

Ecophysiological Studies of *Eleusine indica* (L.) Gaertn. and *Sporobolus pyramidalis* P. Beauv. at Ibadan, Nigeria

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Abstract

Eleusine indica and *Sporobolus pyramidalis* are common grasses in the tropics, including Ibadan, Nigeria. The former is considered a good fodder when young, but the latter has low grazing quality. The objective of this study was to describe some of the morphological characteristics of these 2 prominent species. *S. pyramidalis* is a taller grass having more roots per culm and a longer inflorescence. Seeds of the 2 grasses germinated between 20°C and 35°C and emergence declined with increasing depth until it was zero at 4 cm for *E. indica* and *S. pyramidalis*, respectively. *S. pyramidalis* had a higher rate of germination. The 2 species have stomata on both leaf surfaces, but the number is greater on the adaxial surface. Experiments indicate that *E. indica* is more tolerant and adaptable to biotic disturbances. The biomass contribution by *E. indica* and *S. pyramidalis* is estimated at 1,100 kg/ha and 300 kg/ha, respectively.

A knowledge of the developmental physiology of grasses is of considerable importance in the management of grasslands. The present investigation of the tropical grasses *Eleusine indica* (L.) Gaertn. and *Sporobolus pyramidalis* P. Beauv. is a contribution to our understanding of their ecology and will likely aid the agriculturist in managing these species. *E. indica*, commonly known as fowl-foot grass, has been described by Purseglove (1975) as a successful species of Africa and Asia and is now widely spread throughout the tropics of both hemispheres. It has been introduced into the United States where it is a weed common to many of the warmer states. In the tropics, it grows from sea level to about 1,800 m. The species is particularly common in waste places and along road sides and paths. It was considered a good fodder when Young and Bogdan (1977) further reported it as palatable to cattle in Fiji, Hawaii, South America, and other areas of the world. *S. pyramidalis* is another common grass in Nigeria (Stanfield 1970). It is a tufted perennial plant having low grazing quality and is considered unpalatable to livestock.

It has been observed that the population of *E. indica* is affected by grazing in preflowering condition. The spread of the plant depends mainly on seeds. Both species are adversely affected by repeated cutting. McIllroy (1964) reported that *E. indica* thrives well in trampled areas and becomes dominant along cattle tracks and paths. Our observation is that both species are conspicuously absent under shade.

Study Area

The investigation was carried out at Ibadan (7° 22' N latitude, 3° 58' E longitude) during 1979-80, on an area of 1,032 ha where 4 sites were chosen. The sites were as follows:

Site I - levelled area

Site II - in the vicinity of a small lake

Site III - area with depression and shade

Site IV - comparatively elevated and sloping area.

The silt loam soil at these four sites ranged in pH from 7 to 8,

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organic matter was 3.2%, except at Site II where it was 6.8% and the water holding capacity averaged 35%.

Climate at Ibadan is characterized by 2 distinct seasons: a humid, wet season occurring in March through October, and a dry season lasting from November through February. Sunshine hours ranged from 50 in September to 209 in February, 1979. Precipitation totaled 1,740 mm with 343 mm falling in August. The mean, daily minimum and maximum temperatures ranged from a low of 20°C in December to a high of 36°C in February.

Materials and Methods

Three plant specimens of *E. indica* and 3 of *S. pyramidalis* were carefully collected from each of the 4 sites for morphological characterization. Their plant associates were identified with the help of regional and local flora (Hutchinson and Dalziel 1931, 1963, 1972 and Stanfield 1970). The phytosociological investigations were carried out on 20 quadrats (50 × 100 cm) at each site to determine frequency, density and cover. Importance Value Index (I.V.I.) was calculated for each species by adding relative frequency, relative density, and relative cover values (Curtis and McIntosh 1951).

Seeds collected for germination studies were stored for 3 months and then sterilized with 0.1% mercuric chloride. Twenty seeds were germinated on filter paper placed in petridishes. Germination was tested at temperatures ranging from 10°C to 40°C. Emergence was also evaluated under glasshouse conditions when seed was planted at 0 to 5 cm soil depths. All germination and emergence experiments were carried out in triplicate.

Results and Discussion

Morphological Features

Quantitative observations on the morphology of *E. indica* and *S. pyramidalis* are indicated in Table 1. *E. indica* acquired a height

Table 1. Morphological features of *Eleusine indica* and *Sporobolus pyramidalis* at Ibadan, Nigeria.

Parameters	<i>E. indica</i>	<i>S. pyramidalis</i>
Height, cm	30 - 62	45 - 62
Number of leaves per culm	4 - 5	2.6 - 3.6
Number of spikes per culm	4.2 - 5.6	47 - 80
Number of seeds per spike	58 - 76	-
Depth of longest root, cm	8 - 17	8 - 10
Number of roots per tiller	9 - 11	10 - 20

range of 30 to 62 cm with maximum height occurring at Site II. The vigorous growth here was due to a plentiful and perpetual supply of water from the lake. Greatest rooting depth and greatest number of seeds per culm were found at Site IV. Plants at Site III were the shortest, suggesting that they do poorly in shade.

S. pyramidalis is generally a taller grass, has more roots per tiller and a longer inflorescence in comparison to the former species. Both species have a shallow fibrous root system with a large

number of roots. Adventitious roots develop from the lower nodes under adverse conditions. Root hairs are long and readily visible. Though the contribution of roots to the biomass is less than shoots, they add to the organic matter of soil.

