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Allelopathic suppressive effects of *Thevetia peruviana* L. and *Nerium oleander* L. leaf extracts on germination and seedling growth of *Cyperus rotundus* L.

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ABSTRACT

This study was undertaken to assess the allelopathic suppressive effects of Thevetia peruviana and Nerium oleander vinegar leaf extracts on purple nutsedge (Cyperus rotundus) tuber germination and seedling growth at the Crop Science Laboratory, Eastern University, Sri Lanka from January to February 2019. Fourteen treatments were imposed viz. Control (T_1-no application), 100% vinegar, 100%, 75% and 50% fresh and dry leaf extract of N. oleander and T. Peruviana. Experiment was arranged in a completely randomized design with three replications. Equal sized tubers were soaked in different plant extracts as per treatment structure for a period of two hours before planting. Then leaf extracts were applied to germinating tubers at two days interval for three times. All the management practices were followed uniformly. Germination percentage (%), seedling length, seedling dry weight and seed vigour index were measured ten days after planting. Analysis of variance was performed to determine the effect of treatments on measured parameters and mean separation was done using Duncan's Multiple Range Test ($p < 0.05$). Results revealed that germination and seedling growth parameters of purple nuts edge (Cyperus rotundus L.) were significantly affected by different concentrations and forms of T. peruviana and N.oleander leaf extracts. Lowest performances in all measured parameters were observed in dry leaf extracts 100% and 75% N. oleander and 100% T.peruviana applied treatments. This study found that leaf extracts of T. peruviana and N. oleander have an allelopathic suppressive effect against purple nuts edge tuber germination and seedling growth.

Keywords: *Allelopathic suppressive effect, Leaf extracts, Nerium oleander, Purple nuts edge, Thevetia peruviana*

INTRODUCTION

Weeds are a threat to crop production activities. They battle with crops for light, water and nutrients and they harbour pests and diseases (Rani *et al*., 2011). The crop losses caused by weeds might be higher (Camurkoylu and Demirkan, 1993). Purple nutsedge (*Cyperus rotundus*) is the most invasive and worst weed species belongs to sedge family (Cyperaceae). It is more resistance to traditional weed control methods as it can survive under critical environmental conditions.

Heavy and frequent applications of herbicides cause harmful effects in crops like inhibition of growth, foliar chlorosis, albinism and necrosis (Rao and Madhulety, 2005). Many herbicides persist in the soil for longer period. It causes bio magnification effects and affects the health of humans and animals.

Present trend is to reduce the usage of synthetic herbicides as they are not environmentally friendly. Recently Glyphosate was banned in Sri Lanka. However, herbicides are inevitable in agriculture. Therefore, it is essential to develop herbicides which are biodegradable (Babu *et al*., 2014). Allelopathy is one plant directly affecting another plant's growth either positively or negatively, exuding chemical substances. The phenomenon of allelopathy refers to chemical interactions between the plants (Scrivanti *et al*., 2011). Allelopathy allows

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sustainable weed management while reducing the impact on the environment.

Nerium (*Nerium oleander*) is a toxic plant contains toxic compounds such as glycosides and flavonoids. An important glycoside found in this plant is Oleandrine (Mojarad *et al*., 2013). Flower and leaves of *N. oleander* have allopathic potential. Uslu *et al*., (2018) reported that *N. oleander* flower extract suppressed the growth of Italian ryegrass.

Several studies reported that Thevetia (*Thevetia peruviana*) has allopathic potential. Arora (2013) reported the alleopathic potential of *T. peruviana* on *Triticum aestivum* seed germination. Pavithra *et al*. (2012) reported the suppressive effect of *T. Peruviana* on *Parthneium hysterophorus*. Hence, alleopathic potential of *Nerium oleander* and *Thevetia peruviana* L. could be utilized to control major weeds of Sri Lanka in an environment friendly manner.

The present study was conducted to assess the effects of different forms and concentrations of *N. oleander* L. And *T.Peruviana* L. leaf extracts on purple nutsedge tuber germination and seedling growth.

MATERIALS AND METHODS

Experimental Site

This experiment was conducted from January to February 2019 at Crop Science Laboratory, Faculty of Agriculture, Eastern University, Vantharumoolai, Sri Lanka.

