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# **Study on the Effects of Fresh Shoot Biomass of *Tithonia diversifolia* on the Germination, Growth and Yield of Cowpea (*Vigna unguiculata* L.)**

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## **Authors' contributions**

*This work was carried out in collaboration between the two authors. Author ABO designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author ATO managed the analysis of the study. Both authors managed the literature searches. Both authors read and approved the final manuscript.*

**Case Study**

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## **ABSTRACT**

Studies on the effects of fresh shoot biomass of *Tithonia diversifolia* on the germination, growth performance and yield of cowpea (*Vigna unguiculata* L.) were carried out at the experimental site of the Department of plant science of Ekiti State University, Ado Ekiti in the 2011 and 2012 cropping seasons. Fresh shoots of *Tithonia diversifolia* were collected from the University environment and blended using pestle and mortar to make the fresh shoot biomass (FSB). The FSB was weighed into 50g, 100g, 150g and 200g and thoroughly mixed with collected soils in horticultural pots. The soil sample had already been autoclaved at 100°C for 24hr. The control experiment recorded the highest emergence percentage but similar to the 50g FSB of *T. diversifolia* recorded. Higher FSB resulted to lower emergence percentage. Growth parameters in terms of plant height stem girth, number of leaves per plant and leave area were highest in the 150g *Tithonia diversifolia* FSB but lowest in the control. The highest yield of cowpea was obtained in the 150g *Tithonia diversifolia* FSB applied pots which was similar to those of 100g FSB applied pots. The stimulatory growth factor and yield increase enhanced by FSB of *Tithonia diversifolia* is an indication that *Tithonia diversifolia* possesses no negative allelopathic

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effect on cowpea growth. The poor seedling emergence observed suggests that the land be left for some time to allow proper degrading of the *Tithonia diversifolia* before planting cowpea. This study further revealed that fallowed land occupied by *Tithonia diversifolia* could be successfully used to produce optimum cowpea yield.

**Keywords:** Cowpea; *Tithonia diversifolia*; fresh shoot biomass; growth and yield.

## 1. INTRODUCTION

Cowpea *Vigna unguiculata* is an important grain legume and an essential component of cropping systems in the drier regions of the tropics covering parts of Asia and Oceania, the Middle East, Southern Europe, Africa, Southern USA, and Central and South America. Being a fast growing crop, cowpea curbs erosion by covering the ground, fixes atmospheric nitrogen, and its decaying residues contribute to soil fertility [1]. It has been estimated that a world total of about 12.5 million ha is grown to cowpea with a production of 3 million tonnes [2]. Nigeria is the largest producer and consumer of cowpea with about 5 million ha and over 2 million tonnes production annually. Each Nigerian eats cowpea and the per capita consumption is about 25 to 30 kg per annum [3]. *Tithonia diversifolia* (Mexican sun flower in the family Asteraceae) is an annual weed growing aggressively along road paths and on abandoned farmlands all over Nigeria. This aggressive weed has been reported to contain a large amount of allelochemicals especially in leaves which inhibit growth of many plants [4,5, 6]. Reports have shown that *Tithonia diversifolia* contain large amount of biomass that is rich in nutrients for soil improvement for crop production [7,8,9]. The present study was designed to determine the effects of fresh biomass of *Tithonia diversifolia* on the performance of cowpea (*Vigna unguiculata*) in the study area.

## 2. MATERIALS AND METHODS

The experiment was conducted at the experimental site of the Department of Plant Science, Ekiti State University, Ado Ekiti (7°40'N, 5°15'E). Thirty horticultural pots measuring 30 × 15 cm were filled with 25kg of degraded soil that is free from any trace of *Tithonia diversifolia* growth. The soil was collected from a construction site where the top soil had been scrapped. The soil was autoclaved at 100 °C for 24 hrs. Prior to planting, routine soil analysis was carried out. Soil pH was measured using the pH meter at 1:1 soil to water ratio. Percentage organic carbon was determined by Walkey Black wet oxidation method [10] while percent total Nitrogen (N) was determined by the micro-kjeldahl technique [11]. Available P was extracted by the Bray method and determined calorimetrically [12]. Exchangeable bases were displaced by NH<sub>4</sub><sup>+</sup> from neutral NH<sub>4</sub>OAC solution [13]. The analysis showed that the soil contains 0.51% organic carbon; 0.03% Total Nitrogen; 1.33mgkg<sup>-1</sup> Available Phosphorous; 0.25CmolKg<sup>-1</sup> Potassium and pH of 7.41. Fresh shoots of *Tithonia diversifolia* was collected from the university community. The collected shoots were thoroughly washed in distilled water, ground into fine paste using pestle and mortar and weighed into 50g, 100g, 150g and 200g to form the fresh shoot biomass (FSB). The weighed portions of the blended *Tithonia diversifolia* FSB were intermittently mixed with the soil in the pots. A fifth pot filled with the sterilized soil but without FSB of *Tithonia diversifolia* served as the control experiment. Each treatment was replicated six times.

