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Evaluation of the Effects of Selected Plant Concentrates on the Growth of a Parasitic Plant; Field Dodder (*Cuscuta campestris*) and *Duranta erecta*

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Authors' contributions

This work was carried out in collaboration between both authors. Author BOO designed the study, did experiments, wrote the protocol, managed analyses of the data, literature surveys and wrote the manuscript. Author SMA did experiments, managed analyses of data and wrote the manuscript. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aims: To determine effect of selected plant concentrates on the growth of field dodder (*Cuscuta campestris*).
Study Design: A factorial experimental design; using four level extract application from blue gum, cypress, napier grass and distilled water as the control.
Place and Duration of Study: Masinde Muliro University of Science and Technology from June 2018 to March 2019.
Methodology: It incorporated use of 4 by 4 contingent field experiment, with *Duranta erecta* and *Cuscuta campestris* as independent and dependent variables respectively. It contained three experimental groups of extracts from the blue gum, cypress, Napier grass and distilled water as a control. Each treatment level was replicated four times. Samples of the affected plants (*Duranta erecta*) intertwined with parasite were purposive randomly selected. The parasites point of attachment through a haustoria for selected plants was marked with threads as a start point of

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measurements taken. Marked strings were of different colors to distinguish the type's treatments (concentrates) being applied. Application of 30 ml/cm^2 each of the extracts was done on both plant and parasite. Measurements of the plant heights, parasite length, number of plant leaves and application of extracts were done after every 48 hours.

Results: Analysis of the effects of different concentrates as treatments of the same on parasite length increase, exhibited some differences (F = 1.648, *P* = .18). The mean ranged from lowest to highest extracts of the; cypress at (29.0 ± 17.23), Napier grass at (34.6 ± 28.7), blue gum at (38.7 ± 28.6), and distilled water at (39.4 ± 27.4) respectively.

Conclusion: Cypress extract had the most effect on the *C. campestris.* Followed by blue gum extract which exhibited some effects, then Napier grass. This evidently shows that the parasitic weed can be controlled biologically.

Keywords: Dodder; Cuscuta campestris; Duranta erecta; plant concentrates; blue gum; cypress; Napier grass.

ABBREVIATIONS

C. campestris – Cuscuta campestris
D. erecta – Duranta erecta

1. INTRODUCTION

Field dodder (*Cuscuta campestris*) is an annual obligate stem parasite that attaches itself to a variety of host plants, and is totally dependent on its host plant for assimilating nutrients and water supply. Zaroug et al. [1]. The genus Cuscuta (dodder) are obligate parasitic plants with approximately 170 species distributed throughout the world, Holm et al., [2]. It has common names such as the golden dodder, large-seeded alfalfa dodder, yellow dodder, devil's gut, devil's hair and hail weed among others, belongs to the family Convolvulaceae [3]. Most species of the golden dodder plant consist of mainly leafless, glabrous, yellow or orange twining stems and tendrils, bearing inconspicuous scales in the place of leaves. For *Cuscuta campestris*, the yellow to pale orange true stems, about 0.3 mm in diameter, generally do not twine and attach to the host, but produce tendrils of similar appearance, arising opposite the scale leaves, which do not form coils and haustoria, Agnew, A. D. Q. and Agnew, S. [4].

The native range of this species is obscure. It is thought to be native to North America (Canada, USA and Mexico) and parts of the Caribbean. It is possibly also native parts of South America. Location within which *Cuscuta campestris* has most commonly neutralized in temperate and sub-tropical regions and least abundant in the tropics of Central America, Africa, South East Asia and the Pacific Ocean. It is invasive in parts of Kenya, Tanzania and Uganda. Though the species is widely distributed throughout East Africa, there are few representative collections. CABI Publishing [5].

