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ECOPHYSIOLOGICAL STUDIES ON AGERATUM CONYZOIDES L. IN SOUTH-WEST NIGERIA

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ABSTRACT

Ageratum conyzoides L. common annual herbaceous weed of croplands and wastelands in the warm regions of the world, was investigated under various ecophysiological conditions in Ibadan on an area of 1032 hectares during 1985-86 on three sites I-levelled area, II-elevated area, and III-the area in the vicinity of a lake. The plants in site II were comparatively taller but leaf number and biomass was more at site III. Phytosociological studies revealed *Tridax-Ageratum-Synedrella* community. The generic coefficient and diversity index were maximum for site I, maturity index for site II and species richness index for site III. Index of similarity was high for site II and site III. The soils were loamy sand with highest porosity at site II and highest field capacity at site III. Foliar calcium was higher at the pre-flowering stage. Crude protein in leaves ranged from 2.2 to 6.5% and was higher at the post-flowering stage. Tolerance to the water stress showed a significant difference in growth parameters. The transpiration rate was 4.2 mg/cm^2/hr. The average seed number in an individual plant was 13897$\pm$1610. The seeds showed a better germination in continuous light, when placed at the surface soil, and after storage for a longer duration.

INTRODUCTION

Ageratum conyzoides L. is one of the most common weeds of the warm regions of the world (Holm *et al.* 1977). It is a native of tropical America (Britton 1965; Uphof 1968) but has now spread widely, extending from latitude 30°N to 30°S. The plant grows in a wide range of arable crops and grasslands. It can grow and flower over a wide range of temperatures and seeds produced could germinate under varied conditions (Baker and Stebbins 1965).

Ageratum is a medicinal and ornamental plant. Although scarcely eaten by, man, Dalziel (1936) reported it as an ingredient of soup in parts of southern Nigeria. The widespread distribution and economic importance of the plant prompted the author to undertake ecophysiological study and thereby determine such adaptive features responsible for its wide prevalence.

MATERIAL AND METHODS

a) **Study area :** The investigation was conducted at Ibadan (7°22'N latitude. 3°58' E longitude) during 1985-86, on an area of 1032 hectares located 146 km from

the sea and is on the northern edge of the rain forest zone at three sites (site I-levelled area; site II-comparatively elevated area; site III-in the vicinity of a small lake).

Climate of Ibadan is characterized by two distinct seasons, a humid wet season (March through October), and a dry season (November through February). The mean daily minimum and maximum temperature range from 17.4°C in December to 22.7°C in March and 29°C in July to 35.9°C in February respectively. Precipitation totalled 1521.6 mm with 303 mm each in July and September. Sunshine hours ranged from 111 in December to 216 in December 1985. Evaporation was maximum (9.02mm) in April. The mean relative humidity varied from 30% at 1600 hours in February to 97% at 0700 hours in August.

b) **Morphological studies :** Three plants from each site were collected for measurements of shoot height, spread, diameter at 1 cm above ground, length breadth and area of mature leaves, depth of longest root.

c) **Phenological observations :** These were recorded over a period of 120 days at regular intervals according to Daubenmire (1947). Two stands, one situated in an open area and receiving only rain water and the other getting a regular supply of water, were observed.

d) **Phytosocioogical study :** Ten rectangular quadrats (100 x 50 cm) subdivided into 10 x 10 cm squares were laid down at random at each site. Plants in each quadrat were identified with the help of local flora (Hutchinson and Dalziel 1954-72). Frequency, density and cover were determined as suggested by Phillips (1959). These values were computed into relative values, which on addition gave the Importance Value Index (I.V.I.), a concept developed by Curtis and McIntosh (1951). Species richness index (Odum 1971). and index of diversity (Smith 1974) were calculated. Following indices were also calculated from the basic data :

$$\text{(i) Generic coefficient} = \frac{\text{Number of genera}}{\text{Number of species}} \times 100$$

$$\text{(ii) Maturity index} = \frac{\text{Total frequency}}{\text{Total number of species}}$$

e) **Soil studies :** Soil samples from 0-10 and 10-20 cm depths below the plant were collected from each of the three sites. Bulk density, saturation percentage, porosity, FC were determined as described by Richards (1969). Mechanical and chemical analysis was done according to Udo and Ogunwale (1978). The various parameters determined were pH, conductivity, organic carbon, total nitrogen, available phosphorus, exchangeable bases and cation exchange capacity.

