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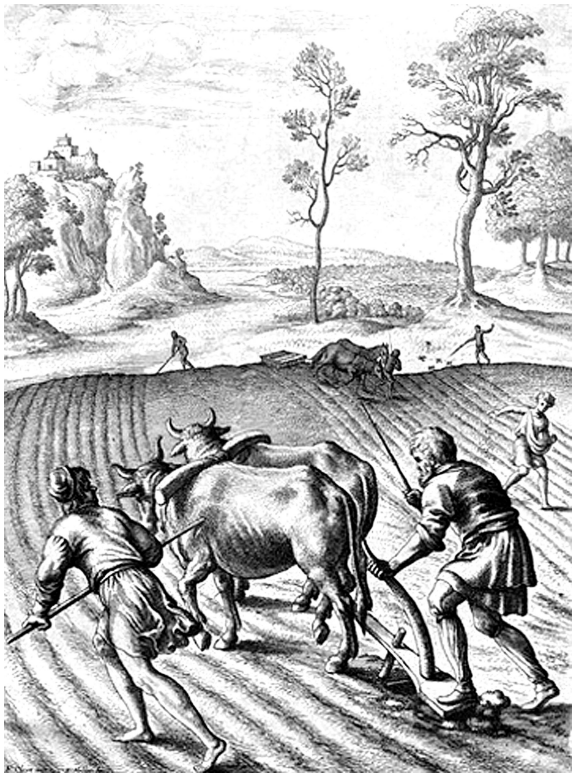

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Interaction of Okra [*Abelmoschus esculentus* (L.) Moench] and *Tithonia diversifolia* (Hemsl) A. Gray) in an Agroecosystem

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Abstract: In order to proffer an effective management of weeds in agroecosystems, a study which revolves around recognizing the crop-weed inter-relationship is needed. In the light of the above, the interaction of *Abelmoschus esculentus* (L.) Moench and *Tithonia diversifolia* (Hemsl) A. Gray) in an agroecosystem located in the University of Ibadan was studied. *Abelmoschus esculentus* and *Tithonia diversifolia* were planted in plastic pots in a randomized block design and watered at alternative days with 2 L of water per pot. Results showed that *Abelmoschus esculentus* planted alone had the greatest plant height, stem diameter, leaf area, number of leaves and biomass accumulation than *Tithonia diversifolia* grown alone. However, analysis of variance carried out with each of the plants revealed that *Tithonia diversifolia* had a significant effect ($p<0.05$) on the dry weight of shoot and root of *Abelmoschus esculentus* and also on its number of leaves. *Abelmoschus esculentus* had no significant effect on the leaf area. The inferences of these results were discussed.

Key words: Interference, *Abelmoschus esculentus*, *Tithonia diversifolia*, agroecosystem

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] is a vegetable crop grown both in tropical and subtropical regions of the world (Ahmed *et al*., 2006). It is principally used in the preparation of soup in Nigeria (Tindall, 1986). According to Awodoyin and Olubode (2009), the immature fruits and leaves of okra are used in soup as thickener because it is a rich source of vitamins and minerals. One of the main limitations to successful okra propagation is the menace of weeds (Adejonwo *et al*., 1989). Weeds vary in growth habits and effects on crops and weed situations also vary from place to place (Akobundu, 1987). In Nigeria, *Tithonia diversifolia* is found almost throughout the country in diverse environments (Olabode, 2004) and it grows in abundance in the South-west Nigeria (Chukwuka, 2003). The aggressiveness of *Tithonia diversifolia* offers it the ability to outcompete most arable crops in cultivated lands (Adesina *et al*., 2007).

Crop-weed interaction offers competition between crop and weed in an agroecosystem in response to resources struggle for their existence and superiority. In view of this fact, there is the need to study the effects of *Tithonia diversifolia* on *Abelmoschus esculentus* in an agronomic setting as information on their interaction is scanty. Target in this study is to establish the inter-relationship between okra and *Tithonia diversifolia* in an agroecosystem.

MATERIALS AND METHODS

Planting material: Okra (*Abelmoschus esculentus* L. var. TAE 38) and *Tithonia diversifolia* seeds were used for the experiment. The seeds of okra and *Tithonia diversifolia* were obtained from Departments of Agronomy and Botany of the University of Ibadan, Ibadan-Nigeria, respectively.

Preliminary experiment: A viability test was carried out on these seeds and test showed 85% germination.

