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Derleme Makalesi

Guinea Grass (*Panicum maximum*) Forage: A Review

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Abstract

As a C4 photosynthetic forage crop native to Africa, Guinea grass (Panicum maximum), is a perennial, highly productive, nitrogen responsive feed with good forage quality. It is well adopted to tropical-subtropical regions, silvopastoral systems, integrated crop-livestock systems, well drained fertile soils but also drought tolerant due to its deep, dense and fibrous root system. Here in this review reader may additionally find information related to apomictic (clonal), sexual and tissue culture production methods in between selected morphological, anatomical and chemical characteristics of the species.

Keywords: Forage, Guinea grass, *Panicum maximum*, tropical

INTRODUCTION

Guinea grass is a C4 grass widely used in tropical pastures for feding cattles (Carvalho et al., 2020), which has high productivity and good forage qualities (Akiyama et al., 2008). It is important for cattle production in tropical regions, very responsive to nitrogen fertilization and have potential for use in silvopastoral systems (Paciullo et al., 2017). Guinea grass is an invasive perennial plant (Adhikari et al., 2021). Panicum maximum grass is native to Africa but was introduced to narly all tropical zones as animal forage. It grows well on well drained fertile soils, can prevent soil erosion and can quickly regrow after fires. This plant has deep, dense and fibrous root system which supports growth during drought. Guinea grass is a clump-forming perennial which grows best in warm and frost free areas with minimum 900 mm precipittaion. Crude protein content of fresh guinea grass and grass silage varies between 5.0-5.6% and 5.0-5.5%, respectively. The digestibility depends on genotype and between 56.9% (variety Gatton) to 87.7% (variety Vencidor) (Aganga & Tshwenyane, 2004). For good production and growth Panicum maximum requires high amounts of nitrogen fertilizer (Mishra et al., 2008).

The use of apomictic, tetraploid, tropical and subtropical forage grass guinea grass origined from Africa (Sousa et al., 2011), as a forage grass in integrated crop-livestock systems is frequent in Brazil (Queiróz et al., 2014). Brazil has high acreages of pastures covered with Guinea grass and is a producer, consumer and exporter of its seeds. Guinea grass is often used to feed beef cattle in Brazil which is the leader country in global meat export of its pasture-raised bovine herds. Elevated biomass generation by C4 photosynthesis pathway loads potential to Guinea grass to be used in bioenergy production (Dias and Alves, 2008). Tropical forage grasses show high growth rates and biomass yields, supported by their C4 photosynthetic pathway. Related to this pathway, the anatomy, morphology and chemical composition of leaf blades may influence consumption, digestibility and total forage quality of this grass (Batistoti et al., 2012). Like as in many gramineous plants, guinea grass cellulosic biomass may be used as a feedstock for bioenergy (Huo et al., 2012).

Grazing management is a key factor for high herbage production and grazing efficiency (Carnevalli et al., 2006). Grazing strategies changes sward structures which may affect patterns of herbage accumulation and sward management (Silva et al., 2009). Tall, tufted, tropical guinea grass post-grazing heights promote changes in sward structure and effect animal performance. Thus, intermittent grazing should be managed at 50 cm residual height (Euclides et al., 2018). When herbage growth dynamics, plant community competition and grazing animal behaviour on grasslands considered, according to Hack et al., (2007), *P. maximum* grass should be grazed at sward heights lower than 100 cm. In a study of Cano et al. (2004), *P. Maximum* grazed to 40 and 50 cm showed good chemical composition and in vitro dry matter digestibility. In response to grazing, the crude protein, in vitro dry matter digestibility, Calcium, Phosphorous and Magnesium contents decreased while neutral detergent fiber, acid detergent fiber and potassium concentrations increased in the leaf blade and stem + leaf sheath fraction.

Agronomic, morphological, anatomical and chemical characteristics of leaves blades of nine guinea grass genotypes were evaluated by Batistoti et al. (2012) in Brazil. Neutral detergent fibre was positively correlated with the parenchyma bundle sheath area and specific leaf area. The specific leaf area was negatively correlated with in vitro organic matter digestibility. Morphological differences among *P. maximum* genotypes did not interfere in biomass accumulation. Leaf width was found useful in the early phases of the process of genotype selection for quality high yielding materials.

