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Ecological Distribution of *Tithonia diversifolia* (Hemsl). A. Gray-A New Exotic Weed in Nigeria

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Abstract: Ecological distribution of *Tithonia diversifolia* (Hemsl). A. Gray was studied in six states of the southwestern Nigeria using three locations in each of the States. The presence of *T. diversifolia* was recorded in all the States and locations surveyed in varying numbers with associated weeds. Survey data were analysed using detrended correspondence analysis (DCA). The first two ordination axes of the DCA accounted for 67.2% (Axis 1, 40.6%; Axis 2, 26.6%) of variance on the site and species components. The DCA separated Ogun State locations from others. *T. diversifolia* was found to be closely associated with *Boerhavia coccinea*, *Fleurya ovaliflora*, *Indigofera subulata*, *Merremia dissecta*, *Mimosa pudica*, *Momordica foetida*, *Phyllanthus mimosoides*, other species of *Phyllanthus*, *Physalis angulata*, *Schrankia leptocarpa* and *Sesbania pachycarpa* in Ekiti, Lagos, Ondo, Osun and Oyo States while these species were absent in Ogun State.

Key words: Ecological distribution, *Tithonia diversifolia*, enumeration, detrended correspondence analysis, southwestern Nigeria

INTRODUCTION

Tithonia diversifolia (Hemsl). A. Gray belongs to the family Asteraceae (formerly Compositae). It originated from Mexico, Central America and Cuba (Royal Horticultural Society, 1956) and has since naturalised in Tropical Asia and Africa (Blake, 1921; Blake, 1957). The genus *Tithonia* is made up of 11 species which include *Tithonia diversifolia*, *T. excelsa*, *T. fruticosa*, *T. glaberrima*, *T. ovata*, *T. playlepis*, *T. rotundifolia*, *T. scaberrima*, *T. speciosa*, *T. tagitiflora* and *T. tubiformis*; all of which originated from Mexico, Central America and Cuba (Arias *et al.*, 1982; Royal Kenya Horticultural Society, 1957). Agnew (1974) reported that the only member of the genus found in Tropical Africa (and Nigeria in particular) is *Tithonia diversifolia*.

T. diversifolia, the Mexican sunflower as it is commonly called, was probably introduced into West Africa as an ornamental plant (Akobundu and Agyakwa, 1987) but has become a weed of field crops and roadsides (Akobundu and Agyakwa, 1987). Opinions varied as regards the introduction and subsequent establishment of *T. diversifolia* in Nigeria. However, the most authentic opinion suggests that the plant gained entrance into Nigeria through Ogbomoso with the seeds of *Zea mays* imported from Israel (Akobundu and Agyakwa, 1987; Lordbanjou, 1991) by the then Oyo State Phased Agricultural Development Project (OSPADP) in the late

1970's. The plant has since spread to various parts of the southern States of Nigeria especially in the last fifteen years where conditions that favour its growth exist. In these areas, the plant has established itself as a serious weed of arable crops, plantations abandoned lawns and roadsides.

T. diversifolia, a new exotic weed in Nigeria, is one of the most underestimated problems in Nigerian agriculture (Akobundu, 1987; Chukwuka, 2003; Ikemefuna, 1995; Njoku, 1995). For most African crop farmers, weed represent the main threat to their crops because the work involved in getting rid of them is cumbersome, time-consuming, enormous and therefore demands considerable manpower. It is therefore in the light of this, that the study on the ecological distribution of *T. diversifolia* in Nigeria was undertaken.

Most imported neotropical plants have become established in the tropics as serious weeds. Examples of such weeds include *Chromolaenna odorata* (Olaoye, 1974) and *Tithonia diversifolia* (Akobundu and Agyakwa, 1987; Chukwuka, 2003). The genus *Tithonia* is well distributed all over the world. Various workers (Agnew, 1974; Blake, 1921; La deeke, 1982; Standley, 1926) have reported on the world distribution of *Tithonia diversifolia*. *T. diversifolia* according to their reports is found in North America (Mexico); South America (in Argentina, Cuba, Natal and Guatemala); Asia (in Philippines, Republic of Myamar, Malaya, Indonesia

and India, West Bengal, Tranvancore and Mycore); Australia (in New South Wales) and Africa (in Tanzania, Cameroon, Kenya, Uganda, Malawi, Egypt, Zambia and Nigeria). Although its mode of distribution has not been well documented, it is connected with importation of food crops, which were meant for cultivation. Other possible means of its distribution is by seed dispersal through the agency of wind and other dispersal mechanisms (for example birds and insects) since the seed is usually light and could be carried by wind over reasonable distance.

In Nigeria today, *Tithonia diversifolia* occurs mainly in the forest zone and the adjoining savanna along the roadsides, farmlands and lawns. Its presence has been recorded and observed in five States (Lagos, Ogun, Oyo, Osun and Ondo) of Southwestern Nigeria (Chukwuka, 2003; Lordbanjou, 1991). It is however prominent along roadsides in the guinea and derived savanna especially near river courses (Chukwuka, 2003). It has been observed on Kafanchan-Jos road, in Akwa-Ibom, Rivers, Cross River and parts of Delta, Imo and Anambra States (Chukwuka, 2003).

MATERIALS AND METHODS

Study area: The six States (Oyo, Osun, Ondo, Ogun, Ekiti and Lagos) of the Southwestern Nigeria were chosen for

the study between January 2 and June 6, 2001. The general mean annual rainfall for this ecozone is 1997 mm per annum; mean maximum and minimum temperatures are 37.57 and 21.37°C respectively (Ekeleme, 1986). The rainfall/evapotranspiration ratio of the ecozone has been estimated to be 1.06 (Oke, 1982). The climate is seasonal with two distinct wet and dry seasons. The soils are mainly of the Egbeda, Olorunda and Iwo series (Smyth and Montgomery, 1962). The series have parent rocks, which are combinations of fine-grained biotite gneiss with coarse granite and gneiss. The soil colour usually varies from brown to brownish red which are fairly clayey with fine and coarse sand fractions.

Field studies of *Tithonia diversifolia* in southwestern Nigeria: A study of the distribution of *Tithonia diversifolia* in Southwestern Nigeria was carried out. This was determined by field survey. Three locations were chosen in each of the six States of Southwestern Nigeria and the inventory of plant species encountered was taken. The locations were chosen from where *T. diversifolia* were found to be growing in the wild. The locations surveyed are shown in Fig. 1.