Experimental design and layout: The experimental design comprised of 3 treatments and 3 replications and completely randomized in the Green House of the Department of Botany, University of Ibadan, Ibadan-Nigeria (Table 1).

Experimental procedure: Top soil samples were collected, air dried and sieved to remove large objects, deadwood and fragments. The 9.8 kg of the dry soil were placed in 10 L plastic pots with each pot perforated at the base to allow excess water to drain out. The pots were arranged in a completely randomized block design and replicated three times. The treatments consisted of *Abelmoschus esculentus* intercropped with *Tithonia diversifolia*, *Tithonia diversifolia* alone and *Abelmoschus esculentus* alone. Each treatment group was watered to field capacity. Three okra seeds were

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Table 1: Experimental design for the treatments

Block 1	Block 2	Block 3
Tithonia diversifolia growing alone	*Abelmoschus esculentus* interplanted with *Tithonia diversifolia*	*Abelmoschus esculentus* growing alone
Abelmoschus esculentus interplanted with *Tithonia diversifolia*	*Abelmoschus esculentus* growing alone	*Tithonia diversifolia* growing alone
Abelmoschus esculentus growing alone	*Tithonia diversifolia* growing alone	*Tithonia diversifolia* interplanted with *Abelmoschus esculentus*

planted 5.0 cm deep in each pot while seeds of *Tithonia diversifolia* were planted by broadcasting 10 seeds in each of the pots. After germination and establishment, seedlings were thinned to 1 seedling per pot and one each of *T. diversifolia* and *A. esculentus* in the intercropped pots. The plants were allowed to grow and watered at alternate days as necessary.

Weekly measurement of plant height, number of leaves, leaf area and stem diameter were taken for 9 weeks, after which the plants were harvested. The plants in each treatment group were separated into leaves, stems and roots with the stems and roots washed clean in running tap water to ensure that all dust and sand particles were removed prior to drying. Subsequently these were placed in separate envelopes and oven dried at 70°C for 48 h to determine their dry weights.

RESULTS

Germination: Experimental results showed that it took the seeds of okra and *Tithonia diversifolia* an average of 3 days for each of them to germinate. None of the seeds (Okra or *T. diversifolia*) inhibited the seeds of the other from germination.

Plant height: The effects of okra on *Tithonia diversifolia* plant height is shown in Fig. 1a. *Tithonia diversifolia* intercrop had a mean height of 117.3±29.6 cm, while *Tithonia diversifolia* grown alone had a mean height of 84.2±10.7 cm. ANOVA result showed that okra had no significant effect on *Tithonia diversifolia* plant height. Figure 1b shows the effect of *T. diversifolia* on okra plant. The okra plant grown alone had a mean height of 108.3±49.0 cm while okra intercropped with *Tithonia diversifolia* had 50±7.69 cm. Analysis of variance showed that *Tithonia diversifolia* has no significant effect on the okra plant height.

Number of leaves: Figure 2a shows the effect of okra on number of leaves of *Tithonia diversifolia*. *Tithonia diversifolia* intercropped with okra had a mean 33.3±10.0 number of leaves. While *Tithonia diversifolia* planted alone had 20.3±0.9 mean number of leaves. This result was not significant. This implies that okra plant has no effect on number of leaves of *Tithonia diversifolia*.

