REHABILITATING SANDY ACID SOILS IN THE SAHELO-SUDANESE REGION WITH ANDROPOGON GAYANUS KUNTH VAR. BISQUAMULATUS, A DROUGHT RESISTANT SAVANNAH GRASS

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ABSTRACT

Root growth of Guinea grass (*Andropogon gayanus* Kunth var. *Bisquamulatus*) and the effects of the crop on soil fertility were studied in Senegal (field conditions). The physiological behaviour of the graminae was also monitored during a drying cycle in a controlled environment (Belgium). The growth of the root system was remarkable during the rainy season. Root turn-over greatly improves soil organic matter content after two years of cultivation. During the drying cycle, the plant performed an osmotic adjustment through K^+ ions and sugar accumulation in the cell sap.

KEYWORDS

Guinea grass, root growth, drought resistance, osmoregulation

INTRODUCTION

Andropogon gayanus Kunth var. *Bisquamulatus* (Guinea grass) provides exceptional DM productions in the dry climate and poor substrates of the Sahelo-Sudanese region. This perennial bunch grass also protects soils against erosion and is recommended for the establishment of temporary fodder crops in integrated farming systems. However between 200-600 mm rainfall, the plant endures severe drought periods during the rainy season. Until now, the mechanisms through which the graminae withstands water-stress and its contribution to soil-fertility improvement are still unknown. The purpose of this study is to give some answers to these questions.

MATERIALS AND METHODS

The effects of the plant on soil fertility were studied in Senegal (ENSA). The soil cores were randomly taken (10-20 cm and 20-40 cm, 10 replicates) at the end of the dry season 1991 in a control plot (traditional farming system) and in a 2-year old crop. The root system was observed at the beginning and at the end of the rainy season 1991 using 5 plants (replicates). For each replicate, the soil was removed over a depth of 80 cm from the centre of the plant. Soil volumes of 60 cm long, 10 cm large and 20 cm depth were regularly divided in order to obtain 12 portions of 10 x 20 x 20 cm for each replicate. The roots were carefully separated and washed. The DM was determined after 24 h drying in an air circulating oven at 105°C.

The capability of osmoregulation during a drought cycle, i.e. active regulation of solute concentration to maintain turgor during a slowly drying cycle (Barlow, 1986), was evaluated in a wind tunnel (Belgium). The precinct was equipped with a weighable lysimeter filled with reconstituted sandy soil and 6 plants were cultivated on the working surface (1 m^2). The day/night temperature and relative humidity varied between 30.5 - 27.5°C and 65 - 70% respectively. The leaf water potential (LWP) was measured daily (6 replicates) on the most fully expanded leaf using the pressure chamber (PMS Instruments Co., Corvalis, Oregon, USA). The same leaf was used to determine the leaf relative water content (RWC) following the pressure-volume technique (Wilson *et al*.; 1980). The symplasmic water content was determined by analyses of 1/LWP and RWC curves. In order to determine the osmotic potential (OP) or the osmotic potential at full turgor (OP x RWC), the following leaf was pressed and the extracted sap was immediately used for osmometric measurements (Crioscopic method, Fiske ONE-TEN, Fiske Associates, Needham Heights, Massachusetts, USA). The K^+ ion concentrations were measured by flame photometry and an enzymatic-UV bioanalysis method (Boeringer n° 716260, Mannheim, Germany) was used to determine glucose, fructose and sucrose concentrations. The solute concentrations were expressed at full turgor according to the RWC of the plants.

RESULTS AND DISCUSSION

Table 1 shows the extraordinary growth of the root system during the rainy season. The underground biomass was multiplied by 250-300% with the return of the rains and developed principally in the deeper layers of the substrate near the plant (x 300 - 400%). The elongated roots were essentially profusely-branched fibrous roots which enable the plant to extract water and nutrients in the sandy soils (Bowden, 1963). The annual turn-over of the root system greatly improves the organic matter content of the soil (see Table 1). After two years the C/N ratio was elevated to an ideal value over 20. In comparison, the effect on soil fertility was the same as the incorporation of 5 T of organic matter every two years (Buldgen *et al.*, 1995).

The decreasing curve of the corrected osmotic potential (Figure 1) clearly demonstrates the active osmoregulation in the plant during a drying cycle as the soil water reserve dropped from 28.5 to 5.5% in volume. The analyses on cell sap revealed that K^+ ions were responsible for 36.5% of the LWP adjustment of the plant, while glucose, fructose and sucrose represented respectively 22.5, 13.4 and 1.5% of the LWP adjustment. Plant growth continued until the wilting point was nearly reached because the stomata probably remained open (El-Sharkawi *et al*., 1985).

In conclusion, it would appear that the root development is essential to supply the plant in water and above all in K^+ ions, thereby maintaining the LWP and the stomata partially open. Secondly, the sugar produced by the ensuing photosynthesis accumulates in the cell sap. The large morphological biodiversity of the variety *Bisquamulatus* (Buldgen *et al.*, 1992) should be explored concerning the root development and/or the capability of osmoregulation.

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Table 1
Root growth at the end of the wet season expressed in % of the root DM in the dry season and contribution to the soil fertility of a 2-year old crop of Guinea grass.

Soil depths	**0 - 20 cm**	**20 - 40 cm**	**40 - 60 cm**	**60 - 80 cm**
Root growth (%)				
Distances from the plant				
0 - 10 cm	115	293	400	414
10 -20 cm	214	267	289	320
20 - 30 cm	206	223	321	261

Pedological parameters

	Control plot		***Crop of Guinea grass***	
	0 - 20 cm	**20 - 40 cm**	**40 - 60 cm**	**60 - 80 cm**
pH KCl	4.1	4.0	6.5	4.2
C %	0.17	0.12	0.09	0.40
OM %	0.30	0.21	1.12	0.69
N %	0.016	0.016	0.022	0.017
C/N	11.3	9.7	29.5	23.5

Figure 1
Water status in Guinea grass during a drought cycle decreasing the soil water reserve (SWR in % volume) from 26 to 5 %.