Preparation of dry leaf extract

Fresh leaves of *T. peruviana* and *N. oleander* were collected from the surrounding areas of the Eastern University, Sri Lanka. Collected leaves were cleaned and shade dried for one week. Dried leaves were grinded into a fine powder and stored in airtight containers until use. Extracts of the leaves were prepared by mixing 50 g of air dried leaf powder in 100 ml vinegar and soaked for 24 hr at 25 ± 5°C. Extract was filtered through Whatman filter paper (No.1) and the volume of filtrate made to 100 ml. Different dilutions of the extracts i.e. 100%, 75%, and 50% were prepared from stock solution by adding distilled water.

Preparation of fresh leaf extract

Collected fresh leaves were cleaned and ground as a paste. Then extracts of the leaves were prepared by mixing 50 g of leaf paste in 100 ml vinegar and soaked for 24 hr at 25 ± 5°C. Extract was filtered through filter paper and the volume of filtrate made to 100 ml. Different dilutions of the extracts i.e. 100%, 75%, and 50% were prepared from stock solution by adding distilled water. The resulted extracts were stored under room condition in the laboratory.

Experimental design and treatments

The experimental design was Completely Randomized Design with fourteen treatments and three replications (Table 1).

Table 1. Description of Treatments

Treatments	Description
T_1	Control (No application)
T_2	100%Vinegar (20% Acetic acid)
T_3	100% *Nerium oleander* dry leaves extract
T_4	75% *Nerium oleander* dry leaves extract
T_5	50% *Nerium oleander*dry leaves extract
T_6	100% *Nerium oleander* fresh leaves extract
T_7	75% *Nerium oleander* fresh leaves extract
T_8	50% *Nerium oleander* fresh leaves extract
T_9	100% *Thevetia peruviana* dry leaves extract
T_{10}	75% *Thevetia peruviana* dry leaves extract
T_{11}	50% *Thevetia peruviana* dry leaves extract
T_{12}	100% *Thevetia peruviana* fresh leaves extract
T_{13}	75% *Thevetia peruviana* fresh leaves extract
T_{14}	50% *Thevetia peruviana* fresh leaves extract

Planting and management

Uniform sized tubers of purple nutsedge were obtained from Crop Farm, Eastern University Sri Lanka. Tubers were separated by hand. Tubers (three/pot) were planted in plastic pots (width and length were 30cm and height was 7cm) filled with mixture of compost and sand at the ratio of 1:2. Pots were kept in the experimental area under the shade house. Irrigation was done in two days interval.

Application of treatments

Selected tubers were soaked in the different plant extracts as per treatment structure for a period of two hours before planting. Then leaf extracts (10 ml) were applied to germinating tubers at two days interval for three times.

Measurements

Germination percentage (%), seedling length (cm), seedling dry weight (g) and seed vigour index (germination percentage × seedling length) were measured at the end of the experiment.

Data analysis

Analysis of Variance was carried out using Statistical Analysis System (SAS) to determine significant differences among treatments ($p<0.05$). Treatment means were compared using Duncan's Multiple Range Test at the 0.05 probability level.

RESULT AND DISCUSSION

1. Germination percentage of tubers

It was found that there were significant differences ($p<0.05$) between the treatments in tuber germination of purple nutsedge. Significantly ($p<0.05$) highest (100%) tuber germination was recorded in T1 (control) than other treatments. Lowest tuber germinations were measured in T3, T4, T6, and T9 (Fig. 1).