f) **Foliar analysis :** Leaves were analysed at preflowering and postflowering stages for total nitrogen, phosphorus, calcium, magnesium, potassium and sodium.

g) **Water stress experiment** : Six week old seedlings were transplanted into nine pots in the glasshouse. One set of pots was watered daily (DW); second set twice daily (TW) while the third set of three pots was watered once a week (OW). At each irrigation 500 ml water was applied. On every Wednesday, shoot height, average leaf area, number of leaves per plant along with relative humidity, temperature and light intensity were recorded. Fresh and dry weights of the plants at post flowering stages were determined.

h) Transpiration of three fairly mature plants were recorded on hourly basis from 0830 to 1830 hours by pot weight method. Total leaf area was also determined.

i) **Seed studies :** Seeds were sterilized in 0.1% mercuric chloride solution for 30 seconds, washed with distilled water, mechanically scarified and kept in sterilized petridishes under continuous dark, continuous light provided by the fluorescent tubes and near window (diffuse light) in the laboratory for germination studies. Seeds were also germinated in pots at surface, 1, 2, 3, 4, and 5 cm depths. In another experiment, effect of storage for 9 days and 4 months on germination was studied.

RESULTS AND DISCUSSION

a) **Morphological studies :** The plants at site II were comparatively vigorous tn height, spread, leaf area and number, and dry wetght (Table 1). The plants in the

Table 1. Morphological measurements of *Ageratum conyzoides* L. at different sites

Parameters	Sites (average± S.D.)		
	I*	II*	III*
Shoot height (cm)	61.3±20.3	69.2±14.2	60.2±21.4
Spread (cm)	37.9±18.0	50.7±27.5	41.3±23.9
Diameter 1cm above soil level (cm)	0.5± 0.1	0.6± 0.5	0.6± 0.2
Mature leaf			
Lenth (cm)	5.5± 0.7	6.8± 1.1	5.7± 1.3
Breadth (cm)	3.8± 0.3	5.0± 0.5	4.2± 0.7
Area (cm^2)	14.2± 4.2	19.5±14.2	14.3± 5.5
Total number of leaves	84±45.4	226± 4.3	119±51 2
Fresh Weight (g)			
Stem	5.5	416.3	188.1
Leaves	2.6	250.6	119.8
Root	85.1	97.7	86.3
Dry weight (g)			
Stem	1.6	204.1	98.3
Leaves	1.0	178.5	87.8
Root	83.4	91.8	81.7

*Site I — Levelled area
Site II — Elevated area
Site III — Vicinity of a lake

vicinity of lake had greater number of leaves and dry weight as compared to those growing on levelled area. The dry weight of roots was greater than the shoot at levelled site whereas it was not so at the other two sites. Accordingly site II was the best for this plant as compared to the other two sites.

b) **Phenological observations :** The seeds germinated in the first week of January at all sites but the development of leaves in the open area lagged behind. Flowering commenced in the 3rd and 4th week of March in the plants getting a regular water supply. It was earlier than the flowering in plants of open area. The first set of seeds was disseminated three weeks after production. Leaves of these plants were consumed by the locust *Zonocerus variegatus* L.

c) **Phytosociological studies :** Table 2 shows the I.V.I. and other parameters for the communities, *Tridax-Ageratum-Imperata* community at site I, *Amaranthus-Tridax-Panicum* community at site II, and *Synedrella-Tridax-Ageratum* community at

Table 2. Phytosociological observations and community parameters for the first thirteen species in the three sites and the overall community

Names of specie	Importance value index			
	Site I (21)	Site II (15)	Site III (18)	Overall (30)
Tridax procumbens	36.8	27.6	29.5	26.6
Ageratum conyzoides	27.7	23.7	26.4	25.2
Imperata cylindrica	21.5	—		7.3
Oldenlandia corymbosa	19.5	—		
Panicum maximum	18 2	24.5	28.3	7.4
Synedrella nodiflora	14.2	—	40.7	19.7
Euphorbia hymsopifolia	11.7	—		6.1
Mariscus alternifolius	11.9	22.7		11.2
Solenostemon monostachyus	11.5	—		
Sporobalus pyramidalis	12.0	20.0	13.3	
Commelina erecta	11.3	19.3	19.5	12.0
Luffa cylindrica	11.2	—		
Chromolaena adoratum	11.0	17.4	13.3	9.8
Amaranthus hybridus	—	35.0	14.3	16.7
Calopogonium mucunoides	—	34.5		
Euporbia hotemorphylla	—	23.7	15.7	12.9
Talimum triangulare	—	19.2		6.9
Sida corymbona	—	13.4	25.7	
Euphorbia hirta	—	14.6	11.2	9.9
Genaric Coefficient (%)	95.0	80	94.4	90
Maturity Index	22.9	34	27.2	15.1
Species Richness Index	1.1	0.7	1.3	0.9
Liversity Index	3.4	3.3	2.6	3.8

