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BIO-HERBICIDAL POTENTIAL OF THE AQUEOUS EXTRACTS OF THE LEAVES OF GLIRICIDIA SEPIUM (JACQ) KUNTH EX WALP ON THE GERMINATION AND SEEDLING GROWTH OF TITHONIA DIVERSIFOLIA (HEMSL) A. GRAY

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Abstract
Considering the harmful effects of synthetic herbicides, alternative weed control methods that are cost-effective and environmentally friendly are being considered and studied. Therefore, the study was conducted to investigate the bio-herbicidal potential of the aqueous leaf extract of Gliricidia sepium on the germination and growth of Tithonia diversifolia. Aqueous leaf extracts of 0g/ ml (control), 0.2g/ml, 0.4g/ml and 0.6g/ml were prepared and 400ml of each concentration were applied to the soil before 50 seeds of Tithonia diversifolia seeds were planted in each planting pot. 100ml of each concentration was added to the soil daily after planting for five consecutive days. The germination percentage was determined on the 10th day after planting. 400ml of each concentration was applied weekly on the seedlings at 2 weeks after germination and continued until seven weeks after germination. A randomized complete block design was to allow each plant to be exposed to the same environmental conditions. The experiment was set up in triplicate. The result showed a significant decrease in the germination percentage of the test plant. The highest concentration of extract, 0.6g/ml had 39.33±0.04% germination while 0.2g/ml, 0.4g/ml and 0g/ml (control) had 63.51±0.24%, 60.82±0.34% and 94.45±0.86% respectively. The growth performances of Tithonia diversifolia were significantly inhibited in all the growth parameters (plant height, leaf area and leaf number) taken, most especially at the highest concentration of extract. The results indicated that the leaf of Gliricidia sepium had inhibitory properties that can be exploited in weed management and control. However, more research should be conducted to ascertain the bioherbicidal potential of the plant.

Keywords: Gliricidia sepium, Bioherbicidal, Tithonia diversifolia, Aqueous extract, Germination

Introduction

One of the greatest challenges to man on the ecosystem is weed management and control. Weeds have caused great economic loss to man, especially farmers. The invasion of weeds on farmlands reduces crop yield and, thus, poses a major threat to food security (Ayeni, 2016). As a result of this, over the years, millions of herbicides have been formulated to control weeds. Unfortunately, these synthetic herbicides have contributed in one way or the other to climate change, which is a serious problem confronting the human race. Synthetic herbicides and pesticides contaminate the soil and water and also affect soil microorganisms (Shequnoval, Klanova and Holoubek, 2015; Ferencz and Balog, 2017; Anasco, Uno, Koyama, Makuoka & Kuwahara, 2017; Woudneh, Ou, Sekela, Tuominen & Gledhill, 2016; Lang and Cai, 2016 and Evans, Shaw & Rypstra, 2017). Attention is now being shifted from the use of chemical-based herbicides to the use of bioherbicides that pose no threat to the ecosystem. Considering the negative effects of synthetic herbicides, alternative methods of weed management that are cheaper, non-toxic to the environment should be considered. This involves the use of herbicidal plants which offers natural control of weeds.

The bio-herbicidal effects of one or more plants on other plants through the release of chemicals are many. Chemical compounds, mostly secondary metabolites (Farooq, Jabran, Cheema, Wahid and Siddiqui, 2018) called herbicides, are released from the donor plants through leaves, seeds, flowers, rhizomes, etc., into the surroundings through leachates, root exudates, volatilization and decomposition of plant residues (Rice, 2016).

Many researchers such as Mattner (2015), Soyler, Canihos, Temel and Hajyzadeh (2018), Jamil (2016), Cheema (2018), and Igbal, Cheema and An, (2015) had reported on the inhibitory effects of herbicidal crops and weeds for weed management. Various aspects of bio-herbicide have been studied by many researchers such as the effects of crops on weeds (Akemo, Regnier and Bennet 2018; Khaliq, Matloob, Irshad and Zamir, 2017), weeds

on weeds (Kohli, Rani, and Verma, 2016), weeds on crops (Sisodia and Siddiqui, 2017) and trees on crops (Oyun, 2015). Bio-herbicide is a pragmatic substitute for synthetic herbicides as bioherbicides do not have residual toxic effects (Bhadoria, 2018). It is cost-effective and eco-friendly. Among the plants that have herbicidal potential in suppressing weeds include Gliricidia sepium. It is a medium-sized leguminous tree belonging to the family Fabaceae. It is generally referred to as quick-stick in English because of its fast growth.

