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Kyriazopoulos A.P., Abraham E.M., Parissi Z.M., Nastis A.S.

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Herbage production and nutritive value of *Dactylis glomerata* L. and *Trifolium subterraneum* L. alone and in mixture

A.P. Kyriazopoulos, E.M. Abraham, Z.M. Parissi and A.S. Nastis
Laboratory of Range Science (236), Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece
E-mail: apkyr@for.auth.gr

SUMMARY – Herbaceous species, in rainfed pastures of the Mediterranean zone, reach maturity very early in the growing season due to the warm and drought conditions. Introduction of drought tolerant grass and legume species in the appropriate mixture could increase the herbage production and the nutritive value. The objective of this paper was to compare monocultures and replacement series mixtures of *Dactylis glomerata* L. cv. Palestina and *Trifolium subterraneum* L. cv. M. baker and to define which mixture was the most pertinent to achieve higher production and nutritive value. The experiment was conducted on the farm of the Aristotle University of Thessaloniki, Northern Greece. The five planting proportions were monocultures of each species and mixtures at 75:25%, 50:50% and 25:75% (*D. glomerata, T. subterraneum*). The experimental design was a completely randomized block with three replications. *D. glomerata* had a higher yield per individual when grown in mixtures with *T. subterraneum* than in monocultures, whereas the yield per individual of *T. subterraneum* was lower in mixtures with *D. glomerata* than in monocultures. *T. subterraneum* was a consistently weak competitor in relation to *D. glomerata*. Total herbage production of *D. glomerata* was not affected by the mixture, whereas total herbage production of *T. subterraneum* as well as total herbage production independently of plant species was significantly higher in the 25:75% and in the 50:50% mixtures compared to the 75:25%. The nutritive value was slightly higher in the 75:25% and in the 50:50% mixtures compared to the 25:75%.

Keywords: *Dactilys glomerata*, *Trifolium subterraneum*, mixtures, yield, forage quality.

RESUME – *"Production de fourrage et valeur nutritionnelle de* Dactylis glomerata *L. et* Trifolium subteraneum *L. en monoculture et en mélange". Le but de l'étude était l'analyse du comportement social des deux espèces fourragères* Trifolium subteraneum *et* Dactylis glomerata *en monoculture et en mélange, au niveau de la production fourragère et de la valeur nutritionnelle, afin de déterminer l'association d'espèces optimale. Le travail a été réalisé dans la station expérimentale de l'Université Aristote de Thessalonique (Grèce). Le dispositif expérimental était constitué de deux parcelles de monoculture (*Dactylis glomerata *L. et* Trifolium subterraneum *L.) et de trois parcelles de mélange (les deux espèces* T. subterraneum *et* D. glomerata *en mélange : 75:25%, 50:50%, 25:75%). Le dispositif statistique mettait en place des blocs aléatoires avec trois répétitions sur les parcelles des traitements. Les résultats obtenus montrent que le rendement en MS par plante chez le* Dactyle *était plus élevé en mélange qu'en monoculture ; tandis que le contraire survenait chez le* T. subterraneum*, qui semblait être un faible concurrent. Le rendement total en MS chez le* Dactyle *n'était pas affecté par les associations d'espèces ; à l'inverse, chez* T. subterraneum *il était plus élevé au niveau de 25:75% et 50:50%. La valeur nutritionnelle n'était guère élevée au niveau de 75:25%, 50:50%.*

Mots-clés : Dactilys glomerata*,* Trifolium subterraneum*, mélange, production fourragère, qualité fourragère.*

Introduction

Herbaceous species, in rainfed pastures of the Mediterranean zone, reach maturity very early in the growing season due to the drought conditions. Thus, herbage production and forage quality, even early in the summer, can be seriously reduced and be incapable of meeting animal demands for production. Introduction of drought tolerant grass and legume species in the appropriate mixture could increase the herbage production and the nutritive value (Munoz and Weaver, 1999). This is due to the ability of the legumes to fix atmospheric N_2 and to benefit companion grasses by transfer of some of the fixed N_2 (Vallis *et al.,* 1977).

