

Allelopathic Potential of Botanical Leaf Extracts on Tuber sprouting and Seedling Growth of *Cyperus rotundus* (L.)

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Abstract

The study entitled “Allelopathic Potential of Botanical Leaf Extracts on Tuber Sprouting and Seedling Growth of *Cyperus rotundus* (L.)” was conducted through a Petri plate bioassay during July 2025 at the Department of Agronomy, The Indian Agriculture College, Radhapuram. The experiment aimed to evaluate the effect of seven botanical leaf extracts (*Azadirachta indica*, *Calotropis sp.*, *Mangifera indica*, *Ricinus communis*, *Pongamia pinnata*, *Tectona grandis* and *Abutilon indicum*) on the tuber germination and seedling growth of *Cyperus rotundus*. Results revealed that all botanicals significantly reduced germination percentage, shoot length, root length, seedling vigor index and fresh seedling biomass of *C. rotundus*. Among the botanicals, *Pongamia pinnata* and *Ricinus communis* exhibited the strongest inhibitory effect, followed by *Mangifera indica*, *Tectona grandis*, *Calotropis sp.*, *Azadirachta indica* and *Abutilon indicum*. The findings suggest that allelochemicals present in *Pongamia pinnata* and *Ricinus communis* possess strong herbicidal potential and can be explored as sustainable bio-herbicides for eco-friendly weed management.

Keywords: Purple nutsedge (*Cyperus rotundus*), Allelopathy, Botanical leaf extract, Sustainable weed management, Bio-herbicides

1. Introduction

Purple nutsedge (*Cyperus rotundus* L.) is recognized as the world’s worst weed due to its ability to survive under adverse conditions and proliferate rapidly (Holm et al., 1991; Horowitz, 1992; Williams, 1982; Kim et al., 1994). Its principal mode of propagation is through basal bulbs and underground tubers (Nishimoto, 2001). Severe yield losses have been reported when purple nutsedge competes with crops for space, water, and nutrients (El-Masry et al., 1980; Messiha et al., 1993; Bryson et al., 2003; William & Hirase, 2004, 2005).

During the 20th century, herbicides were the primary method of weed management, as they effectively suppressed weed competition and nutrient depletion (Hussein, 2001). Various herbicides have been tested against purple nutsedge (Altland et al., 2003; Ferrell et al., 2004; Durigan et al., 2006; El-Rokiek et

al., 2006a, 2007, 2009). However, overreliance on chemical herbicides in the past five decades has raised concerns regarding environmental safety, herbicide resistance, and long-term sustainability.

In this context, **allelopathy** has gained attention as a natural and eco-friendly approach to weed management. Allelopathy refers to the chemical interaction in which one plant suppresses the growth of another through the release of allelochemicals (Rice, 1984). These compounds—derived from flowers, leaves, stems, and roots—include cinnamic and benzoic acids, flavonoids, and terpenes, many of which are phytotoxic (Einhellig, 2002; Singh et al., 2003). Such allelochemicals are released into the environment through leaching, root exudation, or decomposition, and they often interfere with seed germination and seedling establishment (Alam & Islam, 2002; Hussain et al., 2007; Mohamadi & Rajaie, 2009; Naseem et al., 2009).

Allelopathy plays an important role in natural and agricultural ecosystems by shaping interactions among crops, weeds, and trees. While often detrimental, such interactions can be harnessed beneficially for sustainable weed suppression (Asgharipour & Armin, 2010). Consequently, increasing research attention has focused on the allelopathic potential of various plants against problematic weeds (Chon & Kim, 2002, 2004; Chon et al., 2003; El-Rokiek et al., 2006b).

MATERIALS AND METHODS

The experiment was conducted in The Indian Agriculture College, Radhapuram which is situated at 8°26' N latitude and 77°65' 'E' longitude with an altitude of 57 m above mean sea level.

Experiment

Laboratory bioassay study was conducted to find out the effect of aqueous leaf extracts of botanicals (Plate 1) on the control of *Cyperus rotundus* L. The details of the experiments are presented below. The experiment was carried out during July 2025 by following complete randomized block design (CRBD).

Treatment details

The experiment consists of Seven Botanicals with 100% concentration and Distilled water as control are presented as below.

Treatments	Botanicals
T1	Azadirachta indica
T2	Calotropis sp
T3	Mangifera indica
T4	Ricinus communis

T5	Pongamia pinnata
T6	Tectona grandis
T7	Abutilon indicum
T8	Distilled water

Collection of *Cyperus rotundus* tubers

Fresh tubers of purple nut sedge (*Cyperus rotundus* L.) were collected from the field. They were cleaned with triple distilled water, and soil particles were carefully removed using a soft brush.

Collection of botanical

Leaves of seven different plant species were collected at the vegetative stage. The leaves were gently washed with tap water for a few seconds to remove dust and other contaminants. Details of the twenty plant species used in the study and their reported allelochemicals

Preparation of aqueous leaf extracts

Fresh leaves were cut into small pieces and soaked overnight in a 1:1 mixture of alcohol and water. After 12 hours, the soaked leaves were ground using a mixer grinder. The paste was filtered to obtain the extract, which was considered as 100% stock solution (Sripunitha, 2009). This stock was then diluted according to the treatment schedule.