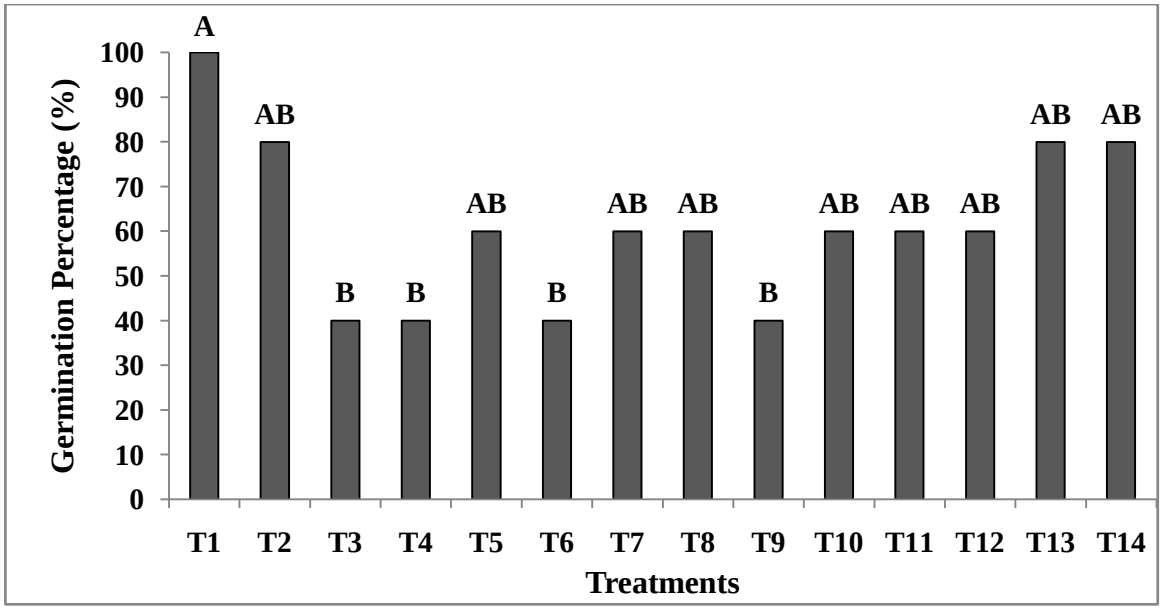

Figure 1. Effect of *Thevetia peruviana* and *Nerium oleander* vinegar leaf extracts on tuber germination of purple nutsedge. Bars with same letter are not significantly different ($\alpha = 0.05$)

There were non-significant difference between T1 (Control) and T2 (Vinegar) in tuber germination. However, vinegar application showed suppressive effect on purple nutsedge. It could be due to the inhibitory effect of vinegar. Kim *et al*., (2000) reported that highest concentration of wood vinegar inhibit growth of canola, barnyard grass, large crabgrass. Smith-Fiola and Gill (2017) also reported the herbicidal activity of vinegar.

Vinegar leaf extracts of *T. peruviana* and *N. oleander* significantly reduced the tuber germination of purple nutsedge. It showed that, leaf extract of these plants has allelopathic potential against purple nutsedge germination. Iskenderoglu (1995) stated that *N. oleander* extract can be used to reduce the germination percentage of *Lolium multiflorum*. It can be inferred that leaf extracts of *N. oleander* can suppress the growth of purple nutsedge tubers.

Minimum germination was recorded in Treatments T3, T4, T6, and T9. Decrease in germination may be due to the inhibitory effects of *T. peruviana* and *N. oleander*.

Allelopathic potential varies with plants (Adler and Chase, 2007). Aqueous leaf extract of *N. oleander* inhibit *Lactuca sativa* and *Bidenspilosa* seed germinations (Hoffmann and Regnier, 2006). Macias *et al*., (2003) suggested that allelo-chemicals that contain phenolic compounds stimulate seedling growth and development at low concentrations while suppress in higher concentration.

Minimum germinations were recorded in dry form than wet form. Releases of phytochemicals are higher in dry form. Efiong *et al*. (2020) opined that phytochemical content varies between liquid and dry forms. Wet samples have more viscosity and lack separation of secondary metabolites corresponding to polarity of solvent used. Tiwari *et al*., (2013) reported that type of solvent influence the extraction of phytochemicals. However vinegar extracts of *T. Peruviana*has higher suppressive effect against purple nutsedge in dry form only. Pavithra *et al*., (2012) reported that seed germination and early growth of P. *Parthneium hysterophorus* was inhibited by *T. Peruviana* dried leaves extract in a concentration dependence manner.

2. Dry weight of seedlings

There were significant differences ($p<0.05$) between the treatments in dry weight of seedlings of purple nutsedge. Significantly ($p<0.05$) highest dry weight of seedlings was recorded in T1 compared to other treatments. Lowest dry weight of seedlings was measured in T3 and T9 (Fig.2).