Cano et al. (2004) grazed *P. maximum* at four different sward heights (20, 40, 60 and 80 cm) by Nellore steers with average weight of 340 kg. Green leaf lamina mass, green stem + leaf sheath mass, mass of dead material, green forage mass, forage mass, leaf area index, dry matter accumulation rate and total forage mass increased by pasture height increases. Pasture height of 40-60 cm showed good morphologic composition and high leaves availability for grazing, good ground cover and dry matter accumulation rate.

A new plant peroxidase was isolated from the leaves of guinea grass with high activity by Centeno et al. (2017). This peroxidase was directly immobilized on the surface of a graphene screen printed electrode and cyclic voltammograms as a redox species demonstrated an increase in the electron transfer process. The graphene-modified electrode exhibits excellent electrocatalytic activity. The new peroxidase from guinea grass allowed the modification of a graphene electrode providing a potential sensor detection system for determination of H2O2 in real samples with some biomedical or environmental importance.

Filho et al. (2016) conducted field trials to evaluate the effects of different irrigation levels and doses of nitrogen aplications on yield and chemical composition of *P. maximum*. Irrigation at the level of 50% of Class A pan evaporation with application of 800 kg N ha year^{-1} resulted with highest productivity, chemical composition and water savings. Concentrations of ADF were reduced by nitrogen fertilization.

Bipolaris maydis inhibits the development of the Tanzania grass and promotes alteration in the quality of the forage (Martinez et al., 2010).

Producing maternal clones, Apomixis (asexual reproduction without fertilization; ie: agave producing plantlets on the old flower stem), is an asexual reproduction type. Guineagrass has both obligate sexual reproduction and facultative aposporous apomixis (Yamada-Akiyama et al., 2009).

Seed is a key factors in crop production. Sexual (or amphimictic) reproduction and asexual (or apomictic) reproduction are two pathways in angiosperms. Sexual (or amphimictic) is a common method used by seed companies to breed new varieties. Whereas asexual (or apomictic) reproduction is receiving increasing attention from scientific and industrial sectors. Controlled apomixis of sexual crops may make a broad and profound effect in agriculture. Apomixis may allow clonal seed production and enable efficient and consistent yields with high quality seeds at lower costs. Apomixis technology may make a revolutionary effect on agriculture and food production by reducing costs, reducing breeding time and escaping the typical complications of sexual reproduction (incompatibility barriers etc) and vegetative propagation (viral transfer etc). But the development of apomixis technology requires a deeper knowledge of the regulatory mechanisms of reproductive development in plants to understanding the genetic control of the apomictic process (Barcaccia and Albertini, 2013).

Somatic embryogenesis was induced in budding leaf segments of guinea grass cultured on Murashige and Skoog's nutrient medium containing 2,4-dichlorophenoxyacetic acid and coconut milk in a study of Lu and Vasil (2981). The embryoids produced plants on a medium containing gibberellic acid before successfully transplanted to soil and grown to maturity. It was determined that the embryogenic callus tissue was formed from lower epidermis as well as the mesophyll tissue. The regenerated plants showed the normal chromosome number of 2n=4x=32.

In a study of Kaushal et al. (2008), 160 accessions representing global germplasm of guinea grass were subjected to study on reproductive diversity in apomictic seed development utilizing ovule clearing and flow cytometric seed screen (FCSS). They demonstrated uncoupling between the three apomixis components, (apomeiosis, parthenogenesis and functional endosperm development), which differed across ploidy levels and genotypes. Reproductive pathways yielded eight different pathways of seed development by uncoupling/recombination between apomixis components. Amongst these, two pathways involving modifications in embryo-sac (ES) (presence of two polar nuclei in aposporous ES that fuse prior to fertilization) and fertilization process (fusion of only one polar nucleus in a sexual ES) have been reported for the first time. Some of the combinations, such as MI (haploids arising from parthenogenetic development of reduced egg cell) were found viable only in hexaploid genotypes. Autonomous endosperm development were also partitioned in hexaploid progenies.

CONCLUSION

Guinea grass is widely used in tropical and subtropical pastures for feding cattles due to its high yield and quality. This perennial crop grows well on well drained fertile soils but also tolerant to drought. It is a tetraploid species which has elevated biomass generation by C4 photosynthesis pathway. It is very responsive to nitrogen fertilization, suitable to silvopastoral systems and integrated crop-livestock systems and often used to feed beef cattle,

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