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GROWTH AND YIELD ATTRIBUTES OF *ZEA MAYS* L. AND *VIGNA UNGUICULATA* L. (WALP) TO DIFFERENT DENSITIES OF *TITHONIA DIVERSIFOLIA* (HELMS) A. GRAY

ZNAČAJKE RASTA I PRINOSA *ZEA MAYS* L. I *VIGNA UNGUICULATA* L. (WALP) POD RAZLIČITOM GUSTOĆOM *TITHONIA-E DIVERSIFOLIA-E* (HELMS) A. GRAY

B. Umar Olayinka, E. Obukohwo Etejere, Z. Bolaji Salihu, Busayo Juliana Lawal

ABSTRACT

Pot experiments were carried out in the Botanical Garden of University of Ilorin, to evaluate growth and yield attributes of *Zea mays* and *Vigna unguiculata* under different densities of *Tithonia diversifolia*. The treatments consisted of five levels of the weed (0, 5, 10, 15 and 20). Split-plot design was used with each of the treatment replicated four times and pots in each main plot followed complete randomized block arrangement. Growth characters such as plant height number of leaves, leaf area and dry matter accumulation in both crops decreased significantly ($p \leq 0.05$) with increase in densities. Number of cob per plant, number of grain per cob and cob weight of *Zea mays* were significantly highest in the control compared to those infested with 5 and 10 densities of *T. diversifolia*. Total yield loss was recorded at densities of 15 and 20 in *Zea mays*. Unlike *Zea mays*, all the densities studied were able to produce pod. However, yield attributes such as pod length, number of seeds per pod and pod filling declined with increasing densities. The effect of *T. diversifolia* was significantly felt at density as low as 10 and as high as 15 and 20 between 4 and 8 weeks after planting. The results showed that high density of *T. diversifolia* has the potential of limiting the growth with the concomitant consequence of causing significant reduction in the yield components of the two test crops studied.

Keywords: Competition, Density, *Tithonia diversifolia, Vigna unguiculata, Zea mays*

SAŽETAK

Provedeni su pokusi u loncima u Botaničkom vrtu Sveučilišta Ilorin radi procjene značajki rasta i prinosa *Zea mays* i *Vigna unguiculata* pod različitim gustoćama *Tithonia-e diversifolia-e*. Postupci su se sastojali od pet razina korova (0,5,10,15 i 20). Primijenjen je split-plot dizajn u svakom postupku s četiri ponavljanja, a lonci u svakoj glavnoj čestici pratili su raspored potpunog slučajnog bloka. Karakteristike rasta kao što su visina biljke, broj listova, površina lista i nakupljanje suhe tvari u oba usjeva znatno su se smanjile ($p<0,05$) s porastom gustoće. Broj klipova po biljci, broj zrna po klipu i težina klipa *Zea mays* bili su značajno najviši u kontrolnoj skupini u usporedbi s onima infestiranima s 5 i 10 gustoća *T. diversifolia*. Ukupan gubitak prinosa zabilježen je u gustoćama 15 i 20 *Zea mays*. Za razliku od *Zea mays* sve ispitivane gustoće mogle su proizvesti mahunu. Međutim, značajke prinosa kao što su duljina mahune, broj sjemenki po mahuni i punoća mahune smanjili su se s povećanjem gustoće.

Djelovanje *T. diversifolia-e* bilo je značajno kod gustoće od 10 do 15 i 20 između 4. i 8. tjedna nakon sadnje. Rezultati su pokazali da visoka gustoća *T. diversifolia-e* može ograničiti rast i prouzročiti značajno smanjenje komponenata prinosa dvaju ispitivanih usjeva.

