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# The Growth and Yield Responses of *Amaranthus dubius* to *Tithonia diversifolia* (Hemsley) A. Gray Leaf Extract.

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Abstract

*Tithonia diversifolia* (Hemsley) A. Gray, commonly known as the Mexican sunflower, is an invasive species of flowering plant in the Asteraceae (Compositae) family. This study aimed to investigate the potential of *T. diversifolia* leaf extract (TDLE) on the growth, yield and quality of *Amaranthus dubius*. The experiment was led in a Randomized Complete Block Design with three replications. The plant height, leaf area, biomass accumulation, and yield-related traits such as leaf yield and nutrient content were assessed. The total fresh and edible yields per plant were 18.48 and 15.44%, respectively, higher than the control. The proximate compositions of the plants were significantly affected by spraying with aqueous extract from the leaves. The mineral contents of the plant were significantly higher than the control's (P<005). The total moisture content (8.20%), protein (15.71%), and carbohydrate (36.48%) were significantly increased after spraying the plants with tithonia extract. The results of this study suggest that the aqueous extract of the leaves of the slender amaranth increases the growth and improves the quality of the crop of plants. However, further investigation is required as TDLE has been reported to process inhibitory allelopathic substances.

**Keywords:** *Tithonia diversifolia*, *Amaranthus dubius*, growth, yield.

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## Introduction

In contemporary agricultural research, there is an expanding interest in exploring botanical extracts as sustainable alternatives to conventional agrochemicals for enhancing crop productivity. One such botanical candidate is the grey leaf extract derived from *Tithonia diversifolia* (Hemsley), a plant species renowned for its pesticidal and growth-promoting properties (Ajayi *et al.*, 2017; Ewanй *et al.*, 2020; Tatsegouock *et al.*, 2020; Amulu *et al.*, 2021).. *T. diversifolia*, commonly known as Mexican sunflower or tree marigold, has attracted attention due to its rich phytochemical composition and potential applications in agriculture. It is an invasive species of flowering plant in the Asteraceae (Compositae) family (Chagas-Paula *et al.* 2012) that was originally brought to West Africa from Central America for ornamental purposes (Ayeni *et al.*, 1997). It is predominant in Nigeria (Olorode *et al.*, 2011), leading to an economic loss of crops (Lusweti *et al.*, 2012). *Tithonia diversifolia* (Hemsley) A. Gray has been reported to contain allelopathic substances which inhibit seed germination and plant growth (Ilori *et al.*, 2010). This allelopathic effect of *Tithonia*

*diversifolia* (Hemsley) A. Gray has constricted its use as a growth regulator or protection of crops. However, there were reports on using *Tithonia diversifolia* (Hemsley) A. Gray as manure for soil amendment and alternative growth media in soilless farming (Chemutai et al., 2019).

*Amaranthus dubius* is one of the about 60-70 species of the genus Amaranthus in the family *Amaranthaceae*. It is a widely cultivated leafy vegetable in the tropics for nutritional value (Mohil and Jain, 2014). It is a cheap source of minerals and vitamins from Central and Northern South America and has been introduced to tropical Africa Colombia (El-Ghamery *et al.*, 2017). Amaranth is rich in lysine, an essential amino acid lacking in cereals and tubers. Amaranth can be cultivated several times within a year, giving it availability and affordability.

Previous studies have highlighted the bioactive compounds present in *T. diversifolia*, including sesquiterpene lactones, flavonoids, and alkaloids, which contribute to its diverse biological activities (Munyaka et al., 2017; Zorloni et al., 2018). Among these compounds, the grey leaf extract has emerged as a subject of interest for its reported efficacy in pest management and plant growth enhancement (Kipkoech et al., 2020). However, the potential effects of *T. diversifolia* grey leaf extract on the growth and yield of vegetable crops remain relatively unexplored.

*Amaranthus dubius*, known as slender amaranth or red spinach, is a leafy vegetable cultivated for its nutritional richness and adaptability to various agroecological conditions. Given the nutritional significance and economic importance of A. dubius in many regions, investigating the influence of *T. diversifolia* grey leaf extract on its growth and yield holds considerable relevance for agricultural sustainability.

Therefore, this research aims to investigate the effect of *T. diversifolia* grey leaf extract on the growth parameters and yield of A. dubius. Specifically, the study will assess plant height, leaf area, biomass accumulation, and yield-related traits such as leaf yield and nutrient content. This research seeks to elucidate the potential benefits and limitations of utilising T. diversifolia grey leaf extract as a bio-fertiliser or biostimulant in vegetable production systems by conducting controlled experiments and employing rigorous statistical analyses.

Ultimately, the findings of this study could provide valuable insights into harnessing botanical resources for sustainable agriculture, with implications for smallholder farming communities striving to improve crop productivity while minimising environmental impacts.

## Materials and Method

### Experimental Site:

The experiment was conducted at the Teaching and Research Farm of Ekiti State University, Ado-Ekiti, Nigeria, in a tropical humid climate characterised by two seasons (Rainy and Dry). The rainy season is from April to October, with a two-week break in August, while the dry season is from November to March.

