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Productivity of five deciduous woody fodder species under three cutting heights in a Mediterranean environment

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RESUME – "Productivité de cinq espèces caduques d'arbustes fourragers à trois hauteurs de coupe dans un milieu méditerranéen". Les espèces caduques d'arbustes fourragers sont appropriées aux milieux semi-arides et sub-humides méditerranéens afin d'assurer du fourrage aux animaux en pâturage pendant la période critique d'été. La hauteur annuelle et la biomasse aérienne pâturable des cinq espèces par rapport à la hauteur de coupe ont été étudiées dans un milieu sub-humide à hivers froids du Centre de la Macédoine, en Grèce. Les espèces étudiées étaient : *Acer campestre* L., *Corylus avellana* L., *Gleditsia triacanthos* L., *Morus alba* L. et *Robinia pseudoacacia* L. Les hauteurs de coupe étaient 10 cm au-dessus du sol (basse), 20 cm (moyenne) et 40 cm (haute). Nos résultats indiquent que les espèces étudiées ne devraient pas être coupées à moins de 40 cm au-dessus du sol chaque année à la fin de la période de croissance afin d'assurer une plus grande quantité de biomasse totale pâturable.

Mots-clés : Arbustes fourragers, arbres fourragers, matière pâturable, hauteur de coupe, Grèce.

Introduction

Deciduous fodder trees and shrubs are important feed resources in semi-dry and sub-humid Mediterranean environments. They provide green foliage (leaves and twigs) of high nutritive value (Papachristou and Papanastasis, 1994) during the summer, when forage of herbaceous plants are of low availability and quality (Papachristou *et al.*, 1999). Therefore, the strategy in the Mediterranean production systems is not only to improve and manage natural shrublands but also to establish artificial woody fodder plantations, to be used as forage reserves. However, before any introduction of certain fodder species to the Mediterranean silvopastoral systems it is necessary to be found out their role and potential as forage resources (i.e. establishment, productivity, nutritive value, resistant to grazing, etc.)

Studies on productivity of deciduous woody plants have shown that it varies among species and between years with air temperature and precipitation significantly affecting the annual changes of biomass (Platis and Papanastasis, 1994; Dini-Papanastasi 1997; Papanastasis *et al.*, 1997). It was suggest (Dupraz, 1999; Papanastasis, 1999), that deciduous fodder trees and shrubs can withstand annual clear cutting at the end of the growing period from the very beginning of their establishment without being damaged. However, their total aboveground biomass is reduced, while its grazeable portion (leaves and twigs) is increased (Papanastasis *et al.*, 1998). Also, if deciduous woody species are to be used as fodder resources for providing green feed to the animals, it is better to be cut once or, at the most, twice during the growing period. Such treatments will ensure not only higher amounts of total biomass but also richer in grazeable material (Platis *et al.*, 1999). In this paper, the relation between cutting height at the end of the growing period and productivity in five woody fodder species was investigated so that management guidelines are developed to better utilize plantations for the benefit of ruminants in the extensive Mediterranean production systems.

Materials and methods

The research was conducted in the Experimental Center of Chrysopigi (northern latitude: 41.15°, eastern longitude: 23.58°), in Central Macedonia, at an altitude of 605 m. Soils are derived from conglomerates of the tertiary period and the pH is 6.1. The climate is sub-humid Mediterranean with

mean annual precipitation 550 mm (16 year average) and a mean annual air temperature 13 °C, with a range of minimum and maximum mean from -0.3 °C (January) to 27.7 °C (July).

The selected woody fodder species were: *Corylus avellana* L., *Gleditsia triacanthos* L., *Morus alba* L., *Acer campestre* L. and *Robinia pseudoacacia* L. Seeds of the species were collected locally in 1989. In the spring of 1990, all the seeds were sown in plastic bags in a nursery of the study area. One year later, in the spring of 1991, the seedlings were planted at a spacing 1.0 x 1.5 m (i.e. 40 plants per plot). The experimental design was a factorial with split combined over year (Steel and Torrie, 1980).