Ključne riječi: natjecanje, *Tithonia diversifolia, Vigna unguiculata, Zea mays*

INTRODUCTION

Tithonia diversifolia popularly known as Mexican sunflower is a perennial shrub of Asteracaea family. As an invasive species in Africa, the plant has established itself as a notorious weed of arable crops (Muoghalu and Chuba, 2005). In Nigeria, it has been found that a single plant produced several 35-212 capitulum heads with each capitulum head carrying 32–62 seeds. Therefore within a square-metre over eight hundred thousand viable seeds could be deposited in the soil seed bank. Seed viability was as high as 93%. Viable seeds germinated readily from the soil surface between 4-6 days and germination percentage increased significantly with decrease in planting depth (Etejere and Olayinka, 2014). The foregoing attributes have been used to explain why theygrow in dense populations with heavily clustered stands. This also enables them to have closed canopies. Their closed canopies and dense populations completely shade out other weeds and neighboring crops (Akobundu and

Agyakwa, 1997; Muoghalu and Chuba, 2005 and Etejere and Olayinka, 2014). The plant grows on a wide variety of ecological habitats ranging from sandy to loamy soils with maximum growth in loamy soil (Etejere and Olayinka 2014).This potential enables the plant to compete and colonize every available site such as railway banks, fallowed lands, building sites and cultivated farm lands. In the Southern Guinea Savanna zone of Nigeria, it has become a serious weed species in cowpea, maize, groundnut, guinea corn and cassava. The weed has also been reported to contain a large amount of allele chemicals especially in leaves which inhibit growth of many plants (Eze and Oni, 1992: Taiwoand Makinde, 2005; Otusanya et al,. 2007).

The aggressive and successful natures of this weed have therefore become a very serious threat to neighboring crops. In the light of the above, this work attempt to evaluate the effect of different densities of this weed on the growth and yield attributes of *Zea mays* and *Vigna unguiculata* with the view to establish the minimum density and the duration of time of the weed that would be detrimental.

MATERIALS AND METHODS

Collection of sample

The seeds of *Tithonia diversifolia* were collected in November/December in 2013 during the fruiting period. The seeds were carefully removed from their capitulum heads, collected in large quantities and stored in paper envelope for one month until they were used for the study. *Zea may s*and *Vigna unguiculata* seeds were obtained at the Kwara State Ministry of Agricultural and Natural Resources, Ilorin, Kwara State and separately stored as done for *T.diversifolia* seeds. The loamy soil used for the experiment was collected from the zoological garden of University of Ilorin, Ilorin, Kwara State.

Viability Test

Viable seeds of *T. diversifolia* were used for the study. The viability of the seeds wasdetermined with the use of floatation methods. This was achieved by dropping the seeds gently in 500 ml beaker filled with water and allowed to stand for 15 minutes.

The floated non-viable seeds were decanted and discarded while those viable seeds that sank were air dried for two days and were then used for the study.

Experimental layout

Fifty pots each measuring 40 cm in height and 30 cm in diameter filled with loamy soil were used The pots were perforated at the bottom to facilitate drainage and thereafter separated into two group tagged as A and B where each groups had twenty five pots. In each group, the pots were arranged following complete randomized block design with four replications. In groups A and B, two seeds each of *Zea mays* and *Vigna unguiculata* were respectively planted. On the same day of sowing of the two test crops, viable seeds of *T. diversifolia* that had undergone viability test were broadcasted and buried on the surface of the soil. The pots were left for two weeks after planting to allow germination and growth of both the crops and weed. At 2 WAP, seedlings of *T. diversifolia* were thinned down to the desired densities of 0, 5, 10, 15, 20 to establish five levels of the treatments. It should be noted that the test crops were equally thinned down to one plant per pot. Other weeds emerging were hand pulled and pots were watered as required to maintain growth.