### Experimental Design:

The land was prepared by clearing the vegetation through slashing and properly packing the debris. The beds of 1m by 3m were made manually using hoes. The experiment was led in a Randomized Complete Block Design with three replications. Poultry manure at 10 tons per ha was applied to each bed two weeks before sowing.

### Extract preparation and application:

Fresh *Tithonia diversifolia* leaves were harvested into a polythene bag, cleaned and blended at a ratio of 1:1 with distilled water (10 grams of leaves with 10 ml of distilled water) to get the extract concentrate. The extract concentrate was diluted at 1ml to 1 litre distilled water to form the treatment applied at one-week intervals to two weeks after sowing.

### Seed collection and sowing:

Seeds of *Amaranthus dubius* were purchased from a farm shop at Ado-Ekiti and sowed to the prepared bed by broadcasting and ensuring uniform distribution of the seeds on the plant bed.

### Data collection:

Data were collected on the plant height, stem girth, and leaf area weekly from 2 WAS for the growth analysis, while the fresh edible weight and whole plant weight were taken after harvest for the yield analysis. The quality of *Amaranthus dubius* was determined through proximate analysis and mineral

contents of the harvested plant using the method described in AOCA 2009.

### Data Analysis:

All data collected were subjected to student T-test analysis using SPSS version 23 at a 95% confidence level.

## Results and Discussion

### Effect of *Tithonia diversifolia* leaf extract on the growth of *Amaranthus dubius*

The growth response of *Amaranthus dubius* sprayed with *Tithonia diversifolia* leaf extract (TDLE) is shown in Table 1. There was a significant increase in the plant height, leaf area, and stem girth of Amaranthus dubius compared to *Tithonia diversifolia* leaf extract. The leaf extract spray of *Tithonia diversifolia* increases the plant height by 24.3% at 5 WAS. The leaf area of *Amaranthus dubius* sprayed with *Tithonia diversifolia* leaf extract differed significantly from the control. At 3 WAS, *Amaranthus dubius* sprayed with an aqueous extract of *Tithonia diversifolia* leaf produced leaves with a leaf area of 32.24 c, which differed from the 19.53 $cm^2$ produced by the control. This increased to 69.69 $cm^2$ at 5 WAS, which was 17.79 $cm^{2,}$ significantly higher than 48.84 $cm^2$ from the control. The stem girth of *Amaranthus dubius* increased from 0.46 cm at 3WAS to 0.80 cm at 5WAS after spraying with *Tithonia diversifolia* leaf extract and differed significantly from the control (0.25 and 0.58 cm).

Table 1: Effect of *Tithonia diversifolia* leaf extract on the growth of *Amaranthus dubius*

| Treatment | Week after sowing | | |
|---|---|---|---|
| | 3 | 4 | 5 |
| | Plant height (cm) | | |
| Tithonia leaf extract | 11.50±0.3 | 21.83±0.05 | 36.33±0.07 |
| Control | 10.17±0.03 | 14.50b±0.01 | 22.00±0.01 |
| Significant | ** | ** | ** |
| | Leaf area ($cm^2$) | | |
| Tithonia leaf extract | 32.24±0.97 | 53.78±0.14 | 69.69±0.22 |
| Control | 19.53±0.03 | 29.63±0.03 | 48.84±0.03 |
| Significant | ** | ** | ** |
| | Stem girth (cm) | | |
| Tithonia leaf extract | 0.46±0.01 | 0.62±0.03 | 0.80±0.09 |
| Control | 0.25±0.01 | 0.37±0.01 | 0.58±0.01 |
| Significant | ** | ** | ** |

### Effect of *Tithonia diversifolia* leaf extract on the yield of *Amaranthus dubius*

Figure 1 shows the yield components of *Amaranthus dubius,* which has been affected by *Tithonia diversifolia* leaf extract. The total fresh yield and fresh edible yield per plant of *Amaranthus dubius* sprayed with *Tithonia diversifolia* leaf extract were 18.48 and 15.44%, respectively, higher than the control.