In choosing the locations, sites with abundant presence of *T. diversifolia* were identified in each State. Three of such sites were randomly selected for detailed investigation. One hundred metre-long and 5 metre-wide

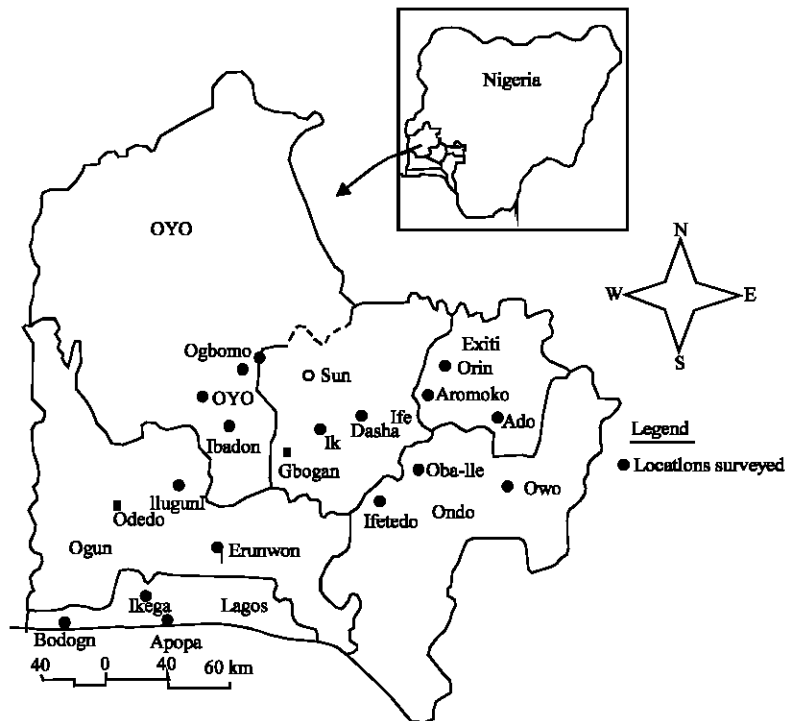


Fig. 1: Map showing the six southwestern states of Nigeria and locations surveyed

belt transect was laid in each location. In each transect, twenty-one 1×1 square meter quadrats were systematically laid at every 5 m point. All the plant species encountered in each quadrat were identified, listed and enumerated. Any unidentified species was taken in a plant press to the University of Ibadan Herbarium (UIH) for identification and authentication. Botanical nomenclature follows that of Hutchinson and Dalziel (1954). Density data obtained from the survey were subjected to Detrended Correspondence Analysis (DCA) in order to ascertain floristic gradient and continuity within the six States (Hill, 1979; Ter Braak, 1988) and default option of the CANOCO program was used (Ter Braak, 1988).

RESULTS

The locations visited and surveyed were Ibadan, Ogbomosho and Ilera-Oyo (in Oyo State); Gbongan, Ile-Ife and Ilesha (in Osun State); Ifetedo-Ondo, Oba-Ile and Owo (in Ondo State); Aramoko-Ekiti, Ado-Ekiti and Orin-Ekiti (in Ekiti State); Odeda-Abeokuta, Ilugun and Erunwon-Ijebu-Ode (in Ogun State) and Ikeja, Apapa and Badagri (in Lagos State). *Tithonia diversifolia* was encountered in all the states and locations surveyed in varying proportions (Appendix 1) with associated weeds.

In Oyo State, the survey showed that *T. diversifolia* was associated with the following plant species- *Amaranthus spinosus*, *Asystasia gangetica*, *Cassia alata*, *Centrosema pubescens*, *Commelina nodiflora*, *Corchorus olitorius*, *Desmodium scorpiurus*, *Euphorbia hyssopifolia*, *Fleurya ovalifolia*, *Ipomoea involucreta*, *Mariscus longibracteatus*, *Merremia aegyptia*, *Merremia dissecta*, *Merremia kentrocaulos*, *Panicum maximum*, *Panicum repens*, *Paspalum orbiculare*, *Phyllanthus amarus*, *Phyllanthus niruoides*, *Physalis angulata*, *Schwenckia americana*, *Sesbania parhycarpa*, *Setaria* sp. and *Trianthema portulacastrum*.

In Osun State, *T. diversifolia* was associated with *Albizia* sp., *Boerhavia coccinea*, *Calopogonium mucunoides*, *Cassia occidentalis*, *Centrosema pubescens*, *Chromolaena odorata*, *Indigofera subulata*, *Mimosa pudica*, *Panicum maximum*, *Phyllanthus amarus*, *Physalis angulata*, *Physalis* sp., *Pueraria phaseoloides*, *Schrankia leptocarpa*, *Sida acuta* and *Triumfetta cordifolia*.

Also associated with *Tithonia diversifolia* in Ondo State were *Centrosema pubescens*, *Chromolaena odorata*, *Desmodium scorpiurus*, *Dioscorea rotundata*, *Euphorbia heterophylla*, *Imperata cylindrica*, *Panicum maximum*, *Paullinia*, *pinnata*, *Phyllanthus mimosoides*, *P. niruoides*, *Phyllanthus* sp., *Spigelia anthelmia* and *Talinum triangulare*.

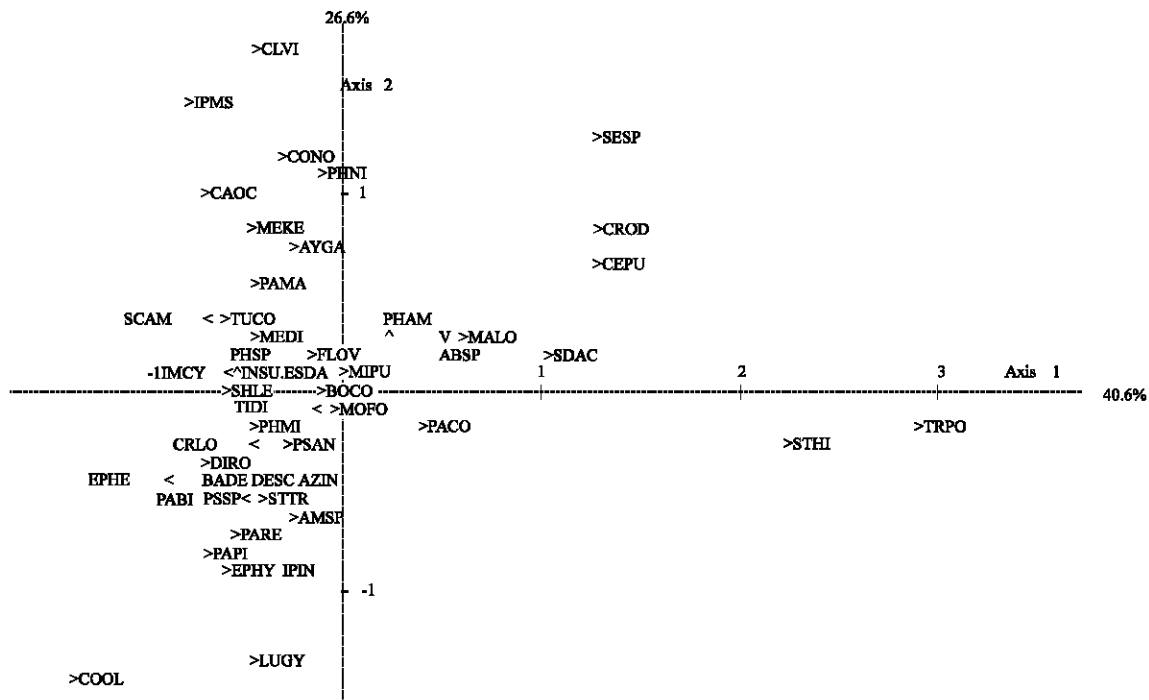


Fig. 2: Species ordination (Detrended Correspondence Analysis) of six southwestern states of Nigeria with reference to *Tithonia diversifolia* and associated plant species