Phytosociological Relations

The Importance Value Index (IVI) for 10 of the 23 species encountered in 20 quadrats at each of the 4 sites is given in Table 2.

Table 2. Importance Value Index of Weed Species at four sites in Ibadan, Nigeria.

Name of species	Importance Value Index			
	I	II	III	IV
<i>Axonopus compressus</i>	25	24	28	15
<i>Borreria ocymoides</i>	19	21	—	24
<i>Cynodon dactylon</i>	3	29	—	1
<i>Desmodium triflorum</i>	41	14	—	11
<i>Eleusine indica</i>	58	74	79	67
<i>Eragrostis tenella</i>	24	9	—	4
<i>Oldenlandia corymbosa</i>	9	3	24	18
<i>Setaria barbata</i>	11	31	12	14
<i>Sporobolus pyramidalis</i>	57	70	86	80
<i>Synedrella nodiflora</i>	12	23	26	16

The highest dominant species were *E. indica* at Site I and II, and *S. pyramidalis* at Site III and IV. The codominant species with *E. indica* on Sites I and II were *S. pyramidalis* and *Desmodium triflorum*, *S. pyramidalis* and *Setaria barbata*, respectively. The codominant species with *S. pyramidalis* on Sites III and IV were *E. indica* and *Axonopus compressus*, *E. indica* and *Borreria ocymoides*, respectively.

Species having an IVI greater than 20 at one or more sites were *A. compressus*, *B. ocymoides*, *Cynodon dactylon*, *D. triflorum*, *Eragrostis tenella*, *E. indica*, *Oldenlandia corymbosa*, *S. pyramidalis*, *Synedrella nodiflora*, and *S. barbata*. Based on IVI, the communities at Sites I to IV are as follows:

- Eleusine-Sporobolus-Desmodium* Community
- Eleusine-Sporobolus-Setaria* Community
- Sporobolus-Eleusine-Axonopus* Community
- Sporobolus-Eleusine-Borreria* Community

Germination Studies

Results of germination studies for the 2 species at different temperatures, soil depths, and environments are presented in Table 3. *E. indica* seeds germinated between 20°C and 35°C with optimum temperature being 25°C. *S. pyramidalis* seeds germinated between 15°C and 35°C. Optimum temperature was 25°C. *S. pyramidalis* had a higher rate of germination.

Optimum germination and emergence occurred at the surface and declined with depth. For *E. indica* there was no germination below 2 cm and none below 3 cm for *S. pyramidalis*. The fact that these grasses have very small seeds, 1 mg and 0.1 mg, respectively, may explain the higher rates of emergence near the surface than when buried in the soil where food reserves are inadequate to allow extension of the plumule through the overlying soil.

The trend of germination of two species in different environments again indicates that *S. pyramidalis* does well in all environments while *E. indica* does not germinate in continuous light.

Studies on Transpiration

Stomata were elliptically shaped pores ranging from 15.0 to 17.5 nm by 22.5 to 25.0 nm in *E. indica* while 12.5 to 15.0 nm by 25.0 nm in *S. pyramidalis*. The 2 species are amphistomatous, i.e., having stomates on upper and under leaf surface, but the number of stomata is greater on the adaxial surface on the leaf. The stomatal density was 710/mm² and 490/mm² on the adaxial and abaxial surfaces respectively for *E. indica* and 540/mm² and 390/mm², respectively, for *S. pyramidalis*.

Table 3. Germination (%) for *Eleusine indica* and *Sporobolus pyramidalis* at different temperatures, soil depths, and environments.

Conditions of germination	<i>E. indica</i>	<i>S. pyramidalis</i>
Temperature		
10°C	0	0
15°C	0	5
20°C	10	20
25°C	40	60
30°C	15	40
35°C	5	10
40°C	0	0
Soil Depth (cm)		
Surface	45	75
1	15	35
2	10	20
3	0	5
4	0	0
5	0	0
Environment		
Continuous light	0	5
Dark	15	15
Glass house	30	65

Transpiration rate measured as weight loss per day per pot was 7.8 mm/day for *E. indica*, which was higher than the 5.2 mm/day measured for *S. pyramidalis*. This may result from the higher stomatal frequency and wider stomatal aperture in *E. indica*. Also, anatomical observation revealed a thinner cuticle for *E. indica* thereby allowing more cuticular transpiration. These evapotranspiration values were determined on potted plants and, therefore, may not reflect what actually happens under field conditions.

Biomass Studies

At the four-leaf stage, the shoot to root mass was 0.9/0.08 g for *E. indica* and 0.4/0.10 g for *S. pyramidalis*. Dry weight increases from the two-leaf stage on to maturity. At any stage of development, *E. indica* showed a relatively higher dry weight than *S. pyramidalis*. The average density of *E. indica* and *S. pyramidalis* calculated from 20 quadrats at each of the 4 sites was 5.4. The average total dry weight of root and shoot of individual plants under an ideal condition of daily watering was 5.3 g and 1.5 g, respectively, as measured in another study. The estimated biomass for *E. indica* and *S. pyramidalis*, including both tops and roots, would be 1,100 kg/ha and 300 kg/ha.

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