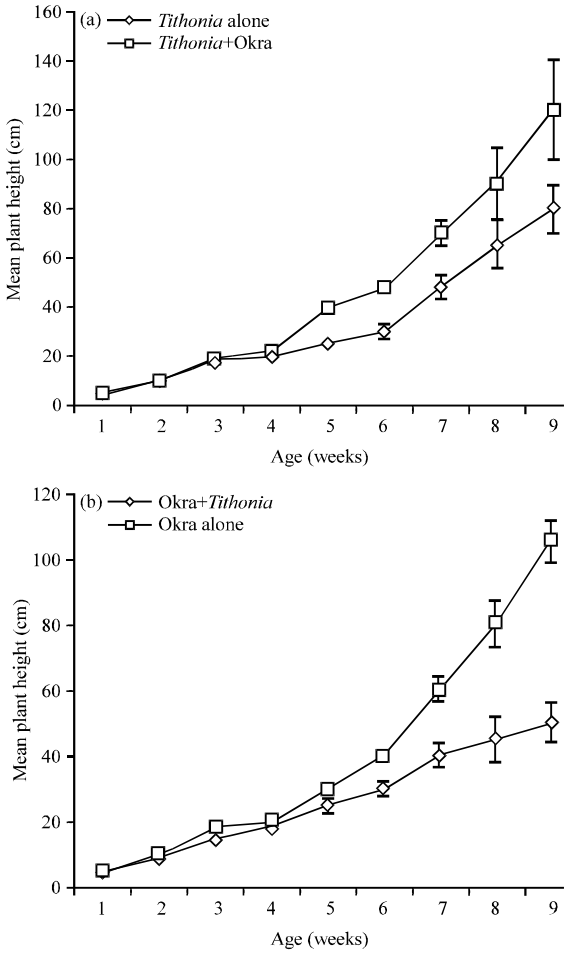

Fig. 1(a-b): Effects of (a) Okra on *Tithonia diversifolia* height (cm) and (b) *Tithonia diversifolia* on Okra height (cm), Error bars are representing standard error

Okra intercropped with *Tithonia diversifolia* had a lower mean number of leaves (6.00±0.59) when compared to the mean number of leaves of okra grown alone (15.7±1.5). It was observed that okra intercropped with *Tithonia diversifolia* had thin and narrow leaves, while okra grown alone had broad and wide leaves. ANOVA results indicate that the effect of *Tithonia diversifolia* on the number of leaves of okra is significant ($p<0.05$). Figure 2b shows the effect of *Tithonia diversifolia* on number of leaves of okra.

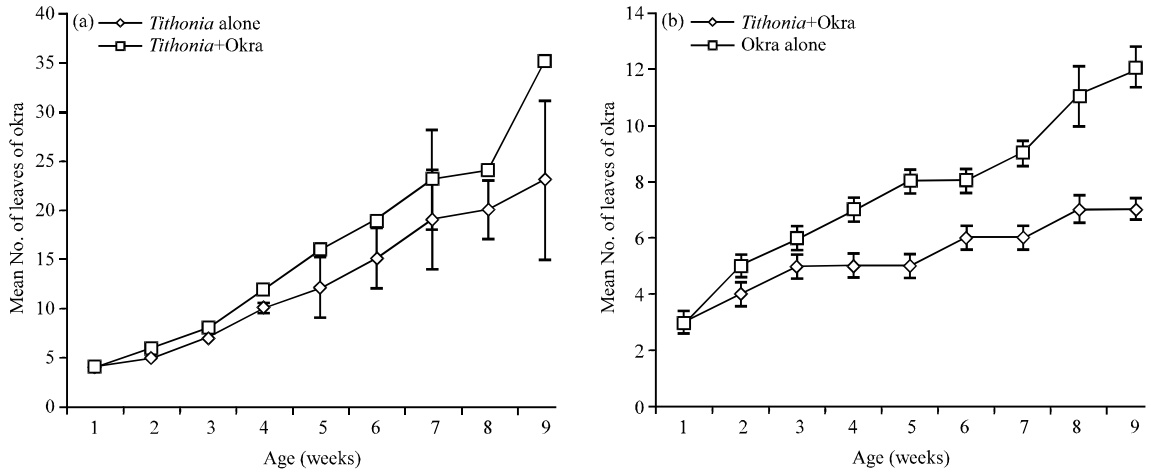

Fig. 2(a-b): Effects of (a) Okra on number of leaves of *Tithonia diversifolia* and (b) *Tithonia diversifolia* on number of leaves of okra, Error bars are representing standard error