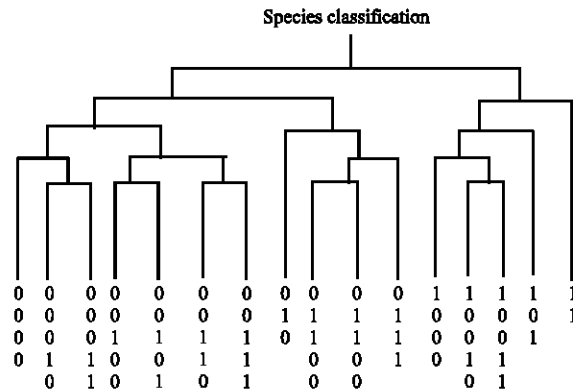


Fig. 3: Species classification of plants associated with *Tithonia diversifolia* in six states of Southwestern Nigeria. The locations surveyed are Ibadan, Ogbomoso, Ilora-Oyo, Gbongan, Ile-Ife, Ilesa, Ifetedo, Oba-Ile, Owo, Aramoko-Ekiti, Ado-Ekiti, Orin-Ekiti, Odeda, Ilugun, Erunwon, Ikeja, Apapa and Badagri. Species in the code numbers are as follows:

- | | | |
|--|---|--|
| <p>0000 : COBE = <i>Commelina benghalensis</i>, 00010 : CAMU = <i>Calopogonium mucunoides</i>, PUPS = <i>Pueraria phaseoloides</i>. 00011 : CLVI = <i>Cleome viscosa</i>. 00100 : PAMA = <i>Panicum maximum</i>. 00101 : AYGA = <i>Aystasia gangetica</i>, FLOV = <i>Fleurya ovaliflora</i>, PARE = <i>Panicum repens</i>, SESP = <i>Setaria</i> sp; 00110 : COOL = <i>Cochorns olitorus</i>, EPHY = <i>Euphorbia hyssopifolia</i>, PHMI = <i>Phyllanthus mimosoides</i>, 00111 : DIRO = <i>Dioscorea rotundata</i>, PSSP = <i>Physalis</i> sp; 010 : CONO = <i>Commelina nodiflora</i>. 01100 : BOCO = <i>Boerhavia coccinea</i>, 01101 : BADE = <i>Brachiara deflexa</i>, 0111 : TIDI = <i>Tithonia diversifolia</i>, 1000 : CEPU = <i>Centrosema pubescens</i>; 10010 : PACO = <i>Paspalum conjugatum</i>, 101 : ABSP = <i>Albizia</i> sp; PHNI = <i>Phyllanthus niruroideis</i>. 11 : AMSP = <i>Amaranthus spinosus</i>,</p> | <p>SPAN = <i>Spigelia anthelmia</i>, INSP = <i>Indigofera</i> sp; AZIN = <i>Azadiractha indica</i>, INSU = <i>Indigofera subulata</i>, PABI = <i>Paspalum orbiculare</i>, STTR = <i>Sterculia tragacantha</i>. DESC = <i>Desmodium scorpiurns</i>, IMCY = <i>Imperata cylindrica</i>, ESPA = <i>Seshania parhycarpa</i>. MEKE = <i>Merremia kentrocaulos</i>, SCAM = <i>Schwenkia americana</i>, PSAN = <i>Physalis angulata</i>. CRLO = <i>Croton lobatus</i>, PHSP = <i>Phyllanthus</i> sp. MIPU = <i>Mimosa pudica</i>, STHI = <i>Strophanthus hispidus</i>, CROD = <i>Chromolaena odorata</i>, LUGY = <i>Luffa aegyptiaca</i>.</p> | <p>TATR = <i>Talinum triangulare</i>. IPMS = <i>Ipomoea</i> sp., CAOC = <i>Cassia occidentalis</i>, MEDI = <i>Merremia dissecta</i>, SHLE = <i>Schrankia leptocarpa</i>, EPHE = <i>Euphorbia heterophylla</i>, IPIN = <i>Ipomoea involucrata</i>, PAPI = <i>Paullina pinnata</i>, TUCO = <i>Triumpheta cordifolia</i>. MOFO = <i>Momordica foetida</i>. PHAM = <i>Phyllanthus amarus</i>. TRPO = <i>Trianthema portulacastrum</i>. MALO = <i>Mariscus longibracteatus</i>,</p> |
|--|---|--|

In Ogun State, *Tithonia diversifolia* were found to be associated with *Calopogonium mucunoides*, *Centrosema pubescens*, *Cleome viscosa*, *Commelina benghalensis*, *Commelina nodiflora*, *Indigofera* sp., *Ipomoea* sp., *Panicum maximum*, *Pueraria phaseoloides*, *Spigelia anthelmia* and *Talinum triangulare*.

Associated with *Tithonia diversifolia* in Ekiti State were *Centrosema pubescens*, *Chromolaena odorata*, *Panicum maximum*, *Sida acuta* and other unidentified grass species.

In Lagos State, *Tithonia diversifolia* was found to be associated with *Amaranthus spinosus*, *Azadiractha indica*, *Brachiara deflexa*, *Centrosema pubescens*, *Cleome viscosa*, *Commelina nodiflora*, *Croton lobatus*, *Luffa aegyptiaca* *Momordica foetida*, *Panicum maximum*, *Paspalum conjugatum*, *Sida acuta*, *Sterculia tragacantha*, *Strophanthus hispidus*, *Talinum*

triangulare, *Trianthema portulacastrum* and other unidentified grass species.

The species ordination (Fig. 2) indicates a discontinuous gradient along the first and second axes (Appendix 2). The first axis shows a cluster of species that are closely associated with *Tithonia diversifolia* (TIDI) and these include: *Boerhavia coccinea* (BOCO), *Fleurya ovaliflora* (FLOV), *Indigofera subulata* (INSU), *Merremia dissecta* (MEDI), *Mimosa pudica* (MIPU), *Momordica foetida* (MOFO), *Phyllanthus mimosoides* (PHMI), *Phyllanthus* sp. (PHSP), *Physalis angulata* (PSAN), *Schrankia leptocarpa* (SHLE) and *Sesbania parhycarpa* (ESDA). Other species which are closely associated with each other but not closely associated with *Tithonia diversifolia* (TIDI) include: *Amaranthus spinosus* (AMSP), *Azadiractha indica* (AZIN), *Brachiara deflexa* (BADE), *Desmodium scorpiurus* (DESC), *Dioscorea*

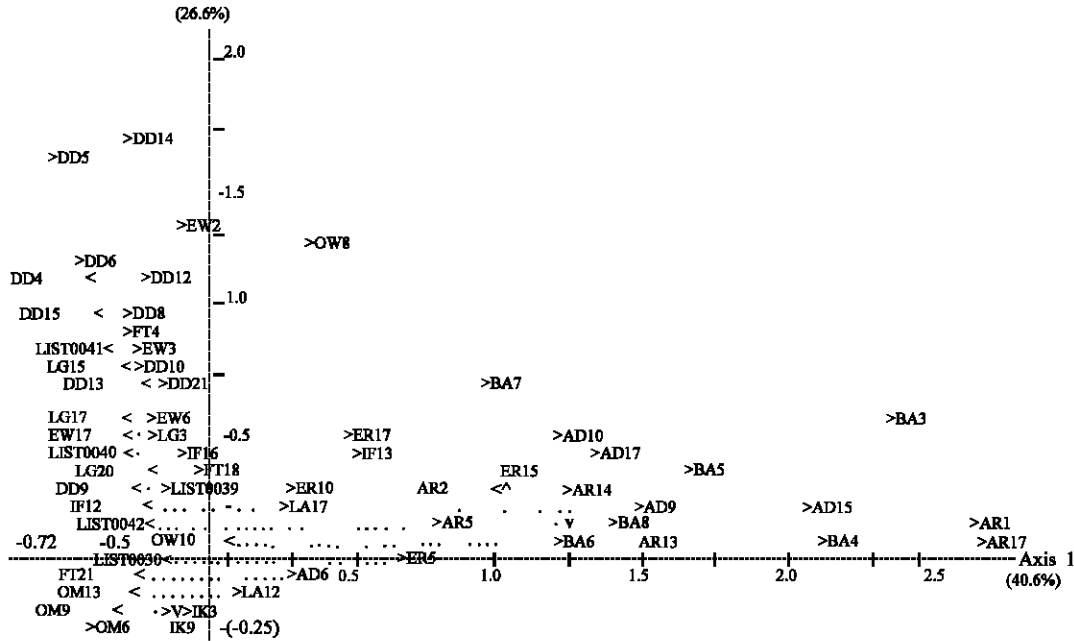


Fig. 4: Stand ordination (Detrended Correspondence Analysis) of six southwestern states of Nigeria with reference to *Tithonia diversifolia* and associated plant species