Tithonia diversifolia (Hemsley) A. Gray is a species of flowering plant that originated from Mexico where it spread to other parts of Central and South America (Orwa, Mutua, Kindt, Jamnadass and Anthony, 2009). It is commonly referred to as Mexican sunflower or wild sunflower that belongs to the Asteraceae family. T. diversifolia was brought to Africa and Asia as an ornamental plant and has become an invasive weed that is widely spread (Jamil, Chema, Mushtag, Faroog and Cheema, 2016). However, the invasion of the tropical rainforest landscape of Nigeria by T. diversifolia is generating a lot of concern because of its aggressive growth rate, heavy seed production, and allelopathic property (Orwa et al., 2009) It reduces crop yield on farmlands, causing failure of crops. The study was designed to determine the bio-herbicidal potential of the leaf of Gliricidia sepium on the germination and growth of Tithonia diversifolia

Materials and Methods

Study Area

The research was carried out at the Environmental Biology research field beside the botanical garden, Rufus Giwa Polytechnic Owo, Ondo State, Nigeria, from June to August 2021. The seeds of Tithonia diversifolia were collected from nearby bushes along Owo/Akure Road, near the Second Gate of Rufus Giwa Polytechnic, Owo.

Preparation of Planting Pots for Growth of Experiment

Agricultural seed germination/nursery planting pots were used for the research work. The planting pots were 30x20cm and perforated at the base and filled with sandy-loamy soil. The sandy loamy used was sieved with the aid of 2mm mesh to remove gravel, debris, and lumps in the soil. A perforation was done to prevent water logging. The experiment was designed in a randomized complete block to ensure each plant has access to equal environmental conditions with triplication of each treatment and control.

Preparation of Fresh Extract of Gliricidia sepium

Concentrations of 200g to 1000 ml, 400g to 1000 ml, and 600g to 1000 ml were obtained from freshly harvested Gliricidia sepium leaves. This was done by weighing the fresh leaves into 200g, 400g, and 600g and cutting them into chips and then were finely blended with mortar and pestle. They were soaked in 1000ml of distilled water for 48hrs, using the method of Adigun and Olukosi (2014). The collected extract was filtered with a muslin cloth to remove debris.

Growth Experiment

Different concentrations of Gliricidia sepium were introduced into the planting pots before planting the seeds. Ten (10) of Tithoniadiversifolia were planted in the soil to a depth of about 3cm in each pot. 100ml of each concentration was added to the soil after planting. It was repeated for five consecutive days. At two weeks after germination, the seedlings in each pot were thinned down to one per pot. The control (0g/ml) was supplied with 400ml of bore-hole water, while the pots (polythene bags) with different aqueous extracts of 200g/1000ml, 400g/1000ml and 600g/1000ml forming 0.2g/ml, 0.4g/ml and 0.6g/ml respectively were supplied with 400ml of each concentration every week for 8wks, starting from two weeks after germination (2WAG)

Germination Percentage

Germination count was determined 14 days after sowing, when germination was completed. Germination percentage was calculated by dividing the number of germinated seeds by the number of seeds planted, multiplied by 100. The plants in each pot were later thinned to one per pot.

Measurement of growth parameters

The following growth parameters were determined every week, beginning from two weeks after germination 2WAG; Mean Plant Height (MPH), Mean Stem Girth (MSG), Mean Leaf Number (MLN), and Mean Leaf Area (MLA). For the plant height, the distance between the base of the shoot at soil level and the upper point of the terminal bud of the seedling was measured, using a metric rule. Leaf area was determined, using the formula according to Otusanya et al. (2007). LA= .Where, LA = Leaf

Area, B= Breadth of the leaf, L= Length of the leaf.

Statistical Analysis

All Data were subjected to analysis of variance (F test) and Duncan's new multiple range test at a 0.05% probability level. The analyses were performed, using the SPSS version 19.