Cuscuta campestris is not only an aggressive weed but can additionally serve as a vector for pathogens, such as Cucumber Mosaic Virus and African Cassava Mosaic Virus, Wisler and Norris 2005 [6]. Current control methods include separation of dodder seeds from crop seeds, pre-emergent herbicides [7,8] and mechanically burning or pulling off dodder from the host plants [6]. *C*. *campestris* is challenging to control because it climbs and wraps up on plants tightly, causing breakage of shoots during hand weeding, Melifonwu et al., [9].

On the process of its germination, the dodder grows in a funny way. It is dicotyledonous and the seedling has only one rudimentary root for anchorage, while the shoot swings around anti-clockwise about, until it makes contact with any stem or leaf, round which it will coil before growing on to make further contacts [10]. The root and the shoot below this initial attachment soon die, leaving no direct contact with the soil, thus it is very hard for one to trace the growth point of the plant at this stage. The plant develops haustoria which are hollow; they penetrate the vascular bundles of the host plant, thus suck nutrients. At this stage, we only see the stem of the dodder plant. After attachment, the dodder attaches their stems to the host plant and cause serious havoc. Agnew, A. D. Q. and Agnew, S., [4].

Dodder is a nonspecific parasite that attacks, sometimes simultaneously a wide range of host species including many cultivated plant species and dicotyledonous weeds, but not grasses or monocotyledonous weeds, Dawson et al., [11].

The golden dodder is a very deadly parasitic weed, however not known to many. Even though it was introduced in Africa several decades ago, and introduced to Kenya in 1963. It has taken

long to spread. However, it is fast spreading in Western parts of the country [4]. The parasite attacks mainly trees, especially the Yellow oleander (*Thevetia peruviana*) or the Euphorbia tree. It also attacks tea farms. The plant has set upon hedges, woody flowerbeds with a vengeance [12,13,14]. It has affected agro forestry, fruit trees and crops among others, Otieno, [15]. Due to its chocking nature, Cuscuta has dried up several plants since it takes up their nutrients, leading to stunted growth, the shade that it forms affects the growth of understory plants, a major reduction in farmers harvest and also a major disturbance to the whole food chain. Most of the animals which depend on plants may also be affected after the drying up and even extinction of certain plant species. The few plants with medicinal values may also diminish once they are brought down by the parasitic plant. This will end up causing a major reduction in plant species diversity. As part of mitigation measures, suggestions of pruning the area of attachment which lead to destruction of host plants, burning the plant and pushing for legislation to list dodder as a prohibited noxious weed.

Thus, the study is focused on fact finding and developing better and eco-friendly ways towards the eradication of field dodder, so as to restore plants which have already been affected or may be susceptible in future. This involves the use of plant concentrates from species that are resistant to the attack of the parasite. This will relieve the farmers and the ecosystem from the effects of dodder.

2. MATERIALS AND METHODS

2.1 Study Site

The research was conducted in Kakamega County at Masinde Muliro University of Science and Technology. The study site was situated along the Comrades Walkway C2, adjacent to the University Bookshop. It falls within the coordinates of 0.288515, 34.765211. The natural environment site was measured and demarcated to a definite study plot measuring 3.2 m by 1.0m in length and width respectively. The area generally had an average temperature of 27 ºC high and 25 ºC low, humidity at 83 %, dew point 62 º, pressure 29.95 pt and wind W4 mph.

2.2 Collection of the Plant Concentrates

The plant concentrates were each extracted from barks and leaves of blue gum tree (*Eucalyptus globulus)*, cypress (*Cupressus sempervirens* Linnaeus*)* and napier grass (*Pennisetum purpureum)*. Fresh leaves and barks of the cypress tree were collected, air dried for 5 days under a shade. The dried particles were separately ground into fine powder ready for analysis. 250 grams of the powder from both the leaves and barks were separately weighed. Through the application of cold extraction method, the weighed quantity of the samples were dissolved in 500 ml methanol then left in the flask for 72 hours at room temperature. The obtained extract was filtered into a conical flask using a funnel and a filter paper to obtain the methanol extract. The residue left was again subjected to second successive extraction according to the procedure described above to obtain the second methanol extract. This process was done six times to exhaustively extract the plant components. The extract obtained was then concentrated using a rotary evaporator at 45°C. The concentrated extract was then stored in 500 ml violes. The same extraction procedure was repeated for napier grass and blue gum particles. All the final extracts in containers were properly labelled and stored at room temperature. The obtained extracts were then subjected to phytochemical tests to confirm the presence of different phytochemical components.