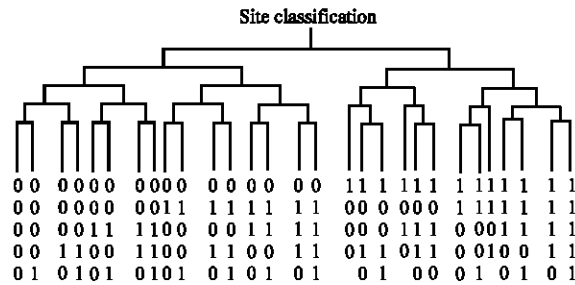


Fig. 5: Site classification of the six states of southwestern Nigeria (Oyo, Osun, Ondo, Ekiti, Ogun and Lagos) where *Tithonia diversifolia* was distributed and the 18 locations surveyed. The locations are Ibadan, Ogbomoso, Ilora-Oyo, Gbongan, Ile-Ife, Ilesha, Ifetedo, Oba-Ile, Owo, Aramako-Ekiti, Ado-Ekiti, Orin-Ekiti, Odeda, Ilugun, Erunwon, Ikeja, Apapa and Badagri. The sites in the code numbers are in appendix 3

rotundata (DIRO), *Euphorbia hyssopifolia* (EPHY), *Ipomoea involucrata* (IPIN), *Panicum repens* (PARE), *Paspalum orbiculare* (PABI), *Paullinia pinnata* (PAPI), *Physalis* sp., (PSSP) and *Sterculia tragacantha* (STTR).

The second axis also shows a discontinuous gradient with *Chromolaena odorata* (CROD), *Centrosema pubescens* (CEPU) and *Seteria* sp., (SESP) at the positive and other species at the negative ends. The species ordination diagram gives an insight into the species abundance in the states and locations surveyed. This is further confirmed by the species classification diagram (Fig. 3), where the first division separated the species closely associated with *T. diversifolia* from those not closely associated with

it as shown by the grouping in the positive and negative axes of the ordination diagram. Species present at one end of the ordination gradient are not likely to be present at the other.

The site ordination diagram (Fig. 4) shows a discontinuous gradient along the first and second axes. The first (horizontal) axis shows a gradient separating Ogun State locations (LG 17, EW6, EW17, LG3, DD2, LG2, LG20, DD9, DD11, LG11, EW16 and LG21) on the negative side of the axis. The second axis also shows a discontinuous gradient with Odeda (DD14, DD5, DD6, DD4, DD12, DD15, DD8) in Ogun State on the negative side of the axis (Appendix 3). This result is further confirmed by the site classification diagram (Fig. 5), which

grouped Ogun State sites together (in code numbers 00000, 00001, 00010, 00011, 00100, 00101, 00110 and 00111). The stand classification diagram (Fig. 5) using the species presence or absence as indicators separated Ogun State locations from other locations surveyed; thereby confirming the results of the site ordination.

DISCUSSION

Tithonia diversifolia was found to be well spread and adapted in southwestern Nigeria especially within the forest zone. This therefore accounts for its spread in Oyo, Osun, Ondo, Ekiti, Ogun and Lagos States in varying densities. In these States, *T. diversifolia* was found to be commonly associated with the roadsides, open and disturbed habitats where plant cover is low, being absent from areas of mature plant establishments. Akobundu and Agyakwa (1987) and Lordbonjou (1991) reported similar findings on *T. diversifolia*. Although *T. diversifolia* is a roadside plant, it has taken over a vast area of land in Ogbomoso, Ilora and Ibadan (Oyo State); Gbongan (Osun State); Odeda, Ilugun and Erunwon (in Ogun State). Consequently, most farmers in these areas have to abandon their farmlands due to the stubbornness of *T. diversifolia* as well as aggressive colonization of their farmlands by *T. diversifolia* and problems associated with cultural control of the weeds by hand weeding and hoeing. It is remarkable to infer that *T. diversifolia*, a roadside plant is gradually becoming a weed of arable crops in these areas.

In all the States surveyed, *Tithonia diversifolia* was found to be commonly associated with *Centrosema pubescens* and *Panicum maximum*. These two species are common roadside, cultivated, open places and abandoned field plants as reported elsewhere (Akobundu and Agyakwa, 1987). Within each State surveyed, the under listed species were found to be associated with *T. diversifolia* at least in two of the locations. These are *Centrosema pubescens*, *Desmodium scorpiurus*, *Merremia aegyptia*, *Sesbania pachycarpa* and *Trianthema portulacastrum* (for Oyo State); *Calopogonium mucunoides*, *Centrosema pubescens* and *Panicum maximum* (for Osun State); *Centrosema pubescens*, *Chromolaena odorata* and *Panicum maximum* (for Ondo and Ekiti States); *Calopogonium mucunoides*, *Centrosema pubescens*, *Panicum maximum* and *Spigelia anthelmia* (for Ogun State) and *Commelina nodiflora*, other unidentified grass species, *Panicum maximum*, *Sida acuta* and *Talinum triangulare* (for Lagos State).

However, species ordination by detrended correspondence analysis (DCA) of plant species in the six

States and eighteen locations surveyed showed three clusters of species along axis 2, which were closely associated with *Tithonia diversifolia* and with one another in varying degrees. The species that were closely associated with each other were clustered together.

The first cluster of species associated with *T. diversifolia* (TIDI) consisted of *Boerhavia coccinea* (BOCO); *Fleurya ovaliflora* (FLOV); *Indigofera subulata* (INSU); *Merremia dissecta* (MEDI); *Mimosa pudica*

(MIPU); *Momordica foetida* (MOFO); *Phyllanthus mimosoides* (PHMI); *Phyllanthus* sp. (PHSP); *Schranksia leptocarpa* (SHLE); *Sesbania pachycarpa* (ESDA) and *Spigelia anthelmia* (SPAN).

The second cluster consisted of *Amaranthus spinosus* (AMSP); *Azadirachta indica* (AZIN); *Brachiara deflexa* (BADE); *Desmodium scorpiurus* (DESC); *Dioscorea rotundata* (DIRO); *Paspalum orbiculare* (PABI); *Physalis* sp. (PSSP) and *Sterculia tragacantha* (STTR) while the third cluster consisted of *Euphorbia hyssopifolia* (EPHY); *Ipomoea involucreta* (IPIN), *Panicum repens* (PARE) and *Paullinia pinnata* (PAPI).