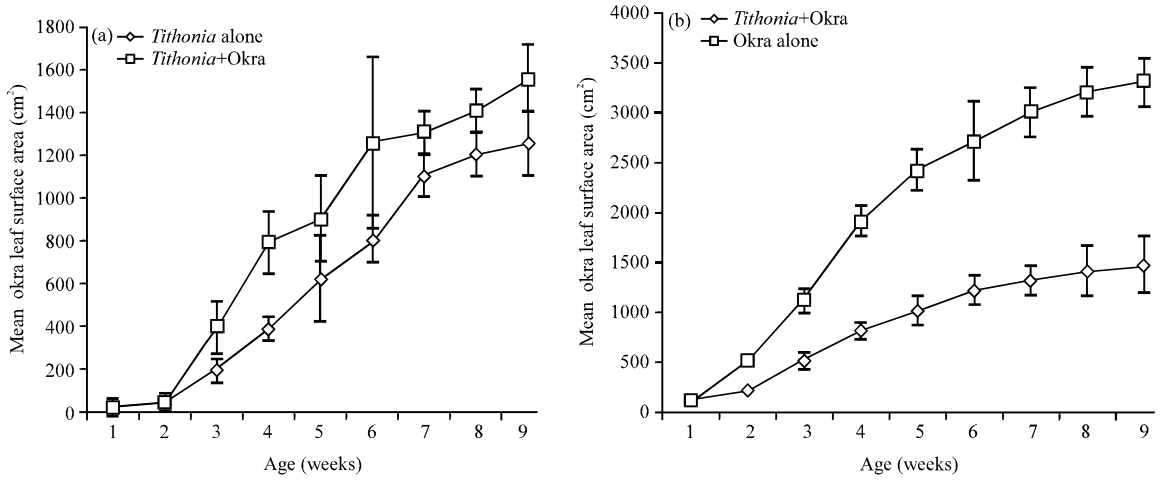

Fig. 3(a-b): Effects of (a) Okra *Tithonia diversifolia* leaf surface area (cm^2) and (b) Effects of *Tithonia diversifolia* on okra leaf surface area (cm^2), Error bars are representing standard error

Leaf surface area: The effect of okra plant on *Tithonia diversifolia* leaf surface is graphically represented in Fig. 3a. *Tithonia diversifolia* intercropped with okra plant had a leaf surface area of 1500±200 cm^2 while *Tithonia diversifolia* grown alone had mean leaf surface area of 1200±230 cm^2. The result when subjected to analysis of variance was significant ($p<0.05$). Thus, okra positively affected the leaf surface area of *Tithonia diversifolia*. Okra intercropped with *Tithonia diversifolia* had mean leaf surface area of 1300±35 cm^2 while okra planted alone had mean leaf surface area of 3200±400 cm^2. Analysis of variance showed that the differences were not significant. Hence, *Tithonia diversifolia* had no effect on leaf surface area of okra plant.

Stem diameter: Figure 4a shows the effect of okra on *Tithonia diversifolia* stem diameter. *Tithonia diversifolia* intercropped with okra had a mean diameter of 1.00±0.06 cm, while *Tithonia diversifolia* alone had 0.84±0.06 cm. The effect of okra plant on *Tithonia diversifolia* stem diameter was not significant. On the other hand, the effect of *Tithonia diversifolia* on okra stem diameter is shown in Fig. 4b. Okra intercropped with *Tithonia diversifolia* had a mean stem diameter of 0.68±0.07 cm, while okra grown alone had a mean diameter of 1.44±0.12 cm. This result was however not significant.

Dry weight: Okra plant intercropped with *Tithonia diversifolia* had a root dry weight of 0.98 kg. This value is lower than okra grown alone root dry weight

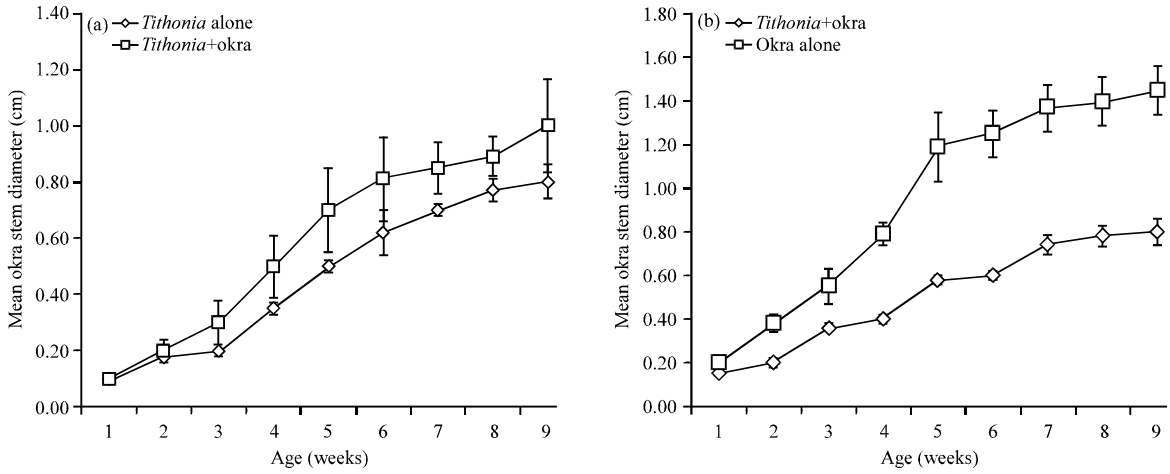

Fig. 4(a-b): Effects of (a) Okra on *Tithonia diversifolia* stem diameter (cm) and (b) Effects of *Tithonia diversifolia* on okra stem diameter (cm), Error bars are representing standard error