Ten seeds of cowpea (Ife-brown variety) collected from the Ekiti State Ministry of Agriculture were planted in each of the pots and given daily watering of 300 ml of water. Planting was

done in March 3 and July 20 of 2011 and 2012 respectively at a depth of 2cm. Emergence count was taken fourteen days after planting. The seedlings were thinned to one per pot after two weeks of planting. Plant height, stem girth and number of leaves were taken at 4 weeks after planting (WAP). The leaf area was also determined at four weeks after planting [14]. Yield and yield parameters were taken after fruit harvesting at maturity and drying. Cowpea plants were then uprooted and the shoot and root biomass determined by weighing on electric weighing balance.

Data collected were analysed using analysis of variance (ANOVA) and means separated using the Duncan's multiple range test (DMRT).

### 3. RESULTS

Effects of fresh shoot biomass of *T. diversifolia* on emergence percentage, plant height and stem girth of cowpea are presented in Table 1. The highest percentage of cowpea emergence was recorded in the control pots which was not significantly different from the 100g *T. diversifolia* applied pots. The emergence percentage in 200g *T. diversifolia* applied pot was lowest. The tallest cowpea plants were observed in the 150g *T. diversifolia* applied pots but not significantly different from the 100g *T. diversifolia* applied pots in 2012 ( $P < 0.05$ ). While the 100g and 200g *T. diversifolia* applied pots produced identical plant heights, they were significantly taller than either the 50g or the control. Stem girth assessment showed that *T. diversifolia* biomass resulted to higher girth than the control. 50g gave lower stem girth of cowpea than either the 150g or 200g but similar girth with the 100g *T. diversifolia* biomass applied pots.

Number of leaves produced by pots that received 100 or 150g FSB of *T. diversifolia* was identical but higher than either the 200 or 50g applied pots Table 2. The control experiment produced the least number of leaves. The leaf area produced in the treatment with 50g *T. diversifolia* FSB was smaller than the higher *T. diversifolia* applied pots while the control produced the smallest leaf area. The highest dry shoot biomass of cowpea was produced in the 200g FSB of *T. diversifolia* while the lowest was produced in the control pots. The dry shoot biomass produced in the treatment with 100 and 150g FSB of *T. diversifolia* were identical but significantly lower than the 200g FSB and higher than the 50g FSB and the control.

Dry shoot biomass was identical and highest in either of 100, 150 or 200g FSB of *T. diversifolia* while the lowest was observed in the control experiment. The 50g FSB of *T. diversifolia* gave higher dry shoot biomass than the control but lower than either of the 100, 150 or 200g *T. diversifolia* FSB (Table 3). The number of pods per plant was significantly highest in the in the 150g *T. diversifolia* FSB applied pots while the lowest was in the control. Number of pods was identical in the 100g and 200g but higher than the 50g *T. diversifolia* FSB applied pots. The highest number of seeds per pod was recorded in either the 150 or 100g *T. diversifolia* FSB applied pots while the control was observed in the control experiment. The 50 and 200g *T. diversifolia* FSB applied pots were identical but lower than either 150g or 100g and higher than the control.

Table 4 shows the effects of FSB of *T. diversifolia* on pod weight and grain yield per cowpea plant. The highest pod weight was observed in the 150g FSB of *T. diversifolia* applied pots but not significantly different from the 100g applied pots. Pod weights in the 50 and 200g FSB of *T. diversifolia* applied pots are equally identical but lower than the either the 100 or 150g *T. diversifolia* FSB but higher than the control. Grain yields in the 100 and 150g FSB of

*T. diversifolia* applied pots were identical but higher than either the 50 or 200g *T. diversifolia* applied pots. While the highest yield was observed in the 150g FSB of *T. diversifolia*, the lowest grain yield was recorded in the control. The 100g and 200g pots recorded similar grain yield but higher than the control.