The species in the third cluster are rare species (with very low densities per square metre) encountered during the survey. Except for *Brachiara deflexa*, *Phyllanthus mimosoides* and *Spigelia anthelmia* that were encountered in three out of six States surveyed. Other rare plant species were encountered in either one or two States. Also, except for *Amaranthus spinosus* and *Spigelia anthelmia* that were encountered in five and seven locations respectively, out of eighteen locations surveyed others were encountered in four or less locations. It is therefore the rareness of these species that grouped them together in their various clusters at anytime they were associated with *Tithonia diversifolia*. Generally, most of these rare species were encountered in Oyo and Osun States, which belong to the Egbeda soil series. This seems to suggest that the association of *T. diversifolia* with the plants in these clusters affected them negatively such that most of them did not survive over time with *T. diversifolia* interference. Baruah *et al.* (1994) working on growth inhibitory sesquiterpene lactones and flavones from *T. diversifolia* reported similar findings. The above result was further confirmed by species classification of plants associated with *T. diversifolia* in the six States surveyed.

On the other hand, the absence of plant species such as *Asystasia gangetica*, *Boerhavia coccinea*, *Cassia occidentalis*, *Fleurya ovaliflora*, *Imperata cylindrica*, *Indigofera subulata*, *Merremia dissecta*, *Merremia kentrocaulos*, *Mimosa pudica*, *Phyllanthus niruroides*,

Phyllanthus sp; *Schrankia leptocarpa*, *Schwenckia americana*, *Sesbania pachycarpa* and *Triumfetta cordifolia*, in Ogun State sites which were closely associated with *Tithonia diversifolia* in other states may be responsible for the separation of Ogun State in the stand ordination. Ojo and Ola-Adams (1996) reported

similar findings in their work on measurement of tree diversity in Nigerian rainforest. The separation of Ogun State locations on both axes of the site ordination diagram as confirmed by the site classification diagram may be attributed to the soil and parent materials of the area, which belongs to the Odeda series.

Appendix 1: Plant species associated with *Tithonia diversifolia* in the sampling locations in six states of southwestern Nigeria. Values are mean densities $m^{-2} \pm$ standard error from 21 stands

| Plant species | Ekiti | | | Lagos | | | Ogun | | |
|---------------------------------|---------|----------|---------|----------|---------|---------|---------|----------|---------|
| | AD | AR | ER | BA | IK | LA | DD | EW | LG |
| <i>Albizia</i> sp. | - | - | - | - | - | - | - | - | - |
| <i>Amaranthus spinosus</i> | - | - | - | - | 3.6±0.5 | 3.0±0.3 | - | - | - |
| <i>Asystasia gangetica</i> | - | - | - | - | - | - | - | - | - |
| <i>Azadirachta indica</i> | - | - | - | - | 1.0±0.0 | - | - | - | - |
| <i>Boerhavia coccinea</i> | - | - | - | - | - | - | - | - | - |
| <i>Brachia deflexa</i> | - | - | - | - | 1.0±0.0 | 1.3±0.3 | - | - | - |
| <i>Calopogonium mucunoides</i> | - | - | - | - | - | - | 6.6±0.6 | 10.±2.4 | 3.3±0.6 |
| <i>Cassia alata</i> | - | - | - | - | - | - | - | - | - |
| <i>C. occidentalis</i> | - | - | - | - | - | - | - | - | - |
| <i>Centrosema pubesceus</i> | 4.5±0.5 | 4.1±0.7 | 2.4±0.4 | 1.7±0.3 | 1.3±0.2 | 1.6±0.3 | 2.1±0.5 | 2.4±0.4 | 3.8±0.9 |
| <i>Chromolaena odorata</i> | 7.0±1.3 | 5.1±0.4 | 8.2±1.6 | - | - | - | - | - | - |
| <i>Cleome viscosa</i> | - | - | - | 7.0±2.0 | 1.0±0.0 | 1.5±0.5 | 7.5±1.8 | 7.0±1.0 | - |
| <i>Corchorus oltorius</i> | - | - | - | - | - | - | - | - | - |
| <i>Commelina benghalensis</i> | - | - | - | - | - | - | 3.5±1.2 | 4.0±3.0 | 2.7±1.7 |
| <i>C. nodiflora</i> | - | - | - | 2.3±0.9 | 1.7±0.2 | 1.7±0.2 | 3.3±1.2 | - | 4.0±0.8 |
| <i>Croton lobatus</i> | - | - | - | - | - | 1.5±0.3 | - | - | - |
| <i>Deusmodium scorpiurus</i> | - | - | - | - | - | - | - | - | - |
| <i>Dioscorea rotundata</i> | - | - | - | - | - | - | - | - | - |
| <i>Euphorbia heterophylla</i> | - | - | - | - | - | - | - | - | - |
| <i>E. hyssopifolia</i> | - | 1.0±0.0 | - | - | - | - | - | - | - |
| <i>Fleurya ovaliflora</i> | - | - | - | - | - | - | - | - | - |
| <i>Imperata cylindrica</i> | - | 5.0±0.0 | - | - | - | - | - | - | - |
| <i>Indigofera</i> sp. | - | - | - | - | - | - | 3.7±0.8 | 4.0±0.9 | - |
| <i>I. subulata</i> | - | - | - | - | - | - | - | - | - |
| <i>Ipomoea involucreta</i> | - | - | - | - | - | - | - | - | - |
| <i>Ipomoea</i> sp. | - | - | - | - | - | - | 2.0±0.6 | 2.3±1.3 | 1.5±0.5 |
| <i>Luffa aegyptiaca</i> | - | - | - | - | - | - | - | - | - |
| <i>Mariscus longibracteatus</i> | - | - | - | - | - | - | - | - | - |
| <i>Merremia aegyptia</i> | - | - | - | - | - | - | - | - | - |
| <i>M. dissecta</i> | - | - | - | - | - | - | - | - | - |
| <i>M. kentrocaulos</i> | - | - | - | - | - | - | - | - | - |
| <i>Mimosa pudica</i> | - | - | - | - | - | - | - | - | - |
| <i>Momordica foetida</i> | - | - | - | - | - | 1.0±0.0 | - | - | - |
| Other grasses | 7.7±1.5 | 12.1±1.3 | 7.9±1.5 | 21.9±4.0 | 2.9±0.6 | 2.5±0.6 | - | - | - |
| <i>Panicum maximum</i> | 3.2±0.6 | 3.5±0.5 | 4.0±0.8 | 2.0±0.5 | 1.4±0.2 | 1.3±0.2 | 5.4±1.0 | 2.5±0.3 | 3.7±1.1 |
| <i>P. repens</i> | - | - | - | 1.0±0.0 | - | - | - | - | - |
| <i>Paspalum conjugatum</i> | - | - | - | 6.0±0.0 | 1.3±0.3 | 1.4±0.2 | - | - | - |
| <i>P. orbiculare</i> | - | - | - | - | - | - | - | - | - |
| <i>Panilimia pinnata</i> | - | - | - | - | - | - | - | - | - |
| <i>Phyllanthus amarus</i> | - | - | - | - | - | - | - | - | - |
| <i>P. mimosoides</i> | - | - | - | - | - | - | - | - | - |
| <i>P. niruroides</i> | - | 3.1±0.4 | - | - | - | - | - | - | - |
| <i>Rhyllanthus</i> sp. | - | - | - | - | - | - | - | - | - |
| <i>Physalis angulata</i> | - | - | - | - | - | - | - | - | - |
| <i>Rhysalis</i> sp. | - | - | - | - | - | - | - | - | - |
| <i>Preraria phaseoloideis</i> | - | - | - | - | - | - | 6.4±1.2 | 13.0±7.0 | - |
| <i>Schrankia leptocarpa</i> | - | - | - | - | - | - | - | - | - |