Measurements of height and annual biomass were done at the end of August from 1992 to 2000. In 1992, 10 plants of each species within each plot were randomly selected and cut at 10 cm height aboveground (low), another 10 plants were cut at 20 cm height (medium), another 10 plants were cut at 40 cm height aboveground (high) and the remaining 10 plants were left as a control. The same plants were recut at the same period in the following eight years. Half of the samples collected each year were hand-separated into grazeable material (leaves, fruits and twigs up to 2 mm diameter) and branches and all of them were weighed in the laboratory after oven drying at 70°C. Grazeable biomass were expressed in g DM per plant. Cutting heights and grazeable material were subjected to analysis of variance (ANOVA) and significant differences among means were detected at the 0.05 probability level using the protected LSD test (Steel and Torrie, 1980).

Results and discussion

Cutting heights affected mean annual height of the various species in a different way (Table 1). The cutting height did not affect the height of *Acer* and *Morus* during the 9-year period. On the contrary, the height of *Corylus* and *Gleditsia* across year affected by the cutting height and was lower in the low cutting (77.0 and 103.8 cm, respectively), comparing to the high cutting (86.4 and 100.8 cm, respectively). Among the three cutting heights, the high and medium ones resulted in significantly taller height than the low cutting. Finally, there were differences among the three cutting treatments in *Robinia* with the high treatment (i.e. cutting at 40 cm) giving the highest height (178.0 cm). Maximum annual growth rates were attained in the fifth year in the high cutting. *Robinia* was the tallest species, across cutting treatments and years following by *Morus*.

Table 1. Mean annual height (cm) of five woody fodder species under three cutting heights

Year	<i>A. campestre</i>			<i>C. avellana</i>			<i>G. triacanthos</i>			<i>M. alba</i>			<i>R. pseudoacacia</i>		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1992	85.5 ^a	91.7	94.9	74.8	66.8	72.6	69.0	66.3	77.2	103.2	103.7	109.0	129.0	149.2	132.5
1993	77.0	76.4	89.0	68.3	67.2	81.4	73.7	73.4	82.5	98.6	98.4	108.7	98.6	98.4	198.7
1994	69.7	70.3	85.2	59.9	56.8	71.8	72.8	78.4	97.5	111.7	111.0	71.8	130.2	148.9	149.8
1995	70.1	72.3	85.9	69.0	77.0	89.6	85.5	85.6	92.4	92.5	95.6	110.5	136.0	167.1	174.2
1996	82.6	88.7	104.8	84.4	102.1	121.6	93.1	97.0	109.3	126.1	131.7	142.2	163.0	193.5	213.3
1997	67.3	72.8	78.8	75.8	87.1	108.7	98.3	90.3	107.2	106.8	108.8	129.2	134.1	161.0	185.0
1998	68.1	69.7	84.9	85.1	99.6	122.4	93.1	94.5	112.1	112.4	114.6	124.8	126.4	157.6	184.7
1999	73.7	82.4	86.3	94.9	110.5	143.7	121.7	117.1	126.5	123.2	126.9	145.5	106.2	233.2	268.1
2000	60.0	67.7	80.7	80.6	97.0	122.6	70.9	80.4	102.5	104.3	115.7	125.6	150.3	155.7	185.7
Mean	72.7 ^b	76.9	87.8	77.0	84.9	103.8	86.4	87.0	100.8	108.8	111.8	118.0	130.4	162.7	178.0

^a Means for all species and three cutting heights (1: low, 2: medium, 3: high) in the same year separated by 23.9 cm differ significantly (LSD_{0.05}).

^b Means separated by 8.1 cm differ significantly (LSD_{0.05}).

Cutting heights affected grazeable material of the various species in a different way (Fig. 1). Percentage of leaves and twigs of the annual biomass was also found to vary widely among species. During of the 9-year period, low cutting height (10 cm) resulted in significant lower biomass than the

high cutting height (40 cm) in all species except *Gleditsia*, where no significant effects were detected. Medium height (20 cm) produced significantly higher grazeable biomass as compared to the low cutting height, only in *Corylus*. All along, *Robinia* was the most productive species. All the other species had far less grazeable material than *Robinia*. The overall ranking at the end of the 9-year period (2000) from the most grazeable material to least was: *Robinia* > *Corylus* > *Acer* > *Morus* > *Gleditsia*. Previous experiments have also shown that *Robinia* was the most productive legume (Papanastasis *et al.*, 1998), while *Morus* has been found to produce top-quality foliage in France (Dupraz, 1999).