Bioassay procedure

The effect of leaf extracts on germination and early seedling growth of *C. rotundus* was tested in laboratory conditions. For each treatment, three tubers were placed in a 9-cm petri dish lined with filter paper, and 3 ml of leaf extract at different concentrations was added. Distilled water served as the control. Each treatment was replicated three times. Petri dishes were incubated at 25°C with a 12-hour light period daily for 15 days. The experiment was conducted twice, and mean values were used for analysis.

Observations recorded

Germination percentage: Counted on the 10th day after sowing (DAS) using the AOSA (1990) formula.

Root length: Measured in centimetres on the 15th DAS.

Shoot length: Measured on the same seedlings in centimetres.

Seedling vigour index (SVI): Calculated using the formula of Abdul-Baki and Anderson (1973):

$$SVI = (\text{Shoot length} + \text{Root length}) \times \text{Germination percentage}$$

Fresh weight: The same seedlings used for length measurements were weighed, and values were recorded in grams.

Results and Discussion

The laboratory bioassay showed that aqueous leaf extracts of all the seven botanical species had a significant allelopathic effect on the germination and early seedling growth of *Cyperus rotundus* (L.).

Germination percentage

Among the treatments, *Pongamia pinnata* was the most effective, reducing germination to 43.48% compared to 100% in the control. This was followed by *Ricinus communis*, *Mangifera indica*, *Tectona grandis*, *Calotropis* sp., *Azadirachta indica*, and *Abutilon indicum*. The order of inhibition was consistent across trials: *Pongamia pinnata* > *Ricinus communis* > *Mangifera indica* > *Tectona grandis* > *Calotropis* sp. > *Azadirachta indica* > *Abutilon indicum*. The reduced germination may be attributed to the interference of allelochemicals with the enzymatic and metabolic activities required for sprouting (Oyun, 2006). Similar inhibitory effects of leaf extracts on weed germination were earlier reported in *Parthenium hysterophorus* by Javaid et al. (2009, 2010).

Allelopathic potential of Botanical Extracts on percent Germination (%) of *Cyperus rotundus* L.,

Treatments	Per cent germination (%)
T1 - Neem	74.3
T2 - Calotropis	71.8
T3 - Mango	57.4
T4 - Castor	49.6
T5- Pungam	43.4
T6 - Teak	64.7
T7 - Abutilon indicum	78.2
T8 - Control	85.6
Mean	65.6
SE (D)	1.32
CD	2.76

Root and shoot length

All botanical extracts significantly reduced root and shoot length of *C. rotundus*. *Pongamia pinnata* caused the highest reduction, with root length reduced by 77% and shoot length by 76% compared to the control. Other botanicals followed the same order as seen in germination percentage. Roots were more sensitive than shoots, which is in line with earlier reports that allelochemicals directly affect cell division and elongation in root tissues (Buckolova, 1971).

Allelopathic potential of Botanical Extracts on Root Length (cm) and Shoot Length (cm) of *Cyperus rotundus* L.,

Treatments	Root Length (cm)	Shoot Length (cm)
T1 - Neem	3.2	6.4
T2 - Calotropis	2.7	5.6
T3 - Mango	1.7	3.7
T4 - Castor	1.6	3.3
T5- Pungam	1.0	2.2
T6 - Teak	2.4	4.4
T7 - Abutilon indicum	3.6	2.2
T8 - Control	4.5	4.4
Mean	2.5	4.02
SE (D)	0.42	0.11
CD	0.89	0.24

Seedling vigour index (SVI)

Seedling vigour index was also drastically affected. The lowest SVI (86% reduction) was recorded in *Pongamia pinnata*, followed by *Ricinus communis* (76%) and *Mangifera indica* (70%), while the control maintained the highest vigour index. These results indicate that allelochemicals strongly affect not only germination but also seedling establishment.

Allelopathic potential of Botanical Extracts on Seedling Vigour Index (gram) of *Cyperus rotundus* L.,

Treatments	Seedling Vigour Index (g)
T1 - Neem	713.28
T2 - Calotropis	600.24
T3 - Mango	316.84
T4 - Castor	248.99
T5- Pungam	146.44
T6 - Teak	446.43
T7 - Abutilon indicum	922.76
T8 - Control	1029.74
Mean	553
SE (D)	10.09
CD	21.40

Fresh weight

Fresh biomass of seedlings was significantly reduced in all treatments, with *Pongamia pinnata* again being the most effective, reducing fresh weight by 42% compared to control. The decline in biomass may be due to suppressed nutrient uptake and reduced metabolic activity under the influence of allelochemicals (Einhellig, 2002).

Allelopathic potential of Botanical Extracts on Fresh weight (gram) of *Cyperus rotundus* L.,

Treatments	Fresh weight (gram)
T1 - Neem	10.6
T2 - Calotropis	9.8
T3 - Mango	8.7
T4 - Castor	8.2
T5- Pungam	7.1
T6 - Teak	9.2
T7 - Abutilon indicum	11.3
T8 - Control	12.4
Mean	9.6
SE(D)	0.19
CD	0.40

Overall findings

The study clearly shows that botanical extracts, particularly *Pongamia pinnata*, *Ricinus communis*, and *Mangifera indica*, have strong allelopathic potential against purple nutsedge. By inhibiting germination, reducing root and shoot growth, lowering seedling vigour, and decreasing biomass, these botanicals demonstrate promising eco-friendly alternatives for managing this persistent weed. The results are consistent with previous research highlighting the herbicidal activity of natural compounds such as flavonoids and phenolics, which could be developed as sustainable weed management tools.