Appendix 1: Continued

| Plant species | Ekiti | | | Lagos | | | Ogun | | |
|----------------------------------|----------|----------|---------|----------|----------|----------|----------|----------|----------|
| | AD | AR | ER | BA | IK | LA | DD | EW | LG |
| <i>Schwenckia americana</i> | - | - | - | - | - | - | - | - | - |
| <i>Schrankia leptocarpa</i> | - | - | - | 1.0±0.0 | 1.0±0.0 | - | - | - | 2.0±0.0 |
| <i>Schwenckia americana</i> | - | - | - | 5.1±1.0 | - | 1.7±0.3 | - | - | 1.0±0.0 |
| <i>Setaria</i> sp. | - | - | - | 2.0±0.0 | - | - | - | - | 2.0±0.0 |
| <i>Sesbania pachycarpa</i> | - | - | - | - | - | - | - | - | 2.0±0.0 |
| <i>Setaria</i> sp. | - | - | - | - | - | - | - | - | - |
| <i>Sesbania pachycarpa</i> | - | - | - | - | - | - | - | - | - |
| <i>Sida acuta</i> | 2.3±0.5 | - | 4.5±0.6 | - | 1.4±0.2 | 1.7±0.2 | - | - | - |
| <i>Spigelia tragacantha</i> | - | - | - | - | - | - | 18.1±2.5 | 9.7±2.5 | 6.8±1.0 |
| <i>Sterculia tragacantha</i> | - | - | - | - | - | 1.0±0.0 | - | - | - |
| <i>Strophanthus hispichus</i> | - | - | - | 6.0±0.8 | 2.0±0.0 | 2.0±0.4 | - | 10.2±3.5 | - |
| <i>Talinum triangulare</i> | - | - | - | 11.7±4.9 | 2.6±0.6 | 1.8±0.3 | 7.6±1.3 | - | 2.8±0.5 |
| <i>Tithonia diversifolia</i> | 39.6±4.2 | 44.5±4.9 | 42.±3.6 | 49.1±4.9 | 26.1±2.0 | 23.8±1.8 | 42.0±4.6 | 89.8±9.6 | 59.8±4.1 |
| <i>Trianthema portulacastrum</i> | - | - | - | 5.0±0.9 | 2.5±0.6 | 2.0±0.4 | - | - | - |
| <i>Triumfetta cordifolia</i> | - | - | - | - | - | - | - | - | - |

Appendix 1: Continued

| Plant species | Ondo | | | Osun | | | Oyo | | |
|---------------------------------|---------|---------|---------|---------|---------|---------|----------|---------|----------|
| | FT | OB | OW | IF | GB | LS | IB | OM | OY |
| <i>Albizia</i> sp. | - | - | - | 2.0±0.0 | - | - | - | - | - |
| <i>Amaranthus spinosus</i> | - | - | - | - | - | - | 1.02±0.2 | 2.9±0.8 | 2.0±0.4 |
| <i>Asystasia gangetica</i> | - | - | - | 2.0±1.0 | - | - | - | - | - |
| <i>Azadiractha indica</i> | - | - | - | - | - | - | - | - | - |
| <i>Boerhavia coccinea</i> | - | - | - | 5.7±3.2 | 1.8±0.5 | 1.6±0.4 | - | - | 1.0±0.0 |
| <i>Brachiara deflexa</i> | - | - | - | 3.0±0.0 | - | - | - | - | 3.0±0.0 |
| <i>Calopogonium mucunoides</i> | - | - | - | 2.3±0.9 | 2.0±0.0 | 1.6±0.3 | - | - | - |
| <i>Cassia alata</i> | - | - | - | - | - | - | - | 1.0±0.0 | - |
| <i>C. occidentalis</i> | - | - | - | 3.0±0.0 | 1.0±0.0 | - | - | - | - |
| <i>Centrosema pubesceus</i> | - | 2.8±0.3 | 5.0±0.4 | 5.3±1.1 | 1.4±0.2 | 1.6±0.2 | 1.1±0.1 | 2.0±0.0 | 1.4±0.4 |
| <i>Chromolaena odorata</i> | - | - | - | 2.7±0.7 | 2.0±0.6 | 1.0±0.0 | 1.0±0.0 | - | 3.5±1.5 |
| <i>Cleome viscosa</i> | - | - | - | 3.0±0.0 | - | - | - | - | 3.0±0.0 |
| <i>Corchorus olitorius</i> | - | - | - | - | - | - | 2.0±10.6 | 3.5±2.5 | - |
| <i>Commelina benghalensis</i> | - | - | - | - | - | - | 1.01±0.0 | - | 2.0±0.0 |
| <i>C. nodiflora</i> | - | - | - | - | - | - | - | - | - |
| <i>Croton lobatus</i> | - | - | - | 4.0±0.0 | - | - | - | - | 3.0±0.0 |
| <i>Deusmodium scorpiurus</i> | 1.7±0.3 | 1.0±0.0 | 1.0±0.0 | - | - | - | - | - | 3.0±0.0 |
| <i>Dioscorea rotundata</i> | - | - | 1.0±0.0 | 2.0±1.0 | - | - | - | - | 2.0±0.0 |
| <i>Euphorbia heterophylla</i> | 5.1±1.1 | 5.5±0.7 | 3.4±1.0 | - | - | - | - | 8.2±2.1 | 4.8±1.2 |
| <i>E. hyssopifolia</i> | - | - | - | - | - | - | - | - | 1.01±0.0 |
| <i>Fleurya ovaliflora</i> | - | - | - | 2.0±0.0 | - | - | - | - | - |
| <i>Imperata cylindrica</i> | 3.0±0.4 | - | 4.0±0.6 | - | - | - | - | - | 5.0±0.0 |
| <i>Indigofera</i> sp. | - | - | - | 2.0±0.0 | - | - | - | - | - |
| <i>I. subulata</i> | - | - | - | 2.3±0.3 | 1.3±0.3 | 1.6±0.3 | - | - | 3.0±0.0 |
| <i>Ipomoea involucrata</i> | - | - | - | - | - | - | - | - | 1.5±0.5 |
| <i>Ipomoea</i> sp. | - | - | - | - | - | - | - | - | 1.0±0.0 |
| <i>Luffa aegyptiaca</i> | - | - | - | - | - | - | - | - | - |
| <i>Mariscus longibracteatus</i> | - | - | - | - | - | - | - | 4.0±0.0 | - |
| <i>Merremia aegyptia</i> | - | - | - | - | - | - | - | - | 4.0±0.0 |
| <i>M. dissecta</i> | - | - | - | 4.0±0.0 | - | - | - | - | 7.0±0.0 |
| <i>M. ketrocaulos</i> | - | - | - | 1.0±0.0 | - | - | - | - | 2.0±0.0 |
| <i>Mimosa pudica</i> | - | - | - | 3.7±1.2 | 2.0±0.0 | - | - | - | - |
| <i>Momordica foetida</i> | - | - | - | - | - | - | - | - | 1.0±0.0 |
| Other grasses | - | - | - | 3.0±0.0 | 7.7±1.5 | - | 1.3±0.3 | - | 1.0±0.0 |
| <i>Panicum maximum</i> | 2.0±0.4 | 1.8±0.2 | 3.4±0.5 | 9.2±0.9 | 1.5±0.2 | 1.9±0.2 | 1.5±0.1 | 2.0±0.6 | 2.5±0.7 |
| <i>P. repens</i> | - | - | - | - | - | - | - | - | - |
| <i>Paspalum conjugatum</i> | - | - | - | - | - | - | - | - | 2.0±0.0 |
| <i>P. orbiculare</i> | - | - | - | 2.0±0.0 | - | - | - | - | 1.0±0.0 |
| <i>Panilinia pinnata</i> | - | 2.0±0.0 | 1.0±0.0 | - | - | - | - | - | - |
| <i>Phyllanthus amarus</i> | - | - | - | 2.0±0.0 | - | - | - | - | 1.0±0.0 |
| <i>P. mimosoides</i> | 3.5±1.0 | 3.3±0.6 | 5.0±0.0 | 1.0±0.0 | - | - | - | - | 1.0±0.01 |
| <i>P. niruroides</i> | 6.0±0.0 | 2.0±0.0 | 3.0±6.0 | - | - | - | - | - | 01.0±0.0 |
| <i>Rhyllanthus</i> sp. | 2.0±0.6 | - | 3.0±1.0 | - | - | - | - | - | 2.0±0.0 |