*Figure in parentheses show total number of species

site III. The total number of species at these sites were 21, 15 and 18, while the total number of individuals were 366, 446 and 207, respectively. The frequency of *Tridax procumbens*, *Ageratum conyzoides*, *Amaranthus hybridus*, *Talinum triangulare*, *Mariscus alternifolius*, *Commelina erecta* and *Synedrella nodiflora* at three sites was high (50-70%). Species having a high density (5-9) were *Tridax procumbens*, *Imperata cylindrica*, *Ageratum conyzoides*, *Oldenlandia corymbosa*, *Amaranthus hybridus* and *Euphorbia heterophylla*. High average cover (200-900 cm^2) was seen in *Solenostemon monostachyus*, *Panicum maximum*, *Luffa cylindrica*, *Commelina erecta*, *Axonopus compressus*, *Sporobolus pyramidalis*, *Calopogonium mucunoides*, *Centrosema pubescens*, *Pennisetum subangustum*, *Sida corymbosa* and *Synedrella nodiflora*.

Generic coefficient, maturity index and diversity index were highest for site II, while species richness index was highest for site III. Maturity Index reflects the long accepted notion that higher the frequency percentage of each species and smaller the number of sporadic species, the more mature the plant community (Pichi-Sermolli 1948). In this study, the community at site II had the highest maturity index (34) where the I.V.I. of *A. conyzoides* was 23.7. However this value is low and hence the community is far away from the climax stage. Generic coefficient at all the sites was above 80% which shows that each community has a larger number of genera as compared to the number of species (Winterringer and Vestal 1956). The overall community based on data from three sites (30 quadrats) could be named as *Tridax-Ageratum-Synedrella* community. Other species having a higher I.V.I. next to these three dominant species were *Amaranthus hybridus*, *Euphorbia heterophylla* and *Mariscus alternifolius*, which could be named as codominants. Generic coefficient and diversity inde xwere fairly high.

Index of similarity could be used to compare the communities. It was 56% each at site I and II, and I and III and 67 at site II and III. This shows that the communities occurring at elevated area and in the vicinity of lake are more similar as compared to other communities.

d) **Soil studies** : Table 3 shows that the soils are mainly loamy sand having the highest porosity at site II and highest field capacity at site III. Moorman et al. (1978) who studied the soils of International Institute of Tropical Agriculture, Ibadan, a site near the place of present investigation, observed that the average texture of soil is sandy loam with a low percentage of silt (11.2 to 18.5%). In this study, the percentage of silt varied from 8 to 12%. The same authors reported the bulk density to be 1.3 g/ml. However, the field capacity was higher (36.6-40.1%) as compared to the IITA soils (8.5-21.0%). Base saturation was higher at surface than sub-surface while cation exchange capacity was higher in the sub-surface at sites II and III. At all the sites, calcium was higher (2.2-8.5 me/100 g) than sodium (0.12-0.18 me/100 g) and potassium (0.19-0.49 me/100 g). The amount of exchangeable calcium in the mineral

Table 5. Effect of water stress on the growth of *Ageratum conyzoides* L.