2.3 Phytochemical Screening

Phytochemical screening was carried out on each of the extracts; cypress, blue gum and napier grass by the use of standard methods. Each of the concentrated extract was underwent qualitative tests through standard procedures [16,17] to detect the presence of alkaloids, flavonoids, saponins, tannins, steroids and terpenoids [18].

The results obtained for the chemical analysis of the extracts as per their chemical composition and percentages are as shown in Table 4.

2.4 Field Set up

The study site was a 3.2 m^2 demarcated area having samples of the *Duranta erecta* plant affected by the dodder. Only those that had the parasite intertwined on them were taken into consideration. For each plant that was selected, the parasite's point of attachment through a haustoria was marked with threads to be used as the place to begin any of the measurements. The threads were subdivided into four main groups which also had four more replicates each. The marked strings were red, blue, green and white

representing the type of treatments which were extracts from blue gum, cypress, Napier grass and distilled water respectively.

Application of 30 ml/cm^2 of the plant concentrates was done using clearly labelled 1 inch painting brushes for each of the extracts. The extracts were applied on both the *D. erecta* and the *C. campestris*. Measurements of the plant heights, parasite length, in centimeters; counting of the plant leaves and application of the extracts were done after every 48 hours for a period of 864 hours (36 days). The extracts were often picked from their storage in the laboratory to the site during application days.

3. RESULTS AND DISCUSSION

3.1 Results

The analysis of the effects of different concentrates as treatments of the same on parasite length increase, they exhibited some differences (F = 1.648, *P* = .18). This was shown on the cypress extracts application having the lowest mean of 29.0 ± 17.23, followed by Napier grass with a mean of 34.6 ± 28.7 and that of blue gum having a mean of 38.7 ± 28.6. The application of distilled water had the highest mean of 39.4 ± 27.4 as indicated in Table 1(a).

Narrowing to the analysis of the effects of plant concentrates as a treatment of the same on *D. erecta* height, there were notable differences at (F = 0.834, *P* = .47) were observed on the same. However, the application of napier grass extracts had the lowest mean of 7.0 ± 2.3 followed by cypress extracts with a mean of 7.4 ± 3.2 while blue gum had a mean of 7.8 ± 4.7 and the application of distilled water had the highest mean of 8.0 ± 3.2

Table 1. The effects of plant concentrates on *Cuscuta campestris*

1(a) Descriptive statistics

Dependent variable: Parasite height

Treatment	Mean ± Standard deviation
Water	39.36 ± 27.43
Blue gum	38.87 ± 28.56
Napier grass	34.63 ± 28.72
Cypress	29.01 ± 17.24

1(b) Tests of between – subjects' effects

Source	F	Significance
Treatment	1.658	0.18

Table 2. The effects of plant concentrates on *Duranta erecta* height

2(a) Descriptive Statistics

Dependent variable: *Duranta erecta* height

Treatment	Mean ± Standard deviation
Water	8.02 ± 3.25
Blue gum	7.84 ± 4.68
Cypress	7.43 ± 3.15
Napier grass	7.01 ± 2.31

2(b) Tests of between – subjects' effects

Source	F	Significance
Treatment	0.834	0.477

Emphasizing on the analysis of the effects of plant concentrates and distilled water as a treatment on the *D. erecta* leaves, a difference at (F = 2.438, *P* = .07) was observed on the same. However, the application of distilled water as a control had the lowest mean of 7.4 ± 1.5 followed by cypress extracts having a mean of 7.9 ± 4.2, then blue gum extracts having a mean of 8.0 ± 1.6. Napier grass extracts had the highest mean of 8.9 ± 2.4.