Appendix 1: Continued

| Plant species | Ondo | | | Osun | | | Oyo | | |
|----------------------------------|-----------|----------|------------|----------|----------|----------|----------|-----------|------------|
| | FT | OB | OW | IF | GB | LS | IB | OM | OY |
| <i>Physalis angulata</i> | - | - | - | 3.0±0.0 | 2.0±0.0 | 1.0±0.0 | - | - | 4.0±0.0 |
| <i>Rhynchosia sp.</i> | - | - | - | 2.5±1.5 | 1.3±0.3 | 2.0±0.3 | - | - | 2.0±0.0 |
| <i>Pueraria phaseoloides</i> | - | - | - | 2.3±0.9 | 2.0±0.3 | - | - | - | 4.0±0.0 |
| <i>Sida acuta</i> | - | - | - | 2.8±0.3 | 1.7±0.3 | 1.6±0.2 | - | - | 1.0±0.0 |
| <i>Spigelia tragacantha</i> | 4.3±1.8 | 2.9±0.4 | 3.5±0.8 | - | - | - | - | - | 1.0±0.0 |
| <i>Sterculia tragacantha</i> | - | - | - | - | - | - | - | - | 3.0±0.0 |
| <i>Strophanthus hispidus</i> | - | - | - | - | - | - | - | - | 3.0±0.0 |
| <i>Talinum triangulare</i> | 4.1±0.4 | 4.3±1.1 | 3.8±1.5 | - | - | - | - | - | 101.8±11.2 |
| <i>Tithonia diversifolia</i> | 64.0±10.8 | 89.8±8.6 | 104.3±10.2 | 52.5±7.8 | 63.9±6.8 | 78.6±5.5 | 79.4±9.4 | 93.5±12.9 | 3.0±0.0 |
| <i>Trianthema portulacastrum</i> | - | - | - | - | - | - | - | - | 1.0±0.0 |
| <i>Triumfetta cordifolia</i> | - | - | - | 4.1±0.8 | 2.0±0.0 | 2.5±1.5 | - | - | - |

Appendix 2: Names of plant species with their codes as reflected in figure 2 (species ordination)

| | |
|------|----------------------------------|
| CLVI | <i>Cleome viscosa</i> |
| IMPS | <i>Ipomoea sp.</i> |
| CONO | <i>Commelina nodiflora</i> |
| CAOC | <i>Cassia occidentalis</i> |
| PHNI | <i>Phyllanthus niruroides</i> |
| MEKE | <i>Merremia keurocaulos</i> |
| AYGA | <i>Asystasia gangetica</i> |
| PAMA | <i>Panicum maximum</i> |
| SCAM | <i>Schwenckia americana</i> |
| TUCO | <i>Triumfetta cordifolia</i> |
| MEDI | <i>Merrimia dissecta</i> |
| PHSP | <i>Phyllanthus sp.</i> |
| FLOV | <i>Fleurya ovaliflora</i> |
| IMCY | <i>Imperata cylindrica</i> |
| INSU | <i>Indigofera subulata</i> |
| ESDA | <i>Sebania parhycarapa</i> |
| MIPU | <i>Mimosa pudica</i> |
| SHLE | <i>Schrankia leptocarpa</i> |
| BOCO | <i>Boerhavia coccinea</i> |
| TIDI | <i>Tithonia diversifolia</i> |
| MOFO | <i>Momordica foetida</i> |
| PHMI | <i>Phyllanthus mimosoides</i> |
| CRLO | <i>Croton lobatus</i> |
| PSAN | <i>Physalis angulata</i> |
| DIRO | <i>Dioscorea rotundata</i> |
| EPHE | <i>Euphorbia heterophylla</i> |
| BADE | <i>Brachiaria deflexa</i> |
| DESC | <i>Desmodium scorpiurus</i> |
| AZIN | <i>Azadirachta indica</i> |
| PABI | <i>Paspalum orbiculare</i> |
| PSSP | <i>Physalis sp.</i> |
| STTR | <i>Sterculia tragacantha</i> |
| AMSP | <i>Amaranthus spinosus</i> |
| PARE | <i>Panicum repeus</i> |
| PAPI | <i>Paullinia pinnata</i> |
| EPHY | <i>Euphorbia hyssopifolia</i> |
| IPIN | <i>Ipomoea involucre</i> |
| LUGY | <i>Luffa aegyptiaca</i> |
| COOL | <i>Corchorus olitorius</i> |
| SESP | <i>Setaria sp.</i> |
| CROD | <i>Chromolaena odorata</i> |
| CEPU | <i>Cenrosema pubescens</i> |
| PHAM | <i>Phyllanthus amarus</i> |
| MALO | <i>Mariscus longibracteatus</i> |
| ABSP | <i>Albizia sp.</i> |
| SDAC | <i>Sida acuta</i> |
| PACO | <i>Paspalum conjugatum</i> |
| TRPO | <i>Trianthema portulacastrum</i> |
| STHI | <i>Strophanthus hispidus</i> |

Appendix 3: List of locations surveyed in the six southwestern states and their codes as reflected in Fig. 4. Numbers attached to the codes indicate the location number during the survey

