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Technical culture of kenaf produced under Tunisian semi arid conditions

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Abstract. Kenaf, *Hibiscus cannabinus L*, is a warm-season annual fiber crop. The stem is a source of fibre production. In Tunisia, kenaf production was introduced in the humid and saharian regions since 1998. Possibility of its culture in Zaghouan, a Tunisian semi arid region, and the optimal density for a higher yielding and nutritive value was our main objective. Three seeding densities (seeds/m²) were used: 27 (D1); 13 (D2) and 5 (D3) seed/m^2. Harvesting was at 75 days age. The highest yield (11.6 t/ha) in terms of edible dry matter (DM) was recorded for D1 and the lowest (6 t/ha) for D3. Protein content was higher (>17%) in leaves and lower (<12%) in stems. The main handicap of its production is water resource. Agricultural companies should be carried out to well introduce this plant in the agriculture systems since it can be a good precursor for some cereal culture due to its capacity to incorporate a high organic matter amount in the soil.

Keywords. Kenaf – Nutritive value – Seeding density – Maturity stage.

Technique cultural du kenaf produit en Tunisie sous des conditions semi-arides

Résumé. *Kenaf, Hibiscus cannabinus est une culture annuelle de saison chaude destinée à la production de fibres utilisée dans l'industrie de textile. En Tunisie, la production du kenaf a été introduite dans les régions humides et sahariennes depuis 1998 dans le cadre des projets agro-industriels visant essentiellement la production de fibre. La possibilité de sa culture dans le gouvernorat de Zaghouan, une région semi-aride en Tunisie, et la détermination de la densité optimale pour un meilleur rendement fourrager et une bonne qualité nutritionnelle étaient notre objectif dans ce présent travail. Trois densités de semis (semences/m^2) ont été utilisées: 27 (D1); 13 (D2) et 5 (D3). La récolte a été effectuée vers les 75ièmes jours après le semis. Le rendement fourrager le plus élevé a été observé avec la densité D1, soit 11.6 t/ha et le plus faible avec la densité D3, soit 6 t/ha. La teneur en protéine en protéine a été élevée (>17%) au niveau des feuilles et faible au niveau des tiges (<12%). Néanmoins, cette culture prometteuses reste tributaire des ressources en eau. Des campagnes agricoles pour la vulgarisation devraient être assurées pour sensibiliser les agriculteurs de l'importance de cette culture fourragère et l'introduire systèmes agricoles puisque elle peut être considérée un précurseur aux cultures céréalières grâce à son pouvoir d'apporter au sol une quantité importante en matière organique.*

Mots-clés. *Kenaf – Valeure nutritive – Densité de semis – Stade de maturité.*

I – Introduction

Kenaf (*Hibiscus cannabinus* L., Malvaceae) is a warm season annual fiber crop closely related to cotton (*Gossypium hirsutum* L., Malvaceae) and okra (*Abelmoschus esculentus* L., Malvaceae) that can be successfully produced in a large portion of the world, particularly in Africa. This annual specie is characterized by its 3- to 4-m height and high production of biomass which is composed primarily of cellulose-rich stalk (Webber, 1993) from which the fiber is extracted. Kenaf requires less than 6 months for attaining a size suitable for practical application. For industrial purposes, the apical part of the plant rich in protein and low in cellulose, may be considered a by-product potentially suitable for livestock production. As the commercial use of kenaf continues to diversify from its historical role as a cordage. Based on the optimum of forage quality and quantity, kenaf was best harvested between 10 and 12 weeks after planting, when CP is approximately 15% (Phillips *et al*., 1999). The ground leaves of kenaf have high digestibility and can be used as a source of roughage and protein for cattle and sheep (Webber, 1993) especially when harvested early (González-Valenzuela *et al*., 2008). Little information is available regarding kenaf forage response to population density, which affects plant morphology, dry matter (DM) accumulation, and susceptibility to lodging. Information of potential yield and chemical composition of kenaf as fodder for ruminants in the Mediterranean areas, especially under semi arid conditions, is presently insufficient. Therefore, the objective of this study was to assess the technical culture of kenaf under Tunisian semiarid conditions, determine the influence of population density on kenaf dry matter (DM) and fresh matter (FM) yields, and forage quality at 75 days after sowing (DAS).

II – Material and methods

1. Kenaf growth and harvest

The kenaf was grown on land owned by the Agricultural High School of Mograne, government of Zaghouan (center east of Tunisia). The experimental field area covered 1000 m^2 (20x50) and divided into height plots. Plots were 2 m spaced and had a 69 m^2 surface (23 x 3 m). They were sown at different seed densities (seeds/m^2). In our present study we focused our aim on only three densities: 27 (D1); 13 (D2) and 5 (D3). The crop was sown in June 2011 and harvested at 75 days age at a height of 180 to 190 cm. The soil was loamy clayey and its pH was 8. Prior to planting, plots were ploughed and fertilizer was applied at a rate of 50 kg/ ha N and 150 kg/ ha P. No K was supplied, as its status was already adequate in the soil. All plots were kept weed-free by hand weeding throughout the growing season.

During growth, the plots were managed as irrigated crops receiving a daily irrigation. At 75 days after planting, kenaf was harvested by hands at approximately 5 cm above ground level using a 1x1m quadrant (three replicates for each plot). Plants within the quadrant were immediately weighed to determine fresh weight. Leaves and stems of the whole plant from each plot were manually separated and dried at 60ºC to constant weight.