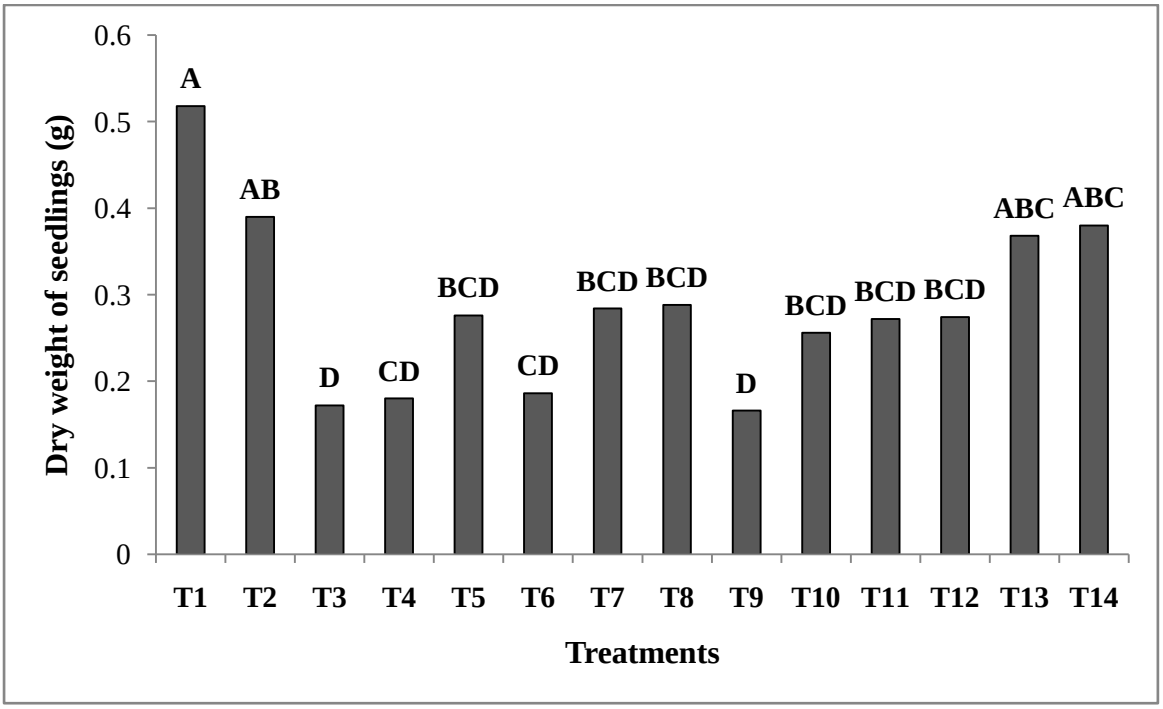

Figure 2. Effect of *Thevetia peruviana* and *Nerium oleander* vinegar leaf extracts on dry weight of seedlings of purple nutsedge. Bars with same letter are not significantly different ($\alpha = 0.05$; DMRT).

Plant dry weight is an indicator of its photosynthesis and competitive ability. There was a difference between T1 and T2 in dry weight of seedlings. This difference may be obtained due to inhibitory effect of vinegar. 5-10% acetic acid herbicide products can give viable control of very small, young weeds while higher concentration and increasing volume of application can control larger weeds (Smith- Fiola and Gill, 2017).

Vinegar leaf extracts of *T. peruviana* and *N. Oleander* significantly reduced the dry weight of purple nutsedge. It showed that, leaf extract of these plants has allelopathic potential against purple nutsedge. Uslu *et al*., (2018) found that flower extracts of *N. oleander* has the ability to reduce dry weight of *Italian ryegrass.* Pavithra *et al*., (2012) reported that seed germination and early growth of *Parthneium hysterophorus* was inhibited by *T. peruviana* dried leaves extract in a concentration dependence manner.

Lowest dry weight was observed in T3 and T9. Dry weight of seedlings increased with the concentration of leaf extracts. This decrease is obtained through allelopathic effect of *T. peruviana* and *N. Oleander* extract on purple nutsedge. Reduction in morphogenetic potential as a result of restricted growth could lead to reduce dry matter accumulation. Similar results were recorded by Algandaby and El-Darier (2016). They reported that dry biomass of *Medicagopolymorpha* seedling

was significantly decreased when treated with plant extracts of *Achillea santolina*, *Artemisia monosperma*, *Pituranthus tortuosus* and *Thymus capitatus* which have allelopathic effects on it. Therefore, it is suggested that *N. oleander* and *T. Peruviana* contain certain chemicals that are harmful to purple nut sedge. Therefore, the leaf extracts of *N. oleander* and *T. peruviana* can be used to suppress purple nutsedge.

3. Seedling vigour index

There were significant differences ($p<0.05$) between the treatments in seedling vigour index of purple nutsedge. Significantly ($p<0.05$) highest vigour index was recorded in T1 compared to other treatments. Lowest vigour index was measured in T9 and T3 (Fig.3).

