019). These substances are absorbed as vapors by angiosperm plants, or can be absorbed from the condensate of these vapors in the form of dew, or the condensate can reach the soil and be absorbed by the roots. Ismaini (2015) is of the opinion that the negative effects of allelopathy depend on the concentration of the chemicals it contains.

Weeds are considered the most harmful to agricultural production (Gharde et al. 2018). Worldwide, huge crop losses have been found to result from heavy weed infestations (Kostina-Bednarz et al., 2023). Weeds are aggressive competitors. Several studies have identified weed species such as *Imperata cylindrica*, *Sida acuta*, and

Chromolaena odorata as sources of allelochemicals that negatively impact leguminous crops (Chon et al., 2005). These chemicals, including phenolic acids, flavonoids, and terpenoids, disrupt enzymatic activities, hinder seed germination, and impair root elongation (Weston, 2005).

Common beans (*Phaseolus vulgaris* L.), a vital legume is very important in fixing atmospheric nitrogen in association with nitrogen-fixing bacteria (Abebe & Alemayehu, 2022).and improve soil fertility. According to Osipitan et al., (2021), it is grown for food, vegetables, fodder, green manure, and cover crops. It is cultivated for its protein, and economic value. Common beans offers a solution to the problem of declining protein intake which is attributed to the scarcity and unaffordable prices of animal protein sources like milk, eggs, meat, and fish (Daniel et al., 2023). Recent researches have shown that about 72% of all plants can produce bioactive metabolites also known as allelochemicals (Kalisz et al. (2021). Despite all these uses, common beans is however often affected by weed competition, which can lead to yield reduction. Weed infestation remains a major challenge in agricultural systems, particularly in common beans (*Phaseolus vulgaris* L.) production, where it significantly affects its germination, growth, and yield (Khaliq et al., 2016).

The allelopathic interactions between weeds and beans are of particular concern in agricultural systems where weed infestation is prevalent. They are vulnerable to the effects which alter their physiological and biochemical processes. Research by Dongmo et al. (2025) demonstrated that extracts from *Tithonia diversifolia* at high concentration significantly reduced seed germination and seedling vigor in groundnuts, though, at low concentrations it made the groundnut parameters to perform wellSimilarly, Ekeleme et al. (2003) had found that *Eupatorium odoratum* leachates suppressed root elongation and nutrient uptake in legume crops.

Despite extensive research on weed competition, limited studies have specifically examined the allelopathic effects of different weed species on common beans germination and growth. Many farmers unknowingly cultivate it on fields dominated by potentially allelopathic weeds, leading to reduced seedling vigor, stunted growth, and lower productivity.

This study was primarily carried out with the aim of evaluating the allelopathic potential of selected weed species on the germination and growth of common beans (P*haseolus vulgaris* L.).

Materials and methods

Study Area

This study was carried out in the Laboratory of the Department of Biological Sciences, Nigeria Police Academy, Wudil. Kano.

Sources of Research Materials

The weeds, *Tridax procumbens (T. procumbens*), and *Cynodon dactylon* (*C. dactylon*), *Leucas martinicensis* (*L. martinicensis*) and *Euphorbia hirta* (*E. hirta*) were collected from different areas within Nigeria Police Academy, Wudil. They were validated by Ibrahim Shuaibu of the Department of Plant Science and Biotechnology, Bayero University, Kano.

Preparation of allelopathic extracts

Clean water was used to wash each species thoroughly. Fresh leaves were then cut into little bits and allowed to air dry, after which it was pounded in a mortar. After this, 100 g of each species powder was measured into 1000 ml of water and kept in separate plastic bucket for seven days giving a 10 % (w/v) extract according to the method of Uka et al. (2022).

Administration of the test crops

Seeds of the test crop (*Phaseolus vulgaris* L.) were treated with various doses of the weed aqueous extracts. Ten seeds were placed in an 8 cm petri dishes with two layers of filter paper. Using a syringe and needle, 5ml of 5, 10 and 20 mg/l aqueous extract of each weed was added to the petri dishes on a regular basis. Sterile water was used as control. The treatments were replicated three times. The embryo protrusion criteria were used to measure germination.