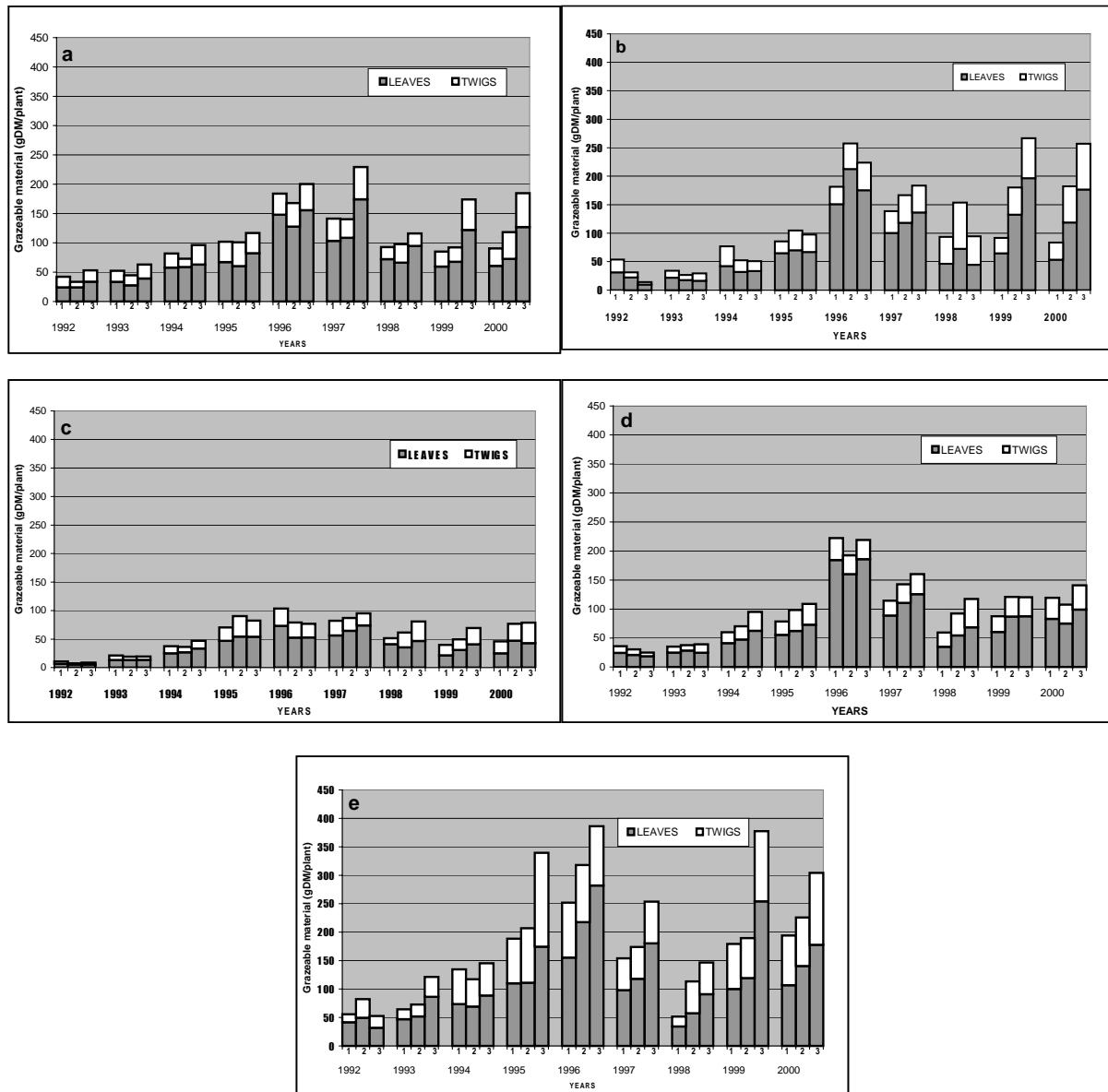


Fig. 1. Grazeable material (g DM/plant) of fodder species: *A. campestre* (a), *C. avellana* (b), *G. triacanthos* (c), *M. alba* (d) and *R. pseudoacacia* (e) in relation with low (1), medium (2) and high (3) cutting heights. Means of leaves and twigs separated by 42.5 and 22.8 g respectively differs significantly ($LSD_{0.05}$) in all species.

It may be concluded that if Mediterranean deciduous woody plants are to be used as feed resources to provide green forage to ruminants during the summer period, they should be preferably cut at 40 cm and certainly not more 20 cm aboveground at the end of the growing period. Such a treatment will ensure not only taller annual height but also higher aboveground biomass rich in grazeable material.

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