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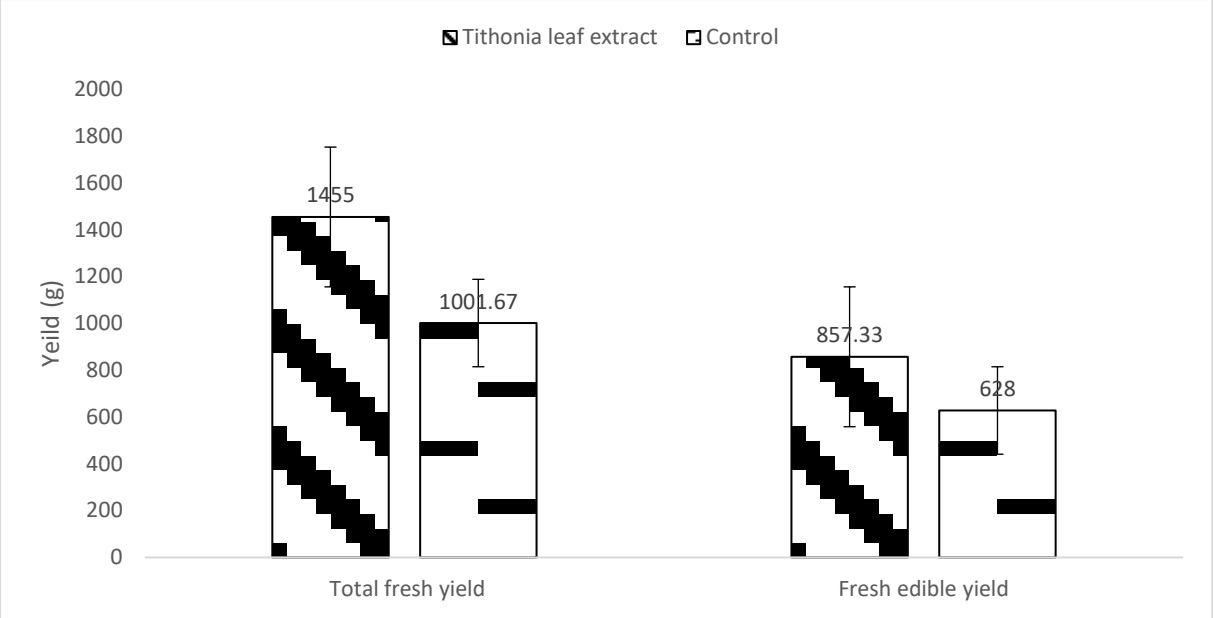

Fig. 1: Effect of *Tithonia diversifolia* leaf extract on the yield of *Amaranthus dubius*

**Effect of *Tithonia diversifolia* leaf extract on the proximate compositions of *Amaranthus dubius***

The *Amaranthus dubius* treated with aqueous extract of *Tithonia diversifolia* produced plants with significantly higher moisture content (8.20%), protein (15.71%) and carbohydrate (36.48%) than the control (Table 2). However, the ash and crude fibre significantly reduced (9.92 and 13.88 %). The mineral contents of the *Amaranthus dubius* were significantly affected by spraying the plants with *Tithonia diversifolia* leaf extract. The N, K, Ca, Mg, Na and P contents increase significantly from the control.

**Table 2: Effect of *Tithonia diversifolia* leaf extract on the proximate compositions (%) and mineral contents (mg kg$^{-1}$) of *Amaranthus dubius***

| Treatment | Moisture | Ash | Protein | Crude fibre | Carbohydrate |
|---|---|---|---|---|---|
| Tithonia leaf extract | 8.20±0.54 | 9.92±0.04 | 15.71±0.44 | 13.88±0.54 | 36.48±0.34 |
| Control | 7.43±0.04 | 12.20±0.01 | 14.16±0.24 | 14.70±0.24 | 35.73±0.24 |
| Significant | ** | ** | ** | ** | ** |

| Treatment | Nitrogen (%) | Potassium | Calcium | Magnesium | Sodium | Phosphorus |
|---|---|---|---|---|---|---|
| Tithonia leaf extract | 2.51±0.24 | 1315.00±1.04 | 1680.00±0.54 | 124.50±0.64 | 17.50±0.33 | 373.05±0.88 |
| Control | 2.27±0.04 | 1130.00±0.84 | 1370.00±0.65 | 112.60±0.09 | 16.35±0.23 | 326.23±0.54 |
| Significant | ** | ** | ** | ** | ** | ** |

*Tithonia diversifolia* leaf extract (TDLE) has been observed to exhibit an inhibitory effect on seed germination and growth of amaranth (Dorning and Cipollini, 2005; Otusanya et al., 2014 Miranda et al., (2015). However, the result of this study proved otherwise. Otusanya et al. 2007 reported that *Tithonia diversifolia* contained allelopathic substances (allelochemicals) that could suppress growth in plants to which the root exudates of *Tithonia diversifolia* inhibited germination, growth and chlorophyll contents of *Amaranthus dubius* (Otusanya et al. 2014). Ilori et al. (2010) also reported that aqueous extracts obtained from the shoot and root of Tithonia diversifolia reduced the chlorophyll accumulation and protein content of *Amaranthus cruentus*. However, the use of *Tithonia diversifolia* manure to improve soil fertility and as an alternative growth media in soilless farming has been reported (Agbede and Afolabi, 2014; Afolabi Olowokere and Odulate, 2018; Chemutai et al., 2019). Therefore, with the results from this study, aqueous extracts from *Tithonia diversifolia* leaf nly inhibit plant growth they cbut

## Conclusion

The aqueous extract from the leaves of *Tithonia diversifolia* increase the growth and improve the quality of *Amaranthus dubius*. Despite various reports on the inhibitory effects of *Tithonia diversifolia*, the results from the study have proved otherwise, indicating that extract from *Tithonia diversifolia* can be used to boost crop production. However, further investigations are required to substantiate the results of this study.

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