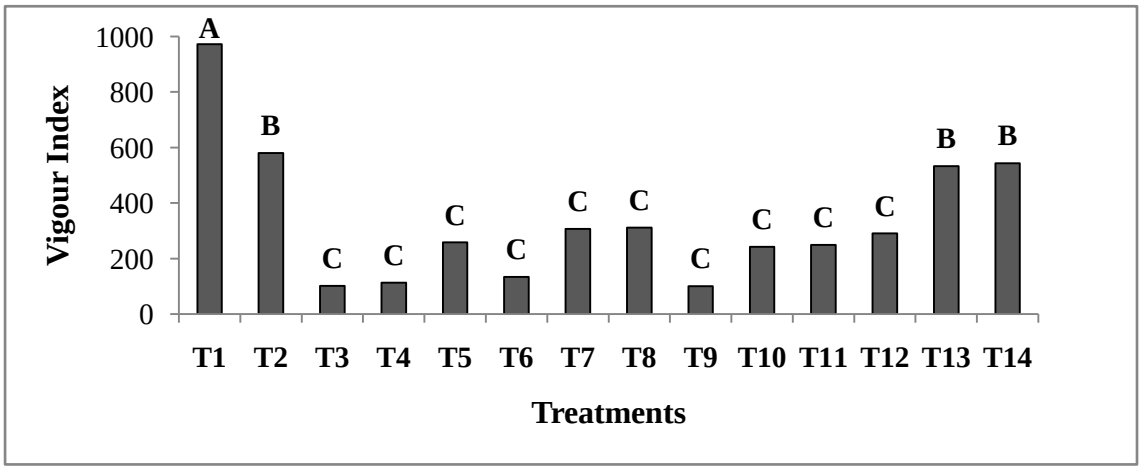

Figure 3. Effect of *Thevetia peruviana* and *Nerium oleander* vinegar leaf extracts on seedling vigour index of purple nutsedge. Bars with same letter are not significantly different. ($\alpha = 0.05$: DMRT)

Seedling vigor index is an important variable that determine the competitive ability of a plant species (Uslu *et al*., 2018). There was a significant difference between T1and T2 in vigour index of seedlings. Vinegar might have potential as a natural herbicide (Chadran *et al*., 2004). Therefore, vinegar might have the ability to suppress the vigour index of purple nutsedge. It could be the reason for lower vigour index of seedlings grown at T2. Vinegar leaf extracts of *T. peruviana* and *N. oleander* significantly reduced the vigour index of purple nutsedge. Leaf extract of these plants has allelopathic potential against purple nutsedge. Lowest vigour index was observed in T3, T4, T6 and T9. Meissner *et al*. (1979) reported that reduction in seedling growth could be attributed to interference of allele - chemicals in major physiological processes of plant metabolism viz. respiration and photosynthesis.

It was also found that, vinegar extracts of *N. oleander* has higher suppressive effect against purple nutsedge in dry and wet forms. Several scientists reported the allelopathic effects of *N. oleander* leaf extracts against several plant species i.e. *Hordeum vulgare* and *Vicia sativa* (Mojarad *et al*., 2013), *Lolium multiflorum* (Uslu *et al*., 2018), *Cyperus rotundus* (Al-Samarai *et al*., 2018). However, vinegar extracts of *T. peruviana* has higher suppressive effect against purple nutsedge in dry form only. Allopathic potential of *T.peruviana* also reported in several studies (Arora, 2013; Pavithra *et al*., 2012).

N. oleander and *T. peruviana* have allelopathic potential. Allelo-chemicals have the capacity to reduce vigour index. Ashrafi *et al*., (2008) reported that plant extract having allelopathic properties has the ability to decrease various attributes of wild barley when treated. Onen (2003) also opined that allele-chemical has the ability to reduce morphological attributes. Uslu *et al*. (2018) found that flower extracts of *N. oleander* has the ability to reduce vigour index of Italian ryegrass. Overall our studies found that vinegar leaf extracts of *T. peruviana* and *N. oleander* has the allelopathic effects against purple nutsedge

4. Seedling length

There were significant differences ($p<0.05$) between the treatments in seedling length of purple nutsedge. Seedling length was significantly ($p<0.05$) highest in T1 compared to other treatments. Lowest seedling length was measured in T3, T4and T9 (Fig.5).