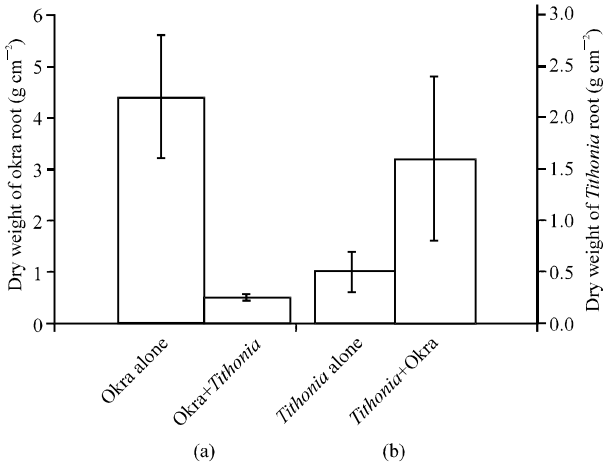

Fig. 5(a-b): Effects of (a) *Tithonia diversifolia* on Okra root dry weight (g cm^{-2}) and (b) Okra on *T. diversifolia* root dry weight (g cm^{-2}), Error bars are representing standard error

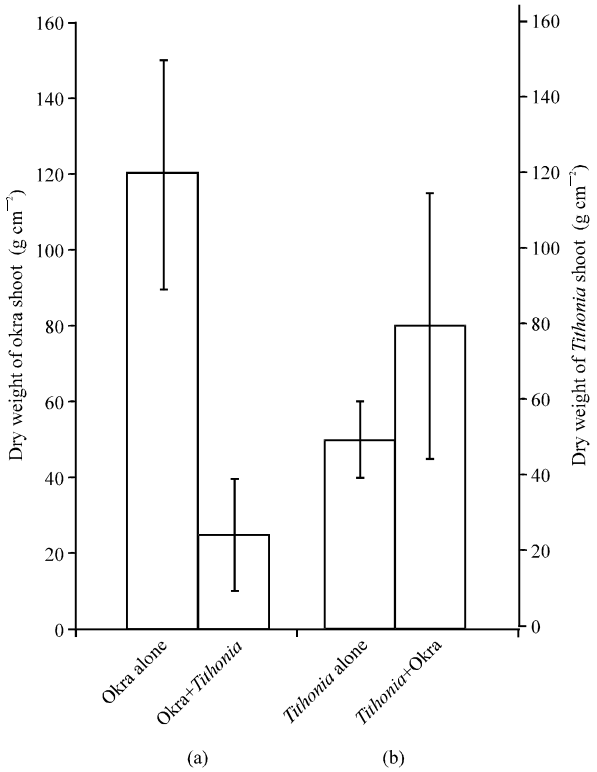

Fig. 6(a-b): Effects of (a) *Tithonia diversifolia* on okra shoot dry weight (g cm^{-2}) and (b) Okra on *Tithonia diversifolia* shoot dry weight (g cm^{-2}), Error bars are representing standard error

of 4.2 g. When subjected to ANOVA, it revealed that there was significant effect of *Tithonia diversifolia* on okra root dry weight ($p<0.05$). The effect of *T. diversifolia* on okra root dry weight is shown in Fig. 5a. *Tithonia diversifolia* intercropped with okra plant had a mean dry weight of 1.6 g while *Tithonia diversifolia* grown alone had 0.5 g. However, there was no significant effect of okra plant on *Tithonia diversifolia* root dry weight. Okra plant intercropped with *Tithonia diversifolia* had shoot dry weight of 0.4 g while okra grown alone had 26 g. When subjected to ANOVA, the effect of this exotic weed was significant ($p<0.05$). This is represented graphically in Fig. 6a. *Tithonia diversifolia* intercropped with okra had shoot dry weight of 78.0 g while *Tithonia diversifolia* grown alone had 49 g. However, this difference was not significant. The effect of okra on *Tithonia diversifolia* is shown in Fig. 6b.