Results and Discussion

Table 1: Effect of aqueous extracts of *Gliricidia sepium* on the Mean Germination Percentage (%) of *Tithonia diversifolia*

Treatment (g/ml)	Germination percent of *Tithonia diversifolia*
0g/ml	94.45±0.86%[a]
0.2g/ml	63.51±0.24%[b]
0.4g/ml	60.82±0.34%[b]
0.6g/ml	39.33±0.04%[c]

Key: Values are Mean ±Standard Error; values followed by the same superscripts are

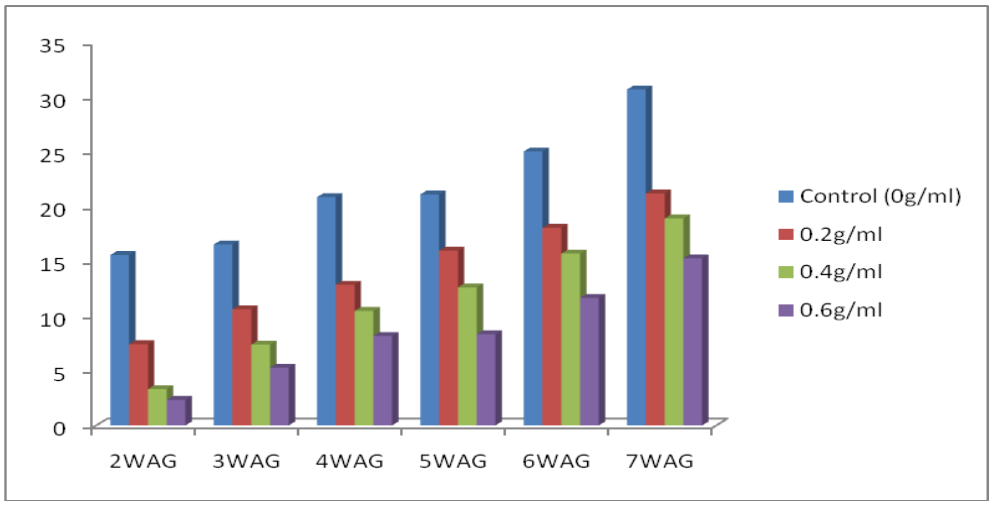

Figure 1: Effects of the leaf of Gliricidia sepium on the mean plant height (cm) of Tithonia diversifolia

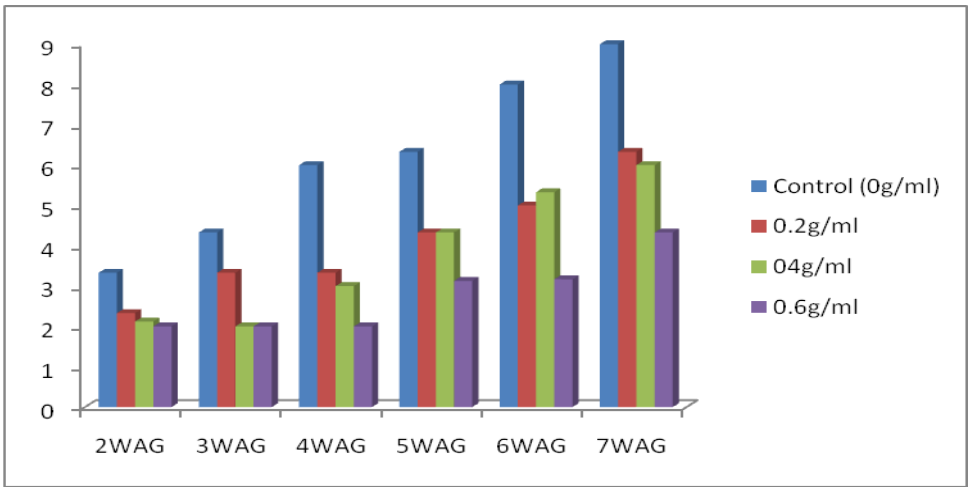

Figure 2: Effect of the leaf of Gliricidia sepium on the mean leaf number of Tithonia diversifolia

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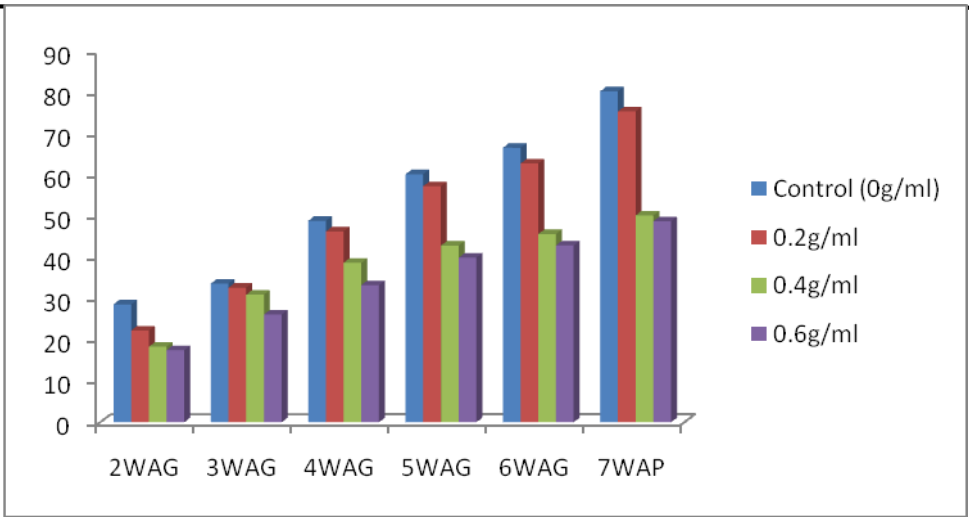

