

## Case Study

### **STUDY ON THE EFFECTS OF FRESH SHOOT BIOMASS OF *TITHONIA DIVERSIFOLIA* ON THE GERMINATION, GROWTH AND YIELD OF COWPEA (*VIGNA UNGUICULATA* L.)**

By

**Ademiluyi Benson Oluwafemi and Ajewole Tolulope Olumide**

Department of Plant Science, Ekiti State University, P.M.B. 5363, Ado Ekiti, Nigeria

Corresponding Author: Ademiluyi Benson Oluwafemi (PhD)

Department of Plant Science, Ekiti State University, P.M.B. 5363, Ado Ekiti, Nigeria

### **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 and the 50g FSB of *Tithonia diversifolia* recorded the highest and similar emergence percentage. 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 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 is an important food 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 t production annually. Each Nigerian eats cowpea and the per capita consumption is about 25 to 30 kg per annum [3]. *Tithonia diversifolia* 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, University of Ado Ekiti. Thirty horticultural pots measuring  $30 \times 15$  cm were filled with equal quantity 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  $100^\circ\text{C}$  for 24 hrs. 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 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. 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 [10]. 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.

Collected data were subjected to statistical analysis of variance and means separated using the Duncan's multiple range test (DMRT).

## 3. Results

The effects of fresh shoot biomass of *Tithonia diversifolia* on the 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. Emergence percentage was in the decreasing order of 98.3 and 99.4; 93.4 and 97.2; 80.4 and 80.5; 46.7 and 63.2; 43.3 and 42.6% in 2011 and 2012 respectively for the control, 50g, 100g, 150g and 200g. 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. While the 100g and 200g *T. diversifolia* applied pots produced identical plant heights, they were 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.

Table 2 shows the effects of FSB of *T. diversifolia* on number of leaves per plant, leaf area and dry shoot biomass per plant. Number of leaves produced by pots that received 100 or 150g FSB of *T. diversifolia* was identical but lower than either the 200 or 50g applied pots. The control experiment produced the least number of leaves. The leaf area produced by 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 by 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 (Table3). 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=0.05)

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=0.05)

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=0.05)

117 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 |

118 Means with the same letter(s) within columns are not significantly different (P=0.05)

## 119 4. Discussion

120 Emergence percentage of cowpea as affected by the FSB of *T. diversifolia* revealed that higher  
 121 biomass per planting pot reduced the percent cowpea emergence. This is an indication that higher  
 122 biomass of *T. diversifolia* biomass incorporation to the soil may be allelopathic to cowpea  
 123 germination. Similar negative allelopathic effects on germination have been reported on okra and  
 124 *Amaranthus cruentus* [11, 6].

125 However, height, stem girth measurement and number of leaves per cowpea plant at 4WAP showed  
 126 that *T. diversifolia* biomass improved these parameters as the biomass increased until the 200g  
 127 application when they decreased. This observation probably indicated the stimulatory effects  
 128 allelochemicals produced by *T. diversifolia* FSB on cowpea. Such stimulatory effects have been  
 129 reported on maize plant [12, 13].

130 Higher yield and yield components were observed in this trial as the FSB of *T. diversifolia* increases  
 131 until a decrease was observed in the 200g FSB application. The highest shoot biomass had been  
 132 observed in the 200g FSB *T. diversifolia*. This probably suggested that this higher FSB of 200g *T.*  
 133 *diversifolia* only led to an increase shoot production without a corresponding increase in yield  
 134 production. Similar yield reduction had been observed in *Glycine max* when higher biomass of  
 135 *Chromolaena odorata* was incorporated into the soil [11]. However, the yield and yield components  
 136 improvement observed in this trial at the rate of *T. diversifolia* FSB probably suggested soil  
 137 improvement by *T. diversifolia* incorporation which led to increased yield. Similar growth and yield  
 138 increase had been reported in soya bean [14, 15]. 

## 139 5. Conclusion

140 The present study had demonstrated that *Tithonia diversifolia* may be useful in improving soil for  
 141 optimum cowpea production in the study area. However the reduction in the total emergence  
 142 percentage of cowpea in the higher *T. diversifolia* FSB incorporated soils suggests a longer time  
 143 between soil incorporation of *T. diversifolia* FSB and planting of cowpea. This is to allow a  
 144 biodegradability and reduction in the allelochemicals produced by *T. diversifolia* which may affect  
 145 total germination percentage of cowpea. This will increase the plant population increase growth and  
 146 subsequently plant yield.