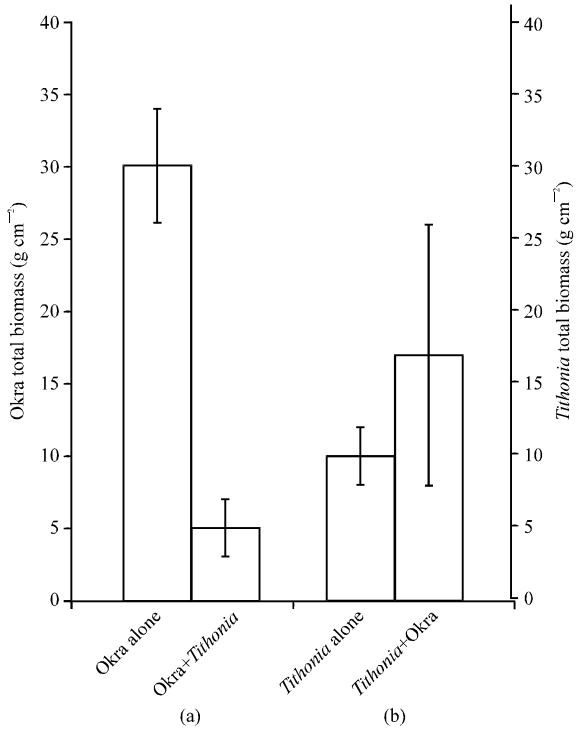

Fig. 7(a-b): Effects of (a) *Tithonia diversifolia* on okra total biomass (g cm^{-2}) and (b) Okra on *Tithonia diversifolia* total biomass (g cm^{-2}), Error bars are representing standard error

The effect of *Tithonia diversifolia* on okra total biomass is presented in Fig. 7a. Okra intercropped with *Tithonia diversifolia* had a total biomass of 5.0 g cm^{-2}. This value is lower compared to the total biomass of 30.0 g cm^{-2} of okra plant grown alone. The result of analysis of variance showed that the effect of *Tithonia diversifolia* on okra biomass was significant. *Tithonia diversifolia* intercropped with okra had a total biomass of 17 g cm^{-2} while *Tithonia diversifolia* grown alone had total biomass of 10 g cm^{-2}.

DISCUSSION

Okra-*Tithonia diversifolia* interaction in agroecosystem was studied in a pot experiment. The result of Okra-*Tithonia diversifolia* interactions revealed that okra plant grown alone had higher plant height, number of leaves, leaf surface area; stem diameter, root dry weight, shoot dry weight and total biomass when compared to okra plant intercropped with *Tithonia diversifolia*. These results are in agreement with findings of Chukwuka (2003) who observed that *Zea mays* grown alone does not compete for light, water and mineral nutrients with any other plant and that weeds grow faster than cultivated crops thus decreasing the effectiveness of crops chlorophyll manufacturing systems. The plant body tissue development and carbohydrate production and yield are greater when arable crops are grown alone. Also, *T. diversifolia* exhibited inhibitory effects on growth responses of crops (Chukwuka, 2003). The authors, therefore, deduce from the results of this study that the decrease in plant height, stem diameter, number of leaves, leaf surface areas, total biomass in okra intercropped with *Tithonia diversifolia* could be due to competition for nutrients, water as well as light. This attribute contributed to the reduced growth performance of the okra plant intercropped with *Tithonia diversifolia*.

The number of leaves, leaf surface area and stem diameter are higher in *Abelmoschus esculentus* grown alone than that intercropped with the weed. This is in agreement with Kramer and Kozlowski (1960) who reported that the influence of light on cell enlargement and differentiation, through effects on plant metabolism and especially hormone synthesis is reflected in changes in plant height, leaf size, structure of leaves and stem diameters. Both fresh and dry weights of okra grown alone are more than that intercropped with *Tithonia diversifolia*. This again is due to non-interference for environmental resources. Okra grown alone had environmental resources such as light, nutrients and space to itself. Several workers (Brandenberger, 1995; Brandenberger and Dainello, 1996) reported that weed infestation lowers yield and yields are frequently reduced by weeds competing with vegetables and other crops for water, nutrients and light. *Tithonia diversifolia* intercropped with okra was observed to outgrow *Tithonia* alone. This result agrees with the findings of Brandenberger (1995) as well as Brandenberger and Dainello (1996). Weeds that can compete best always tend to dominate a field seeded with a slower growing vegetable. The total biomass and fresh weight per stand of *Tithonia diversifolia* when intercropped with okra had more weight than the *Tithonia diversifolia* grown alone. *Tithonia* is able to accumulate nutrients and had overall advantage for space and nutrient. In conclusion, *Tithonia diversifolia* intercropped with okra had an overall advantage and greater biomass which leads to reduced performance of okra and therefore should be controlled as to ensure high yield of the crop.

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