Data collection

Germination percentage: was calculated using the method of Rehman et al. (2010)

$$\text{Germination \%} = \frac{\text{no. of seeds germinated}}{\text{Total no.of seeds}} \text{ X } 100$$

Root and shoot length: were measured using ruler (Kabir et al., 2010)

Vigor index = Germination % X seedling length

Percentage inhibition (I) on the growth parameters: This was calculated using the formular

$$I = \frac{E1 - E2}{E1} \text{ X } 100$$

Where, I = % inhibition; E1= Control plant; E2= Treated plants

Data Analysis

Data collected was subjected to one-way analysis of variance test using the statistical package SAS version 9.0.Where there was a significant difference in the treatment, their means were separated using the Duncan's Multiple Range Test (DMRT).

Results and Discussion

Results

Effects of the selected weeds on Germination Percentage

Table 1 presents the effects of the selected weeds on the germination of common beans. Generally, the results showed that there was a gradual decrease in germination percentage across all the treatments as the concentration of the extracts increased. The results also revealed that the control performed better than the treated materials in all the weeds. However, among the treatment materials, at all concentrations, the least germination of 70 % was observed in *E. hirta* (20mg/l) (Table 1)

Table 1: Effects of aqueous leaf extracts (mg/l) of selected weed species on percentage germination of *Phaseolus vulgaris*

Gen/Treatment	Control (mg/l)	5 (mg/l)	10 (mg/l)	20 (mg/l)
L. martinicensis	99.33^{a}	95.67^{a}	90.00^{a}	82.00^{a}
C. dactylon	97.00^{b}	92.67^{b}	88.00^{b}	75.00^{b}
T. procumbens	95.00^{c}	85.00^{c}	80.67^{c}	72.00^{c}
E. hirta	90.00^{d}	80.00^{d}	75.00^{d}	70.00^{d}
Mean	95.33	88.34	83.42	74.75
S.E.±	0.64	2.12	1.77	3.77

Means with the same letters in a column are not significantly different

Effects of the selected weeds on shoot length

The effects of the aqueous leaf extracts of the weeds on the shoot length is presented in Table 2. The results indicated an inverse relationship between the treatments and the shoot length. The shoot length decreased as the concentration of the weed extract increased, though there appears to be no significant difference at the concentrations of 0, 5, and 10 mg/l in the plant extracts. As such, the shortest shoot length of 5.42 cm was observed in *C. dactylon.*t at 20 mg/l (Table 2).

Table 2: Effects of aqueous leaf extracts of selected weed species on the shoot length of *Phaseolus vulgarris*

Treatment	Control (mg/l)	5 (mg/l)	10 (mg/l)	20 (mg/l)
L.martinicensis	11.65^{a}	10.15^{a}	9.10^{a}	8.37^{a}
C. dactylon	9.74^{a}	9.30^{a}	8.40^{a}	5.42^{b}
T. procumbens	12.00^{a}	$9{,}67^{a}$	9.50^{a}	7.82^{a}
E. hirta	10.93^{a}	10.05^{a}	8.70^{a}	7.12^{ab}
Mean	11.08	9.79	8.93	7.18
S.E. ±	1.26	1.00	1.00	1.15

Means with the same letters in a column are not significantly different

Effects of the selected weeds on root length

Table 3 shows the effects of the aqueous leaf extracts of the selected weeds on the root length of common beans. The results revealed that there was a gradual reduction in the length of the roots as the concentration of the weed extracts were increased. As such the control treatments had the longest roots. However among the treated materials, the longest roots were observed at the concentration of 5 mg/l in all the weeds. The greatest effect observed in E. hirta at the concentration of 20 mg/l (Table 3).

Effects of the selected weeds on seedling vigour

Table 4 presents the results of the effects of weed extracts on seedling vigour index of common bean. It was observed from the results that there was a gradual reduction in the seedling vigour as the concentration of the extracts were increased. The results showed that the vigour ranged between 11.50 (*C. dactylon*) and 23.67 (*T. procumbens*) when 20 mg/l and 5 mg/l concentrations were used respectively. The results further indicated that, the control experiments performed better across board and were followed by the treatment with 5 % concentration. All treatments with 20 % concentration gave the least vigour (Table 4).