The table contains phtochemical composition of the obtained extracts and their percentage composition.

3.2 Discussion

3.2.1 Determination of effect of plant concentrates on *Cuscuta campestris*

Cuscuta campestris reacted differently to various treatments that were applied. The three treatments (cypress, blue gum, napier grass) and the control exhibited different results upon application.

The application of cypress extracts had the least mean as shown on (Table 1a). Notable effects observed on the field dodder were; some replicates began to wilt as extract application and time progressed. This showed that Cypress extract application had an impact on the parasitic weed due to the high presence of saponins. Other aspects that may have brought about these results and observation can be attributed to the presence of glyceric and glycolic acids in cypress plant that causes burning effects on the parasitic weed, Botanical-online. Cypress compounds. 2018 [19]. Napier grass extract which had the second last mean, caused a scorching effect on the *Duranta erecta* leaves along the edges.

Table 3. The effects of plant concentrates on *Duranta erecta* leaves

3(a) Descriptive statistics

Dependent variable: *Duranta erecta* leaves

Treatment	Mean ± Standard deviation
Napier grass	8.85 ± 2.35
Blue gum	8.01 ± 1.68
Cypress	7.96 ± 4.22
Water	7.41 ± 1.54

3(b) Tests of between subjects – effects

Source	F	Significance
Treatment	2.438	0.066

Table 4. Phytochemical percentage composition

Plant extract	Chemical group	Percentage composition (%)
Cypress	Alkaloids	0.7
	Flavonoids	0.22
	Tannins	0.31
	Saponins	1.9
	Phenola	0.067
	Totals	**3.197**
Blue gum	Flavonoids	0.666
	Saponins	1
	Tanins	1.2
	Alkaloids	1.2
	Totals	**4.066**
Napier grass	Alkaloids	0.004
	Saponins	0.002
	Flavonoids	0.021
	Tannins	Nil
	Totals	**0.027**

3.2.2 Determination on the effect of plant concentrates on *Duranta erecta* plant leaves growth and height

The analysis of the effects of plant concentrates on the *Duranta erecta* leaves growth and height, some differences were observed. Napier grass concentrates showed some effect on the *D. erecta* leaves as it had the least mean after statistical data analysis, according to (Table 3a). As application progressed, the *Duranta erecta* leaves were drying up at the edges. Some ended up falling off due to the burning effect of the extract attributed to the high concentrations of flavonoid components. Its height reduced too as the leaves were dying up. There may also be some secondary compounds found in napier grass; which has Ethyl acetate, ethanol and nitrate compounds that are toxic if comes in contact with plant leaves [20]. The blue gum and cypress applications showed no effect on the leaves and the height as the growth rate of the *D. erecta* went on normally. This was clearly shown by the high means obtained for the two concentrates and the control.

4. CONCLUSION

Cypress extract had the most effect on the *C. campestris* by reducing its growth at a rate of 3 cm per 48 hours and making it to wilt with time. The blue gum extract also exhibited some effects on the growth of the dodder at a rate of 1 cm per 48 hours but not as much as that of Cypress, followed by that of napier grass. This evidently shows that the parasitic weed can be controlled biologically. On the *Duranta erecta* plant, napier grass had the most effect on its growth.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Fig. 1. *Cuscuta campestris* on *Duranta erecta*

Fig. 2. *Cuscuta campestris* point of attachment to the *Duranta erecta* (3cm coil)

Fig. 3. Blue string; Point for cypress extract application

Fig. 4. Green string; Point for napier grass extract application

Fig. 5. Red string; Point for blue gum extract application

Fig. 6. *Cuscuta campestris* on Yellow oleander tree

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