Weeks	Average growth parameters++								
	Shoot height (cm)			Number of Leaves			Leaf areas (cm^2)		
	DW	TW	OW	DW	TW	OW	DW	TW	OW
12-3-86	6.4g	7.0e	6.6f	7.0g	8.0g	6.0h	6.4h	6.0cd	4.5e
19-3-86	9.3g	9.0e	7.9f	11.0g	10.0g	7.0h	9.6e	8.5ed	6.2de
26-3-86	16.2g	15.0e	12.3ef	25.0fg	24.0fg	18.0gh	17.1d	15.6be	11.2de
2-4-86	24.4fg	22.4ef	18.6de	31.0f	29.0ef	39.0ef	20.0fg	17.0ed	15.6ab
9-4-86	33.5ef	31.5de	29.3cd	45.0cf	54.0de	44.0gf	26.3c	23.7ab	21.7be
16-4-86	43.2do	41.7cd	37.2c	64.0de	72.0cd	62.0de	30.8be	25.5ab	23.9b
23-4-86	53.5cd	53.1bc	51.4bc	78.0cd	83.0bc	81.0bcd	31.5bc	28.8ab	32.4a
30-4-86	63.1bo	66 8ab	57.3ab	93.0bc	103.0ab	89.0c	35.1ab	28.6ab	24.7a
7-5-86	70.9ab	74.7a	67.0a	102.0ab	139.0b	132.0b	36.5ab	30.0a	35.5a
14-5-86	78.7a	80.9a	77.3a	118.0a	176.0a	158.0a	39.5ab	31.0a	37.4a
LSD (1%)	14.3	16.7	11.0	23.8	16.5	20.8	6.4	14.4	6.3

*DW — Daily watering; TW — Twice a week watering; OW — Once a week watering; ++ Means followed by a same symbol in a column are not significant.

Microclimatic conditions in the glasshouse were ($X \pm S.D$)

Relative humidity : (%) 67.8 ± 11.9 Light intensity (μ E m^{-2} sec^{-1} : 50 ± 34.2 Temperature (°C): 30.8 ± 3.9

colonization by this plant under wide range of habitats. However, flowering was delayed in plants that were watered daily, while those watered once a week had comparatively, the deepest root system.

g) **Transpiration studies** : The average rate of transpiration during 0830 to 1830 hours was 4.2 mg/cm²/ hr (Table 6). The relative humidity ranged from 55 to 82%. The average water loss through transpiration varied from 0.6 (1830 hours) to 5.2 g (1230 and 1330 hours). Comparatively higher water loss occurred during 1130 to 1630 hours. This seems to be obvious since transpiration is a function of evaporation force of the surrounding air and the leaf area provided enough soil water is available (Sarmiento and Monasterir 1975).

Table 6. Rate of transpiration in *Ageratum conyzoides* L.

Hours	Mean loss in weight (g)* (X ± S.D.)	Relative Humidity (%)
0930	3.2±1.8	82
1030	2.6±0.5	76
1130	4.1±0.7	73
1230	5.2±0.4	65
1330	5.2±0.6	62
1430	4.6±0.7	63
1530	3.9±0.6	56
1630	3.8±1.4	55
1730	1.6±0.1	61
1830	0.6±0.1	64

*Average of three observations

Total water loss (g) 34.8±3.9

Total leaf area (cm²) 831.8±177.1

Total duration of experiment 10

$$\text{Rate of transpiration} = \frac{34.8}{831.8 \times 10} = 4.2 \times 10^{-3}\ \text{g/cm}^2\text{/hr}$$

h) **Seed studies** : The average number of seeds in an individul plant of *A. conyzoides* was 13897 ± 1610. The germination was highest in continuous light, when planted at surface and after storage for a longer duration (Table 7). The seeds germinated under laboratory conditions only after they were scarified. Thus the seeds were dormant due to impermeability of seed coat to water. Light is known to affect the absolute germination percentage and the rate of germination in many plants (Mayer and Poljakof-Mayber 1975). In this study, the germination was low in diffuse light (natural reflected light during day and dark during night) and continuous dark. However, germination was higher at 36 $\mu E\ m^{-2}\ sec^{-1}$ as compared to 44 $\mu E\ m^{-2}\ sec^{-1}$. This can be explained in terms of variable light intensity rather than the fixed intensity. Seeds placed below 1 cm depth failed to emerge. Storage of seeds for four months improved the germination either due to after ripening requirement or diffusion

Table 7. Effect of environment on the germination of *Ageratum conyzoides* L. seeds

Environment	Germination (%) (x ± S.D.)
I Light (nE m^{-2} sec^{-1}	
Continuous (36)	44.4±11.4
Diffuse (42)	37.8± 8.1
Dark (0)	31.1± 3.1
II Depth (cm)	
Surface	86.7
1	20.0
2	0.0
3	0.0
4	0.0
5	0.0
III Time of storage (days)	
9	37.8± 8.1
120	55± 8.3

of inhibitors. However, this characteristic of *Ageratum* points out to its ecological equipment for regeneration of population.

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