Table 3: Effects of aqueous leaf extracts of selected weed species on the root length of *Phaseolus vulgaris*

Treatment	Control (mg/l)	5(mg/l)	10 (mg/l)	(20 mg/l)
L.martinicensis	13.63ᵃ	10.35ᵃ	10.40ᵃ	10.21ᵃ
C. dactylon	9.74ᵇᶜ	9.30ᵇ	8.05ᵇᶜ	6.42ᶜ
T. procumbens	10.63ᵇ	9.50ᵃᵇ	9.05ᵃᵇ	7.62ᵇ
E. hirta	8.60ᶜ	6.05ᶜ	6.70ᶜ	4.12ᵈ
Mean	10.65	9.05	8.55	7.07
S.E. ±	0.97	1.01	1.00	1.00

Means with similar letter within a column are not significantly different

Table 4: Effects of aqueous leaf extracts of selected weed species on seedling vigour index of *Phaseolus vulgaris*

Treatment	Control (mg/l)	5 (mg/l)	10 (mg/l)	20 (mg/l)
L.martinicensis	25.45ᵃ	23.67ᵃ	20.32ᵃ	18.62ᵃ
C. dactylon	19.75ᵇ	18.98ᶜ	16.80ᵇ	11.50ᵇ
T. procumbens	23.75ᵃ	21.33ᵇ	20.00ᵃ	16.95ᵃ
E. hirta	19.08ᵇ	17.80ᶜ	15.87ᶜ	12.25ᵇ
Mean	22.01	20.43	18.37	14.81
S.E. ±	1.33	0.99	0.87	1.00

Means with the same letter within a column are not significantly different

Comparative effects of aqueous leaf extracts of weed species on germination and growth of common beans seedlings

Germination Percentage

Figure 1 shows the comparative effects of the leaf extract of the selected weeds on the germination of Phaseolus *vulgaris*. The highest reduction was observed when the leaf extract of *Tridax procumbens* (17.19 %) was used. This was followed by *Euphorbia hirta* while the least inhibition was observed in L. *martinicensis* (15.93 and 11.53 %) respectively.

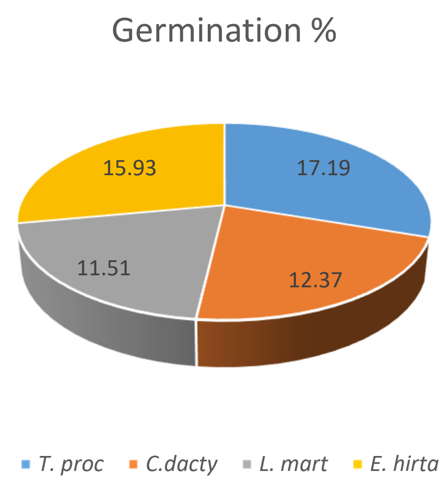

Figure 1: Comparative effects of aqueous leaf extracts of selected weed species on percentage germination

Shoot Length

Figure 2 presents the comparative effects of the leaf extracts of selected weeds on the shoot length of common beans. The results indicated that the greatest inhibition was caused by *Euphorbia hirta* (25.95 %). This was followed by *L. martinicensis* and *Tridax procumbens* (22.72; 22.36 %) while, *C. dactylon* showed the least inhibition with 20.16 % inhibition.

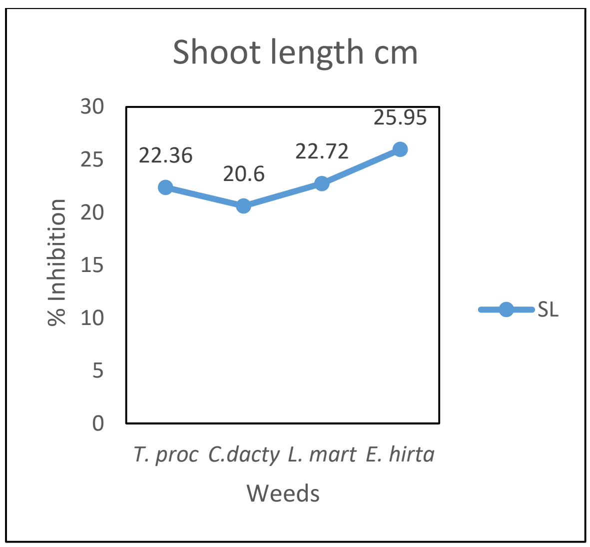

Figure 2: Comparative effect of the leaf extract of selected weeds on the shoot length of common beans

Root Length

Figure 3 shows the comparative effects of selected weeds on the root length of common beans. The results revealed that the highest inhibition was observed in *Euphorbia hirta* treated common beans (38.49). This was followed by *L. martinicensis* (22.71). The least inhibition was observed in *Tridax procumbens* with 21.75.