Figure 3: Effect of the leaf of *Gliricidia sepium* on the mean leaf area (cm) of *Tithonia diversifolia*

The aqueous extracts of the leaves of *G. sepium* inhibited the germination and growth of Tithonia diversifolia. There is accumulating evidence of the negative effects of bio-herbicidal plants on the fitness of other competing plants, such as the reduction of seed germination and seedling growth (Cheng and Cheng, 2015). In this study, concentrations of 0.6g/m, 0.4g/m, 0.2g/m had 39.32+- 0.04, 63.82 +0.34, and 63.82 germination. These values are significantly lower than 94.45 of the control(0.0g/mo). The extract of Gliricidia sepium was found to significantly inhibit the seed germination of the test crop, *Tithonia diverisifolia* in Table 1. This is similar to the work of Ayeni (2016) who reported that aqueous extracts of the leaves and barks of G. sepium had a significant inhibitory effect on the germination and growth of Biden pilosa. It was revealed in the report that both extracts had inhibitory effects on the germination of radicles as no radicle emerged until 72hrs experimental time in the extract-treated seeds.

Bio-herbicidal plants interfere with the growth of nearby plants by dispersing chemicals into the soil that may inhibit/stimulate neighboring plant growth, nutrient uptake, or germination. Herbicides released by plants through leaching, volatilization, exudation or decomposing of remains are one of the important components of the stresses that may influence seed germination, plant growth and nutrient uptake of the associated species

In this study, the effect of aqueous extracts of *Gliricidia sepium* at different concentrations on the seedling growth of *Tithonia diverisifolia* was also investigated. There was a significant reduction of the growth (plant height, leaf area, leaf number), particularly at the highest concentration of the extract. This is observed in tables two (2) to four (4). The effects were observed from 2WAG (weeks after germination) to 7WAG (weeks after germination). Figures 1 to 3 showed the effect of the aqueous extract of *Gliricidia sepium* on the growth of *Tithonia diverisifolia.* The treatments that were 0.2g/, 0.4g/ml, and 0.6g/ml had lower values in proportion to their respective concentration, compared to 0g/ml, which is the control except in a few cases.

The result of this is similar to the work of Popoola, Akinwale and Adelusi (2020) who reported that the aqueous extract of Gliricidia sepium and other selected weeds inhibited the germination and growth of cowpea. The extract also acted as a contact herbicide by inhibiting the shoot growth of maize and cowpea (Olowokotomo and Afuye, 2019). Sale and Oyun (2013) had earlier attributed the inhibitory effect of Gliricidia sepium to the presence of Alkaloids and polyphenols, which were considered to be allelochemicals.

However, this report is also contrary to the report of Ilori, Sanni and Adenegan-Alakinde (2011) who reported that *Gliricidia sepium* significantly enhanced the shoot height, leaf area, and fresh and dry weight of Celosia agentia. The difference in bio-herbicidal effects observed on the field can be attributed to the transformation of herbicides, adsorption by colloids and dilution by precipitation. During the processes, the allelochemicals can lose their bio-herbicidal effects.

Conclusion

The present study indicates that a high concentration of *Gliricidia* extract is effective at inhibiting the growth of this invasive and aggressive weed, Tithonia diversifolia.

Considering the detrimental effect of this weed, therefore, its infestation should be controlled to reduce its association with cultivated crops. To mitigate the effect of global warming on the ecosystem, efforts should be taken by considering the use of eco-friendly chemicals which can only be obtained from living organisms, especially plants. Therefore, the bio-herbicidal potential of *Gliricidia sepium* should be exploited and utilized in the formation of bio-herbicides which may be a good alternative to synthetic herbicides that are threats to the ecosystem.

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