Data collection

Growth parameters such as plant height, number of leaves, leaf area of *Zea mays* and *Vigna unguiculata* were measured at 4, 8 and 12 weeks after planting (WAT). The plant height was measured using meter rule, matured open leaves were manually counted and leaf area was determined using the formula: 0.75 length × breadth according to Moll and Kamprath (1977) as modified by Abayomi and Adedoyin (2004) for the maize. In the cowpea, leaf area determination was according to the method of Pearcy (0.5 × Length × Breadth). The values 0.75 and 0.50 are conversion factors for Zea *mays* and *Vigna unguiculata* respectively. During each sampling periodshoot and root dry weight was determined from each treatment by oven drying them at 80 ^{o}C for 72 hours to compute total dry weight. The dry weight in grams was determined using Electronic MP 101 balance. Yield attributes that were determined for *Zea mays* were number of cobs per plant, number of grains per cob and cob weight per plant. Whereas in *Vigna unguiculata,* yields parameters recorded included pod length, number of seeds per pod and pod filling. The filling potential was determined following the method of Olorunmaiye (2010) as no of seedsover pod length.

Data analysis

The data obtained were subjected to analysis of variance using Gentstat Statistical Packages and mean separated using Duncan Multiple range Test at 0.05 level of probability.

RESULTS

Effects of different densities of *Tithonia diversifolia* on growth parameters

Result of the effect of different densities of *T.diversifolia* on plant height of *Zea mays* and *Vigna unguiculata* is presented in Fig.1. At different growth periods (4, 8 and 12 WAT), plant height in both crops was significantly ($P \leq 0.05$) influenced by different densities of *T. diversifolia.* Significant by the highest plant was achieved in the control pots except at 4 WAT in *Vigna unguiculata* (Fig. 1*).* With increasing *T. diversifolia* densities the plant height of both croped tends to decrease. *T. diversifolia* at the highestdensities (20) significantly reduced the plant height compared to those of 5, 10 and 15 densities at final sampling period (12 WAT).

Number of leaves of *Zea mays* and *Vigna unguiculata* followed the same pattern of response as plant height (Fig. 2). In both crops, significantly greatest number of leaves was recorded in the control pots during each of the growth periods except at 4 WAT for *Zea mays*where density of *T. diversifolia* of 5 populations was at par with the control. Exposing the crops to *T. diversifolia* density of 20 populations resulted in a significantly reduction in number of leaves compared to other densities studied most importantly at 8 and 12 WAT. *T. diversifolia* at 10 and 15 densities showed number of leaves production at 8 and 12 WAT in *Vigna unguiculata* and *Zea mays* respectively that were statistically similar (Fig. 2).

Leaf area production in both crops was significantly affected by different densities of *T. diversifolia* in each of the growth periods (Fig. 3). Significantly highest leaf area was recorded in the control and followed in decreasing order of magnitude by those of 5, 10, 15 densities of *T. diversifolia*. In all the sampling periods significantly lowest leaf area was recorded at 20 density of the weed. At 4 WAT, in *Zea mays* significant difference was recorded among different densities whereas in *Vigna unguiculata* pots infested with 10, 15 and 20 densities of *T. diversifolia* were at par with each other (Fig. 2). At 8 and 12 WAT, leaf production followed decreasing trend with increase in

T. diversifolia densities. However, leaf areas recorded were statistically similar between densities of 15 and 20 at 8 WAP in both crops and at 12 WAP in *Vigna unguiculata* (Fig.3).

The results of total dry weight as significantly influenced by different denstities of *T. diversifolia* except at 4 WAP in *vigna unguculata* are shown in Fig. 4. The highest dry matter production was recorded in the control and found to decrease with increased densities of *T. diversifolia*. At 8 and 12 WAP, statistical differences in total dry matter production in *Zea mays* were not recorded between 5 and 10, as well as 15 and 20 densties of *T. diversifolia.* Whereas in *Vigna unguiculata*, at 8 WATthe effect of *T. diversifolia* densities at 10 and 15 on total dry matter was at par with each other. At 12 WAP, the control pots had dry matter values that did not differ significantly from those of pots grown with 5 densities of *T. diversifolia*. Similarly, dry matter accumulation of *Vigna unguiculata* when infested with 10 and 15 densities of the weed were found to be statistically similar.