2. Chemical analysis and in sacco dry matter degradability

Dried samples of young stems and leaves were ground through a 1 mm screen and analyzed for the contents of crude protein (CP), ash (AOAC, 1990), neutral detergent fiber (NDF) and acid detergent fiber (ADF) (Robertson and Van Soest, 1981) and Van Soest *et al*. (1991). For the determination dry matter degradation, samples of leaves and young stems were ground through a 3mm sieve and two replicate samples of each, weighing about 3g, were placed into nylon bags and incubated in the rumen of fistulated heifer. Elapsed the incubation time (48 h), bags were gently rinsed with tap cold water, oven dried (60ºC, 48 h) and weighed to calculate the degradability of the dry matter as the difference between the initial vegetal material (3 g) and the residual of the incubation. The fistulated heifer was fed on concentrate (4 kg/d) and alfalfa hay (8 kg/d).

III – Results and discussion

1. Vegetative growth of kenaf and biomass production

It is well reported that biomass production is influenced by vegetative and growth rate of the plant, population density. In our present study three plant densities were examined: 27 (D1), 13 (D2) and

5 (D3). At very low planting densities (<20 plants/m^2) kenaf produces multiple branches, which renders harvesting more difficult (Massey, 1973). Nevertheless stem diameter decreased as population density increased resulting from intraspecific competition among plants (Acreche *et al*., 2005, Reta *et al*., 2010). This fact can explain partly the lowest DM contents (21.2 %) reported in this present study when plant density is the lowest (5 plants/m^2). Similar DM contents were recorded earlier (19.1%) by Rude *et al*., (2002) when kenaf was harvested at 42 DAS. In relation with plant density, an opposite trend was observed for fresh and dry matter yields of the whole plant (Table 1). The highest yields of fresh (51.9 t/ha) and dry matter (11.6 t/ha) corresponded to the highest density (27 plants/m^2). These DM production yields were dramatically higher than that reported by Chantiratikul *et al*., (2009) who recorded 0.12-0.95 t/ha DM yield harvested 75 DAS.

It appears therefore that DM yield of kenaf do depend upon plant variety, seeding rate, maturity stage (Bañuelos *et al*., 2002) and other agronomic factors.

Table 1. Dry matter (DM) contents (%) and biomass production (Fresh matter, FM; and dry matter, DM) (t/ha) of kenaf at different seeding densities

Plant density	D1	D2	D3
% DM	22.3	22.7	21.2
FM (t/ha)	51.9	39.9	29.2
DM (t/ha)	11.6	9	6.2

2. Chemical composition and in sacco DM degradability

Data on chemical composition and in sacco DM degradability of leaves and stems of kenaf harvested at 75 DAS are presented in Table 2. Mineral contents varied between 6.7 and 12.6% corresponding the lowest values to stems (D1) and the highest to leaves (D3). Kenaf leaves contain a higher concentration of CP (>22%) and in sacco DM degradability (>70 DM) than the stems (Table 2) which are less digestible (36-40% DM) due to their high NDF(54-65%) and ADF (42-50%) contents and poor levels of CP (7.5-11.5%). This was expected because mature tissues (at the base) accumulate higher amounts of metabolic products than the younger parts at the top. With respect to plant density, increases in population density were not related to kenaf nutritive value in terms of crude protein (CP) and fiber concentrations as was suggested earlier by Reta *et al*. (2010). This response is probably predictable when considering that density increase did not modify the forage leaf and stem proportions, which are related to forage quality in terms of CP and fiber concentrations (Swingle *et al*., 1978). The average CP, NDF and ADF concentrations were slightly higher than those reported either by Reta *et al*. (2010) who recorded 177, 453, and 524 g/kg respectively for the whole plant harvest at 87 DAS or by Muir (2002) with a population density of 16 plants/m^2 and harvested at 83 DAS during its flowering phase. When compared with leaves, this author reported lower CP concentrations (192 g/kg) and higher ADF (280 to 290 g/kg) and NDF (350 to 380 g/kg) concentrations. The higher CP and lower NDF and ADF concentrations reported in our study, as compared with those of the other authors can be probably due to an earlier phonological phase at harvesting.

To optimize forage quality and quantity, kenaf should be harvested between 60 and 80 days after planting since the proportion of leaf in the total DM decreases dramatically at about 80 days after planting (Phillips *et al*., 1999). Crude protein content at this time would be >15% and in situ OM disappearance could be >69% (Phillips *et al*., 1999). These findings justify partly the successful use of kenaf to replace Alfalfa as a crude protein supplement for lambs fed Bermuda grass or Fescue hay.

Table 2. Chemical composition (g/kg DM) and in sacco dry matter degradability (%) at 48h incubation of leaves and stems of kenaf grown at different plant densities

	Density	MM	CP	NDF	ADF	D48
Leaves	D1	11.1	23.1	26.8	19.9	70
	D2	12.0	22	28.9	22.4	73
	D3	12.6	22.5	27.0	20.5	75
stems	D1	6.7	7.5	65.8	50.4	36
	D2	9.4	11.5	54.9	42.1	40
	D3	7.2	9.1	61.7	47.1	41

It has also been determined that chopped kenaf (29% dry matter, 15.5% crude protein, and 25% acid detergent fiber) is a suitable feed source for Spanish (meat-type) goats.

IV – Conclusion

This research further supports the feasibility of producing kenaf not only for fiber, but also for a livestock feed. The greater water requirement of kenaf could be a problem in areas where irrigated water is limited. An optimum population density for DM production corresponded to 27 plants/m^2. However, for an optimum nutritive value in terms of CP and DM degradability a density of 13 plants/m^2 was accepted. Future research should focus on cultural methods to maximize kenaf's nutritive value and total dry-matter production.

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