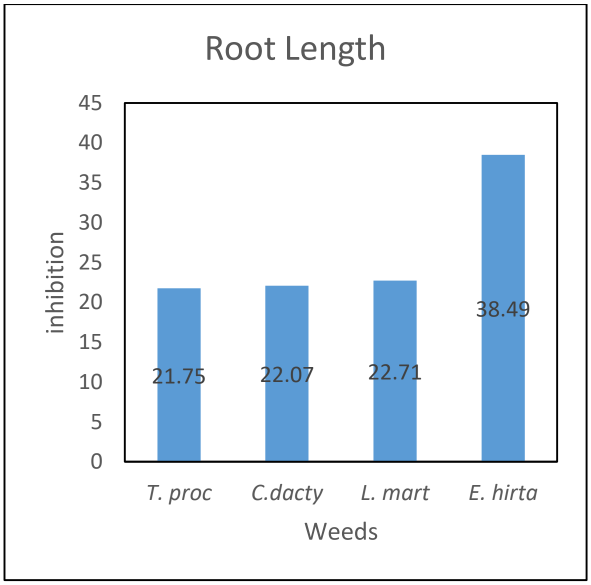

Figure 3: Comparative effects of selected weeds on the root length of common beans

Seedling Vigour Index

Figure 4 presents the comparative effects of the leaf extracts of selected weeds on the seedling vigour of *Phaseolus vulgaris*. The results indicated that *C. dactylon* created the highest inhibition with 20.3 % of the inhibition. This was followed by *Euphorbia hirta* (19.78 %) then by *Tridax procumbens* (17.49). *L martinicensis* had the least inhibition of 16.84 %.

Discussion

The inhibitory effects of the four selected weeds on *Phaseolus vulgaris* L seed germination and seed growth was clearly evident in this study. The results showed that seedling germination and total seedling growth were gradually reduced by the extracts of all the weeds, this happened as the concentrations of the leaf extracts were increased. Uka et al. (2022) had earlier reported that, the least suppression was seen at a concentration of 5%, while the highest suppression was observed at a concentration of 20%. Similarly, Ayeni & Kayode (2014) reported that the effects of the extracts were concentration-dependent.

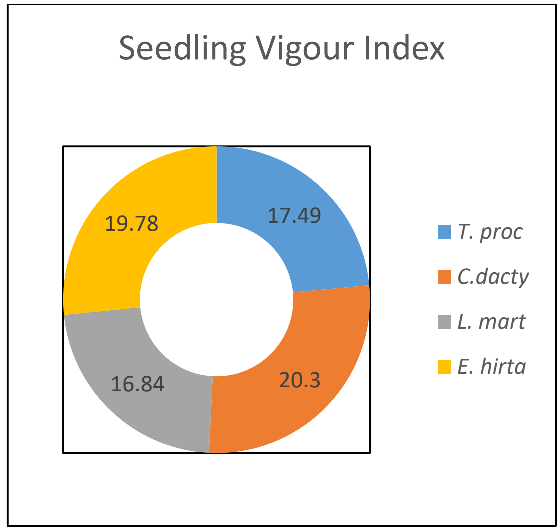

Figure 4: Comparative effects of the leaf extracts of selected weeds on the seedling vigour of common beans.

This finding is in consonance with the works of Al-Behadili (2025) who reported that mixing clover residues with soil significantly reduced the germination and growth of barley crops, and this effect increased with the concentration of plant residues. Similarly, Grisi et al. (2012) reported that the germination of barnyard grass and morning glory diaspores were prevented from growing by the leaf extracts of *Sapindus saponaria.*