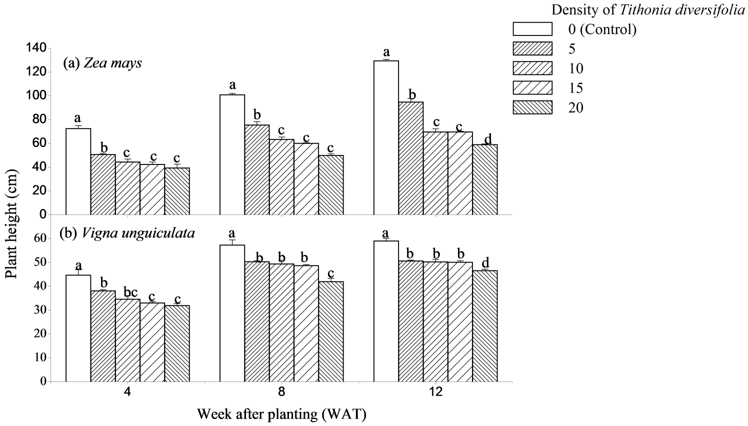

Fig.1. *Plant height (a) Zea mays and (b) Vigna unguiculata as affected by different densities of Tithonia diversifolia. Means followed by the same letter during each sampling period are statistically similar at P≤0.05 level of significance. Vertical bars represent standard error (SE±) of means*

Slika 1. *Visina biljke a) Zea mays i b) Vigna unguinata pod djelovanjem različitih gustoća Tithonia-e diversifolia-e.*

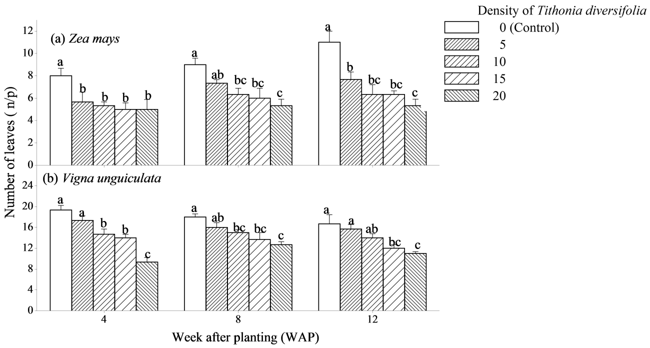

Fig. 2. *Number of leaves of (a) Zea mays and (b) Vigna unguiculata as affected by different densities of Tithonia diversifolia. Means followed by the same letter during each sampling period are statistically similar at P≤0.05 level of significance. Vertical bars represent standard error (SE±) of means*

Slika 2. *Broj listova a) Zea mays i b) Vigna unguiculata pod djelovanjem različitih gustoća Tithonia-e diversifolia-e*

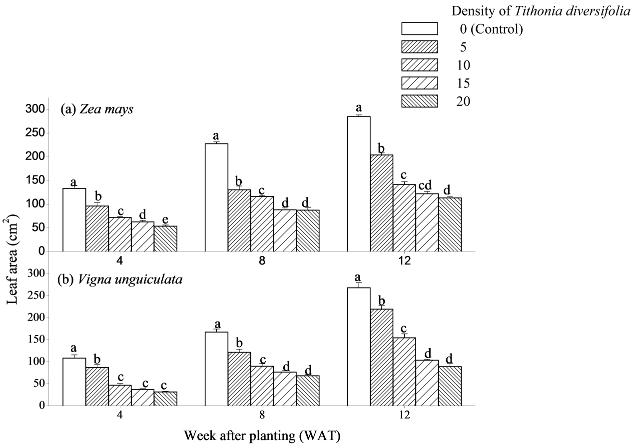

Fig. 3. *Leaf area of (a) Zea mays and (b) Vigna unguiculata as affected by different densities of Tithonia diversifolia. Mean followed by the same letter during each sampling period are statistically similar at P≤0.05 level of significance. Vertical bar represent standard error (SE±) of means.*