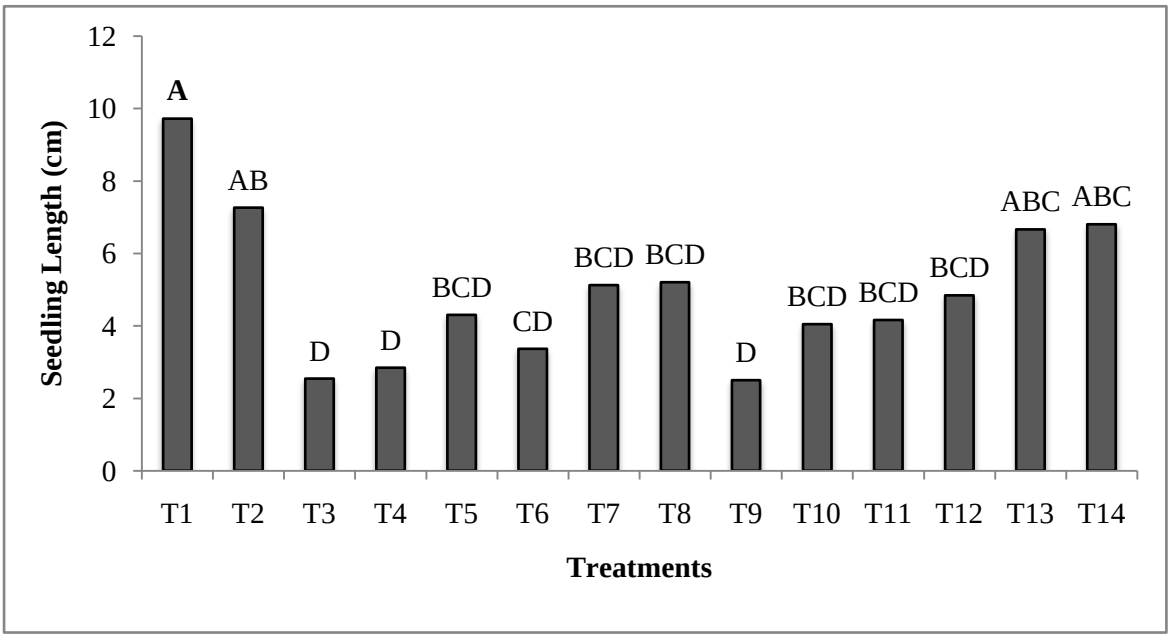

Figure 4. Effect of *Thevetia peruviana* and *Nerium oleander* vinegar leaf extracts on seedling length of purple nutsedge. Bars with same letter are not significantly different ($\alpha = 0.05$; DMRT).

Vinegar reduces the length of purple nutsedge seedlings. Findings of Zhou Ling *et al*., (2008) revealed that wood vinegar with different concentration suppressed the maize seed germination and seedling length considerably. Vinegar might have potential as a natural herbicide (Chadran *et al*., 2004). Therefore, vinegar has the ability to suppress the seedling length of purple nutsedge.

Minimum seedling length was observed in T3, T4 and T9. Study of Macias *et al*., (2004) suggested that allele-chemicals that contain phenolic compounds inhibits seedling growth and development at higher concentrations. Nekonam *et al*., (2014) reported that *Amaranthus retroflexus*'s germination, seedling length, and weight were inhibited by *Crocus sativus*, *Ricinus communis*, *Nicotiana tabacum*, *Neriumo leander* and *Sorghum vulgare* extracts. Reduction in seedling growth of wild barley when treated with leaf extract of sun flower was reported by Ashrafi *et al*., (2008). Uslu *et al*., (2018) reported that seedling length of ryegrass was significantly decrease by flower

extract of *N. oleander*. These results depicted that *N. oleander* and *T. peruviana* leaf extract can be used to suppress the growth of purple nutsedge.

CONCLUSION

Germination and seedling growth of purple nutsedge were significantly affected by different concentrations and forms of *Thevetia peruviana* and *Nerium oleander* vinegar leaf extracts. Lowest performances were observed in 100% and 75% *Nerium oleander* dry leaf extracts and 100% *Thevetia peruviana* dry leaves extract. Therefore, vinegar leaf extracts of *N. oleander* and *T. peruviana* could be used to suppress the growth of purple nutsedge in a environment friendly manner.

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