When compared to the control, the treatment with aqueous extract of *Tridax procumbens* resulted in a consistent reduction in seed germination, root length, shoot length, seedling length and seedling vigour index of common beans. The presence of allelochemicals in *Tridax procumbens* may be responsible for the decrease in these parameters. Ghodake et al. (2012) investigated the allelopathic effect of *Euphorbia* species on wheat germination and observed inhibition in germination percentage and root-shoot length. The effect of several weed extracts on seed germination, radicle, plumule length, biomass of *Zea mays* and seedlings have been reported by Gella et al. (2013). The seed vigour index of weed extracts decreased as concentrations increased (Uka et al., 2022; Zohaib, 2014). The concentrations of aqueous extract of *Tridax* *procumbens* significantly reduced root and shoot length. Allelochemicals responsible for root and shoot length inhibitions have been identified as phenolic compounds (Sein et al., 2022). Popoola et al. (2020) reported a similar inhibitory effect of *Tridax procumbens* aqueous extract on cowpea. Similarly, allelopathic effect of spurge (*Euphorbia hierosolymitana*) on wheat was studied by Saeid et al. (2010), and they asserted that the extract inhibited both plumule and radicle lengths. Similarly, this study showed that the aqueous extract of *E. hirta* inhibited the germination and growth of the common beans seedlings. The higher the concentration of *E. hirta* aqueous extract on common beans, the higher the inhibitory effect. These findings are in line with those of Uka et al. (2022) on maize, Otusanya et al. (2015) on hibiscus and Popoola et al. (2020) on cowpea. They observed that varying the concentration of *T. diversifolia* and *C. odorata* greatly reduced the germination of the seeds of *H. sabdariffa. Similarly,* Ilori et al. (2010) observed that the aqueous extract of *C. odorata* significantly reduced germination, plumule and radicle length in *Vigna unguiculata*. The allelochemicals in the aqueous extracts either prevented embryo development or slowed the mitotic division process of the seeds (Marharjan et al., 2007).

The allelopathic suppression of germination might be caused by phenolic compounds in the aqueous extracts which inhibit water intake and alter gibberellic acid production or activity (Otusanya & Ilori, 2012). The common beans radicle and plumule growth was considerably reduced by the aqueous extract of *E. hirta*. The radicle and plumule inhibition increased as the concentration of the aqueous extract was increased. This is in line with the findings of Sein et al. (2023) who reported a 50 % reduction in the shoot and root length of cress after being treated with varying concentrations of *Marsdenia tenacissima* leaves. The development of the plumule was greatly delayed in this study compared to that of the radicle. The suppression of the radicle by the aqueous extracts might be due to direct interaction of the radicle with allelochemicals (steroidal glycoside 3) in the extract, which could interfere directly with respiration or oxidative phosphorylation (Sasinath et al., 2006; Uka et al., 2022).

The application of the aqueous leaf extract of *C. dactylon* also resulted in a significant decrease in seed germination rate in the beans studied. In this study the root length, shoot length and seedling length of the research were significantly reduced. Sein et al. (2022) reported that, at concentrations greater than 10 mg dry weight of *Ochna integerrima* leaf extracts had an inhibitory impact on the radicle and plumule of six different important plants. He also noted that the roots were more susceptible to the treatment than the shoot. The allelochemicals observed in the plant leaves may be responsible for the inhibitory actions.

Furthermore, the results also revealed that the leaf extracts of *L. martinicensis* also caused a remarkable decrease in the traits of the beans studied. The effect was also observed to be dose dependent. As the concentration increased, there was a corresponding decrease in the traits. These effects may be as a result of certain inhibitory compounds like flavonoids, alkaloids and phenolic compounds contained in this weed. This result is in consonance with the work of Al-Behadili (2025) who reported that germination and growth parameters including shoot and root biomas of barley was inhibited by clover residues. These compounds are known for their effect on vital processes at the seed germination stage and seedling growth due to the effect of allelopathic compounds on most of the physiological activities of the plant when they enter the cells with water, such as affecting cell permeability, building proteins, respiration, and the process of photosynthesis.

The results also revealed that there was a differential effect on the germination and growth of common beans. *Euphorbia hirta* was observed to be the most notorious among the weeds, followed by *Tridax procumbens*. These two have been reported to affect most plants and cause them not to grow and, if they grow, they will not develop well. Fendiyanto et al. (2024) reported that *Clidente hirta* was however positively used to enhance rice production by inhibiting the growth of other weeds.

Conclusion

Based on the results obtained from this study, it can be concluded that all the selected weeds had significant anti- growth effects on the germination and growth of common beans (*Phaseolus vulgaris*). The study also concludes that the concentration of the extracts had a significant effect on the growth of common beans. In all the plant extracts, 20 mg/l had the greatest effect. It can also be concluded that *Euphorbia hirta* created the highest inhibition.

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