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## 151 References

- 152 1. Singh BB, Ehlers JD, Sharma B, Freire Filho FR. Recent progress in cowpea breeding 22-40. In Fatokun CA,  
153 Tarawali SA, Singh BB, Kormawa PM, Tamò M (eds). *Proceedings of the III World Cowpea Conference held at*  
154 *the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, 4-8 2000* . IITA, Ibadan, Nigeria.  
155 2002:22-40.
- 156 2. Singh BB, Asante SK, Florini D, Jackai LEN, Fatokun C, Wydra K. (1997). Breeding for multiple disease and  
157 insect resistance. IITA Annual Report. 1997 :11: 22.
- 158 3. Fatokun CA, Tarawali SA, Singh BB, Kormawa PM, Tamò M. (eds). Challenges and opportunities for enhancing  
159 sustainable cowpea production. *Proceedings of the III World Cowpea Conference held at the International*  
160 *Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, 4-8 September 2000* . IITA, Ibadan, Nigeria. 2002:385.
- 161 4. Eze SNO, Gill LS. *Chromolaena odorata* problematic weed. *Compositae Newsletter*. 1992: 20:14-18.
- 162 5. Taiwo LB, Makinde JO. Influence of water extract of Mexican sunflower on growth of cowpea. *Africa Journal of*  
163 *Biotechnology*. 2005;(4) 355-360.
- 164 6. Otusanya OO, Ilori OJ, Adelusi AA. Allelopathic effect of *Tithonia diversifolia* on germination and growth of  
165 *Amaranthus cruentus*, Res. J. Environ. Sci. 2007: 1 (6) 85-293.
- 166 7. Gachengo CN, Palm CA, Jama B, Otheieno C. *Tithonia* and Senna green manures and inorganic fertilizers as  
167 phosphorus sources for maize in western Kenya. *Agroforestry Sys*. 1999: 44: 21-36.
- 168 8. Niang C, Gachengo C, Nziguheba G, Amadalo B. *Tithonia diversifolia* as green manure for soil fertility  
169 improvement in western Kenya; A review *Agroforestry Sys*. 2000: 49: 201-2221.
- 170 9. Abukusta Onyango MO, Onyango JC. Influence of organic and inorganic source of fertilizer on growth and leave  
171 yield of Kale (*Brassica oleraceae* var). *Journal of Agriculture, Science and Technology*. 2002: 4(1) 38-51.
- 172 10. Kayode J, Otoide JE. Leaf cuticle variation in *Amaranthus spinosus* as indicators of environmental pollution.  
173 *Pakistan Journal of Scientific and Industrial Research*. 2007: 50 (5): 327-329.
- 174 11. Ademiluyi BO. Effect of *Tithonia diversifolia* (Hemsl) A. Gray on the growth and yield of okra (*Abelmoschus*  
175 *esculentus*). *Journal of Agricultural Science and Technology B* 2012: 2: 219-222.
- 176 12. Oyerinde RO, Otusanya OO, Akpor OB. Allelopathic effect of *Tithonia diversifolia* on germination, growth and  
177 chlorophyll content of maize (*Zea mays* L.) *Scientific Research and Essay*. 2009: 4 (12) 1553-1558.
- 178 13. Ademiluyi BO, Omotoso SO. Comparative evaluation of *Tithonia diversifolia* and NPK fertilizer for soil  
179 improvement in maize (*Zea mays*) production in Ado Ekiti, Southwestern Nigeria. *Research Journal of Agronomy*  
180 2008: 2 (1): 8-11.
- 181 14. Nimje PM, Seth J. Effect of P and FYM on nutrient uptake by soybean. *Indian Journal of Agronomy* 2003:33:134-  
182 142.
- 183 15. Odu, C.T. and Mba, C.C. 2009. Microbiology consideration for maximizing nutrient availability through organic  
184 fertilization: proceedings of natural organic fertilizer seminar, Kaduna 67-80.  
185