| Location | Code |
|---------------|--|
| Ibadan | IB1, IB2, IB3, IB4, IB5, IB6, IB7, IB8, IB9, IB10, IB11, IB12, IB13, IB14, IB15, IB16, IB17, IB18, IB19, IB20, IB21. |
| Ogbomoshosho | OM1, OM2, OM3, OM4, OM5, OM6, OM7, OM8, OM9, OM10, OM11, OM12, OM13, OM14, OM15, OM16, OM17, OM18, OM19, OM20, OM21. |
| Ilorin-Oyo | OY1, OY2, OY3, OY4, OY5, OY6, OY7, OY8, OY9, OY10, OY11, OY12, OY13, OY14, OY15, OY16, OY17, OY18, OY19, OY20, OY21. |
| Odeda | DD1, DD2, DD3, DD4, DD5, DD6, DD7, DD8, DD9, DD10, DD11, DD12, DD13, DD14, DD15, DD16, DD17, DD18, DD19, DD20, DD21. |
| Erunwon | EW1, EW2, EW3, EW4, EW5, EW6, EW7, EW8, EW9, EW10, EW11, EW12, EW13, EW14, EW15, EW16, EW17, EW18, EW19, EW20, EW21. |
| Ilugun | LG1, LG2, LG3, LG4, LG5, LG6, LG7, LG8, LG9, LG10, LG11, LG12, LG13, LG14, LG15, LG16, LG17, LG18, LG19, LG20, LG21. |
| Ifetedo | FT1, FT2, FT3, FT4, FT5, FT6, FT7, FT8, FT9, FT10, FT11, FT12, FT13, FT14, FT15, FT16, FT17, FT18, FT19, FT20, FT21. |
| Owo | OW1, OW2, OW3, OW4, OW5, OW6, OW7, OW8, OW9, OW10, OW11, OW12, OW13, OW14, OW15, OW16, OW17, OW18, OW19, OW20, OW21. |
| Oba-Ile | OB1, OB2, OB3, OB4, OB5, OB6, OB7, OB8, OB9, OB10, OB11, OB12, OB13, OB14, OB15, OB16, OB17, OB18, OB19, OB20, OB21. |
| Ado-Ekiti | AD1, AD2, AD3, AD4, AD5, AD6, AD7, AD8, AD9, AD10, AD11, AD12, AD13, AD14, AD15, AD16, AD17, AD18, AD19, AD20, AD21. |
| Aramako-Ekiti | AR1, AR2, AR3, AR4, AR5, AR6, AR7, AR8, AR9, AR10, AR11, AR12, AR13, AR14, AR15, AR16, AR17, AR18, AR19, AR20, AR21. |
| Orin-Ekiti | ER1, ER2, ER3, ER4, ER5, ER6, ER7, ER8, ER9, ER10, ER11, ER12, ER13, ER14, ER15, ER16, ER17, ER18, ER19, ER20, ER21. |
| Apapa | LA1, LA2, LA3, LA4, LA5, LA6, LA7, LA8, LA9, LA10, LA11, LA12, LA13, LA14, LA15, LA16, LA17, LA18, LA19, LA20, LA21. |
| Ikeja | IK1, IK2, IK3, IK4, IK5, IK6, IK7, IK8, IK9, IK10, IK11, IK12, IK13, IK14, IK15, IK16, IK17, IK18, IK19, IK20, IK21. |
| Badagri | BA1, BA2, BA3, BA4, BA5, BA6, BA7, BA8, BA9, BA10, BA11, BA12, BA13, BA14, BA15, BA16, BA17, BA18, BA19, BA20, BA21. |
| Ile-Ife | IF1, IF2, IF3, IF4, IF5, IF6, IF7, IF8, IF9, IF10, IF11, IF12, IF13, IF14, IF15, IF16, IF17, IF18, IF19, IF20, IF21. |
| Gbongan | GB1, GB2, GB3, GB4, GB5, GB6, GB7, GB8, GB9, GB10, GB11, GB12, GB13, GB14, GB15, GB16, GB17, GB18, GB19, GB20, GB21. |
| Ilesha | LS1, LS2, LS3, LS4, LS5, LS6, LS7, LS8, LS9, LS10, LS11, LS12, LS13, LS14, LS15, LS16, LS17, LS18, LS19, LS20, LS21. |

REFERENCES

Agnew, A.D.Q., 1974. Upland Kenya Wild Flowers. A flora of the Fern and Herbaceous Flowering Plants of Upland Kenya. Oxford University Press.

Akobundu, I.O., 1987. Weed Science In The Tropics. Principles and Practice. John Wiley and Sons, Singapore.

Akobundu, I.O. and C.W. Agyakwa, 1987. A Handbook of West African Weeds. A Publication of International Institute of Tropical Agriculture, Oyo Road, Ibadan, Nigeria.

Arias, J., M.E. Martin and M.J. Gimenez, 1982. Chemical control of new weed in northern Argentina, *Tithonia tubaeformis* (Jacq). Maleza II: 177-181.

Baruah, N.C., J.C. Sarma, N.C. Barua, S. Sarma and R.P. Sharma, 1994. Germination and growth inhibitory sesquiterpene lactones and a flavone from *Tithonia diversifolia*. Phytochemistry, 36: 29-36.

Blake, S.F., 1921. Revision of the genus *Tithonia*. Contrib. US. Natt Herbarium, 20: 428-436.

Blake, J.J., 1957. Gardening in East Africa. A Practical Handbook. Longmans, Green and Co. London, New York, Toronto.

Chukwuka, K.S., 2003. Biology and Control of *Tithonia diversifolia* (Hemsl). A. Gray- A new exotic weed in Nigeria. Ph.D. Thesis, University of Ibadan, Ibadan, Nigeria.

Ekeleme, F., 1986. Nitrogen and Potassium Leaching off Inselberg Surface Lichens at the University of Ife Campus. M.Sc. Thesis, University of Ife, Ile-Ife.

Hill, M.O., 1979. DECORANA- A FORTAN Program for Detrended Correspondence and Reciprocal Averaging. Ecol. Syst. Ithaca, U.S.A. Cornell University Press.

Hutchinson, J. and J.M. Dalziel, 1954. Flora of West Tropical Africa. Vol. 1 and 2. 2nd Edn., Revised by Keay, R.W.J. and F.N. Heppers, 1972, respectively. Crown Agents for Overseas Government and Administration, Millbank. London.

Ikemefuna, P.N., 1995. Weed Science and Our Environment. Paper Presented by the President, Weed Science Society of Nigeria (WSSN) at the 22nd Annual Conference at International Institute of Tropical Agriculture, Ibadan, 7th November 1995.

La Deeke, J.C., 1982. Revision of *Tithonia*. Rhodora, 84: 453-522.

- Lordbanjou, D.T., 1991. Studies on Mexican sunflower *Tithonia diversifolia* (Hemsl.) A. Gray in Southwestern Nigeria. M.Sc. Thesis, University of Ibadan.
- Njoku, P.C., 1995. The role of Universities of Agriculture in appropriate manpower development for modern weed management in agriculture. Paper Presented at the 22nd Annual Conference at International Institute of Tropical Agriculture, Ibadan, November 6, 1995.
- Ojo, L.O. and B.A. Ola-Adams, 1996. Measurement of tree diversity in the Nigerian rainforest. *Biodiversity and Conservation*, 5: 1253-1270.
- Oke, S.O., 1982. The relationship between the number of species and the area of soil mats on Hill 3 of the University of Ife Campus. B.Sc. Thesis University of Ife, Ile-Ife.
- Olaoye, S.O., 1974. The biology and control of the Siam weed, *Eupatorium odoratum* in southwestern Nigeria. M.Sc. Thesis University of Ibadan.
- Royal Horticultural Society, 1956. Dictionary of Gardening. A Practical and Scientific Encyclopedia of Horticulture. Edited by Fred, J. Chittenden. 2nd Edn. Vol. IV. PT-ZY. Oxford. The CLARENDON Press.
- Royal Kenya Horticultural Society, 1957. Gardening in East Africa. A Practical Handbook. Jex-Blake, A.J. (Ed.), 4th Edn., Longmans, Green and Co. London.
- Smyth, A.J. and R.F. Montgomery, 1962. The Soils and Land Use of Central Western Nigeria. The Government Printer, Ibadan.
- Standley, P.C., 1926. Contributions from United States National Herbarium. Vol. 23. Trees and shrubs of Mexico. Smithsonian Institution, United States National Museum. Washington Government Printing Office.
- Ter Braak, C.J.F., 1988. CANOCO-A FORTRAN Program for Canonical Community Ordination by (partial) (detrended) (canonical) Correspondence Analysis, Principal Component Analysis and Redundancy Analysis (Version 2.1). Ministry of Agricultural Mathematics Group. Technical Report LWA-88-02. Wageningen, Netherlands.