**Table 1. Effects of fresh shoot biomass of *T. diversifolia* on emergence percentage, plant height and stem girth of cowpea**

Treatment	Emergence percentage		Plant height at 4WAP (cm)		Stem girth at 4WAP (cm)	
	2011	2012	2011	2012	2011	2012
50g	97.4a	97.2a	15.7c	20.5c	1.8b	1.9b
100g	80.4b	80.5b	23.0b	27.1ab	2.1ab	2.1ab
150g	46.7c	63.2c	32.4a	30.7a	2.6a	2.4a
200g	43.3c	42.6d	25.4b	24.3b	2.3a	2.3a
Control	98.3a	99.4a	15.8c	19.8c	1.1c	1.3c

\*Means with the same letter(s) within columns are not significantly different (P=.05)

**Table 2. Effects of fresh shoot biomass of *T. diversifolia* number of leaves plant<sup>-1</sup>, leaf area and dry shoot biomass plant<sup>-1</sup>**

Treatment	Number of leaves plant <sup>-1</sup>		Leaf area (cm <sup>2</sup> )		Dry shoot biomass plant <sup>-1</sup>	
	2011	2012	2011	2012	2011	2012
50g	22c	24c	77.8b	98.3b	15.6c	16.1c
100g	45a	42a	100.2a	120.4a	20.5b	21.0b
150g	46a	39ab	98.9a	121.2a	21.3b	20.9b
200g	36b	35b	94.3a	95.6b	25.8a	25.0a
Control	12d	14d	50.1c	48.5c	12.2d	14.9c

\*Means with the same letter(s) within columns are not significantly different (P=.05)

**Table 3. Effects of fresh shoot biomass of *T. diversifolia* on dry root biomass plant<sup>-1</sup>, number of pods plant<sup>-1</sup> and number of seeds pod<sup>-1</sup>**

Treatment	Dry root biomass plant <sup>-1</sup>		Number of pods plant <sup>-1</sup>		Number of seeds pod <sup>-1</sup>	
	2011	2012	2011	2012	2011	2012
50g	1.3b	1.6b	5.3c	4.8c	5.2b	4.6b
100g	2.2a	2.6a	7.0b	6.4b	6.8a	6.5a
150g	2.1a	2.9a	8.4a	7.8a	7.6a	7.2a
200g	2.1a	2.0a	7.3b	6.6b	5.4b	5.2b
Control	0.6c	0.8c	1.0d	1.3d	3.3c	2.8c

\*Means with the same letter(s) within columns are not significantly different (P=.05)

**Table 4. Effects of fresh shoot biomass of *T. diversifolia* on pod weight and grain yield plant<sup>-1</sup>**

Treatment	Pod weight plant <sup>-1</sup> (g)		Grain yield plant <sup>-1</sup> (g)	
	2011	2012	2011	2012
50g	25.3b	26.5c	22.0b	23.1b
100g	31.8a	33.1ab	27.7a	28.1a
150g	35.2a	37.4a	30.7a	32.1a
200g	27.1b	30.6bc	21.2b	23.6b
Control	18.4c	20.2d	10.3c	11.9c

\*Means with the same letter(s) within columns are not significantly different (P=.05)

#### 4. DISCUSSION

Emergence percentage of cowpea as affected by the FSB of *T. diversifolia* revealed that higher biomass per planting pot reduced the percent cowpea emergence. This is an indication that higher biomass of *T. diversifolia* biomass incorporation to the soil may be allelopathic to cowpea germination. Similar negative allelopathic effects on germination have been reported on okra and *Amaranthus cruentus* [15,6]. Earlier investigations have also suggested that allelochemicals or toxins are released from weeds by actions of micro-organisms during decomposition which may interfere with plants growth processes [16,17].

However, height, stem girth measurement and number of leaves per cowpea plant at 4WAP showed that *T. diversifolia* biomass improved these parameters as the biomass increased until the 150g application. This observation probably indicated the stimulatory effects allelochemicals produced by *T. diversifolia* FSB on cowpea. Such stimulatory effects have been reported on maize plant [18,19].

Higher yield and yield components were observed in this trial as the FSB of *T. diversifolia* increases until a decrease was observed in the 200g FSB application. The highest shoot biomass had been observed in the 200g FSB *T. diversifolia*. This probably suggested that this higher FSB of 200g *T. diversifolia* only led to an increase shoot production without a corresponding increase in yield. Similar yield reduction had been observed in *Glycine max* when higher biomass of *Chromolaena odorata* was incorporated into the soil [15]. However, the yield and yield components improvement observed in this trial at the rate of *T. diversifolia* FSB probably suggested soil improvement by *T. diversifolia* incorporation which led to increased yield. Similar growth and yield increase had been reported in soya bean [20,21]. It had earlier been reported that the green leaf biomass of *T. diversifolia* contains an average of about 3.3%N, 0.3%P and 4.1%K on dry matter basis [22].

#### 5. CONCLUSION

The present study had demonstrated that *T. diversifolia* may be useful in improving soil for optimum cowpea production in the study area. However the reduction in the total emergence percentage of cowpea in the higher *T. diversifolia* FSB incorporated soils suggests a longer time between soil incorporation of *T. diversifolia* FSB and planting of cowpea. This will increase the plant population, increase growth and subsequently plant yield.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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