Slika 3. *Površina lista a) Zea mays i b) V. unguiculata pod djelovanjem različitih gustoća T.diversifolia-e*

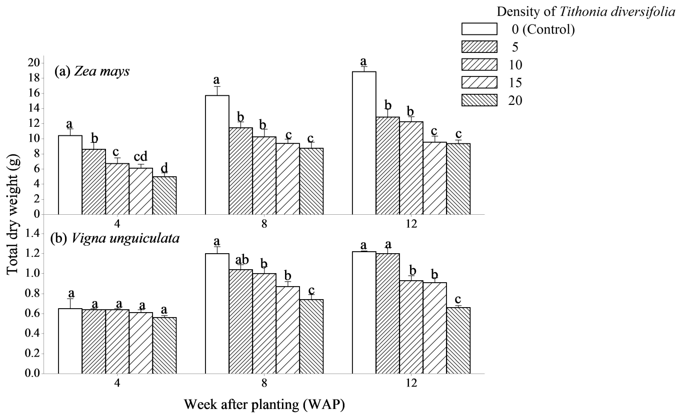

Fig. 4. *Total dry weight of (a) Zea mays and (b) Vigna unguiculata as affected by different densities of Tithonia diversifolia. Mean followed by the same letter during each sampling period are statistically similar at P≤0.05 level of significance. Vertical bars represent standard error (SE±) of means.*

Slika 4. *Ukupna suha težina a) Zea mays i b) V. unguinata pod djelovanjem različitih gustoća T.diversifolia-e*

Effects of different densities of *Tithonia diversifolia* on yield components

Table 1 shows the effect of different densities of *T. diversifolia* on yield components of Zea *mays.* The control pots had significantly highest number of cobs per plant, number of grains per cob and cob weight per plant with values of 2.00±0.00, 27.00±3.78 and 9.81±1.39g respectively. This declined with increasing densities of the *T. diversifolia* up to 10 densities. In this study, pots infested with 15 and 20 densities of *T. diversifolia*after reaching physiological maturity were unable to produce cobs let alone the grains. Unlike *Zea mays*, all the pots of Vigna *unguiculata* infested with different densities of *T. diversifolia* after reaching the physiological maturity were able to produce pods with seeds in them. The yield components however were found to be density dependent and statistically different (Table 1). The control pots showed significantly highest pod length (15.17±0.31 cm) number of seeds per pod (11.67±0.88) and pod filling (0.77) when compared with pots infested with *T. diversifolia* at 5, 10, 15 and 20 densities. Significantly lowest pod length, number of seeds per pod and pod filling were recorded from the highest density (20) of *T. diversifolia* with respective values 5.07±0.17 cm, 1.67±0.34 and 0.31±0.61 (Table 1). Number of seeds per pods at densities of 10 and 15 were statistically similar. The pod filling potential recorded from pots infested with 5, 10 and 15 densities of *T. diversifolia* were statistically at par with one another (Table 1).

Table 1. Yield attributes of *Zea mays* and *Vigna unguiculata* as influenced by different densities of *Tithonia diversifolia.* Within column means followed by the same letters are statistically the same at p≤ 0.05 level of significance.

Tablica 1. Značajke prinosa *Zea mays* i *Vigna unguiculata* pod djelovanjem različitih gustoća *Tithonia diversifolia*

Zea mays	Density	Number of cob per plant	Number of grain per cob	Cob weight per plant (g)
	0	2.00 ± 0.00^{a}	27.00 ± 3.78^{a}	9.81 ± 1.39^{a}
	5	1.33 ± 0.33^{b}	10.33 ± 0.33^{b}	5.45 ± 0.13^{b}
	10	0.67 ± 0.33^{c}	5.00 ± 0.57^{bc}	4.50 ± 0.41^{b}
	15	0.00 ± 0.00^{d}	0.00 ± 0.00^{d}	0.00 ± 0.00^{c}
	20	0.00 ± 0.00^{d}	0.00 ± 0.00^{d}	0.00 ± 0.00^{c}
	p-value	<0.001	<0.001	<0.001
Vigna unguiculata		Pod length (cm)	Number of seeds per pod	Pod filling
	0	15.17 ± 0.31^{a}	11.67 ± 0.88^{a}	0.77 ± 0.04^{a}
	5	13.27 ± 0.18^{b}	8.00 ± 0.58^{b}	0.60 ± 0.04^{b}
	10	10.23 ± 0.29^{c}	5.33 ± 0.33^{c}	0.52 ± 0.20^{b}
	15	7.43 ± 0.35^{d}	3.67 ± 0.33^{c}	0.50 ± 0.47^{b}
	20	5.07 ± 0.17^{e}	1.67 ± 0.34^{d}	0.31 ± 0.61^{c}
	p-value	<0.001	<0.001	<0.001

DISCUSSION

The increased densities of *T. diversifolia* had profound effect on the growth of *Zea mays* and *Vigna unguiculata*as demonstrated in this study. Growth attributes such as plant height, number of leaves, leaf area and dry matter production of both crops were affected at all densities of the weed studied.

A significant reduction in growth was observed when the crops were infested with *T. diversifolia* at 10, 15 and 20 densities most importantly between 4 and 8 WAP. The reduction in growth at these periods could mean that the effect of *T. diversifolia* density on crop growth was critical at these periods. Remison (1978) reported reduced plant height, number of nodes, green leaves, peduncles and pods as densities of *Euphorbia heterophylla* increased. The reduction in both crop growths could also be attributed to ability of the weed to compete with the crops for limited resources such as water light, space and nutrients. *T. diversifolia* has been reported to grow aggressively, massively and vigorously in any area where it colonizes and established itself as single plant species with wide canopy that effectively shade out all other plants (Akobundu and Agyakwa, 1997; Muoghalu and Chuba, 2005; Etejere and Olayinka, 2014). The efficient utilization of the limited resources for high biomass production better than the crops is competing with could be one of the major reasons why the increased density of the plant tend to reduce all the growth parameters that were studied.

The yield components in *Zea mays* was adversely affected with increased density of *T. diversifolia* in such way that crop infested with *T.diversifolia* at 15 and 20 densities could not produce cob, let alone a single grain. The implication of the scenario is that higher densities of *T. diversifolia* in maize field could lead to significant reduction in yield or no yield most importantly when *T. diversifolia* population is as low as 10 and as high as 15 or 20. *Tithonia diversifolia* in their natural environment has been found to exhibit prolific growth in terms of dense population with heavily clustered and closed canopy. These impeccable attributes conferred the weed the advantage of shading and suppressing the growth of other weeds and neighboring crops (Muoghalu and Chuba, 2005). In cowpea, yield components such as pod length, number of seed per pod and pod filling declined as densities of *T. diversifolia* increased. The present results agree with the findings of Obadoni et al, (2009) who reported decrease in pod number, pod length and pod yield among four varieties of cowpea with increased densities of guinea grass (*Panicum maximum*).

CONCLUSION

It is obvious from the foregoing results that *T. diversifolia* densities as low as 10 and as high as 15- 20 when allowed to grow in maize and cowpea fields longer than four weeks of planting could results in significant decrease in growth and yield loss in the two test crops studied.

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Author's address - Adresa autora:

Bolaji Umar Olayinka,
e-mail: umarbolaji@yahoo.com
Emmanuel Obukohwo Etejere,
Zuluqurineen Bolaji Salihu,
Busayo Juliana Lawal,
Department of Plant Biology
University of Ilorin, Ilorin Nigeria

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