In a grass-legume mixed stand the maintenance of the balance between the two species is of great importance as grasses are, in general, better competitors than legumes. This is closely related with the selected grass and legume species in the mixture. Several annual forage legumes (*Trifolium alexandrinum, Trifolium incarnatum, Trifolium squarrosum, Trifolium subterraneum*) are grown in

mixtures with annual grasses (*Avena sativa, Lolium multiflorum, Lolium rigidum*) in the Mediterranean zone since they can utilize winter rainfall. (Lannucci *et al.,* 2002; Porqueddu and González, 2006). The mixtures of perennial grasses and annual legumes are more complex as the perennial grasses effect on emergence, survival and seed set by annual legumes (Dear and Roggero, 2003). Porqueddu and Maltoni (2005) obtained encouraging results studying mixtures of *Dactylis glomerata* and *Medicago polymorpha*. However, limited information is available concerning the growth of the annual drought tolerant legume species (Watson *et al.*, 1984) *Trifolium subterraneum* in mixtures with the perennial grass *Dactylis glomerata*. Thus, the objective of this paper was to study monocultures and replacement series mixtures of *Dactylis glomerata* and *Trifolium subterraneum* and to define which mixture was the most pertinent to achieve higher production and nutritive value.

Materials and methods

The experiment was conducted in the farm of the Aristotle University of Thessaloniki, Northern Greece (longitude: 40^{o} 34´, latitude: 23^{o} 43´), at an altitude of 10 m above sea-level. The climate of the area according to the bioclimatogram of Emberger (1942) could be characterized as Mediterranean semiarid with cold winters. The mean annual precipitation is 443 mm and the mean annual temperature is 15.5 ^{o}C.

Seeds of *Dactylis glomerata* cv.. Palestina (D.glom) and *Trifolium subterraneum* cv. M. baker (T.sub) were sown individually in jiffy pots full of white peat of medium coarse structure with nutrients and trace elements in high concentration (TKS 2) in September 2005. The seedlings transplanted to 15 plastic pots (30 cm diameter, 30 cm deep) full of grassland soil (0-20 cm) that was collected in August 2005 from the farm of the Aristotle University of Thessaloniki in October 2005. The total planting density was eight plants per pot. Herbage production from every individual plant and from every pot was determined by clipping all vegetation at 1 cm above ground at the end of the growing season (late June) and oven-drying at 65^{o}C for 48 h. This was followed by chemical analysis for crude protein (CP) (AOAC, 1990), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) (Van Soest *et al*., 1991).

A randomized complete block design was used with five competitive replacement series. The five planting proportions were monocultures of each species and mixtures at 75:25%, 50:50% and 25:75% (D.glom:T.sub). Each treatment was replicated three times. Blocks were randomly assigned to a location within the farm and pots were randomized within each block biweekly. General linear models procedure (SPSS 14 for Windows) was used for ANOVA. The LSD at the 0.05 probability level was used to observe the differences among means (Steel and Torrie, 1980).

Results and discussion

Dry matter production of D.glom (Fig. 1A) did not significantly differ among the study mixtures. On the other hand, T.sub (Fig. 1A) had significantly higher dry matter production in the monoculture and lower in the 75:25% (D.glom:T.sub), while there were no significant differences between the 50:50% and the 25:75% mixtures. However, dry matter production per plant of D.glom (Fig. 1B) was significantly higher in 25:75%, followed by 50:50% and lower in monoculture. Conversely, dry matter production per plant of T.sub (Fig. 1B) was significantly higher in monoculture and lower in 75:25%. Regarding the total dry matter production of the three mixtures, this was significantly lower in 75:25% and did not significantly differ between the others (Fig. 2).

These results suggest that T.sub was more productive than D.glom and consequently the mixtures with high proportion of it were also more productive. Additionally, the high proportion of T.sub in the mixtures favored the growth of D.glom's plants. Similar results were report by Usai (1999). On the contrary, T.sub was a consistently weak competitor in relation to D.glom as its dry-matter (DM) weight was strongly inhibited by the presence of D.glom. Similarly, Dear and Cocks (1997) had reported that D.glom had negative effect on early growth and survival of T.sub. It has to be noticed, that although D.glom was in the first year after sowing it was very competitive. It is expected to be more competitive the following years as it reaches its maximum production on the second year after sowing (Abraham and Nastis, 2001). Consequently, 25:75% mixture is suggested as the most suitable, in order to avoid the needing of re-sowing T.sub in the following years.

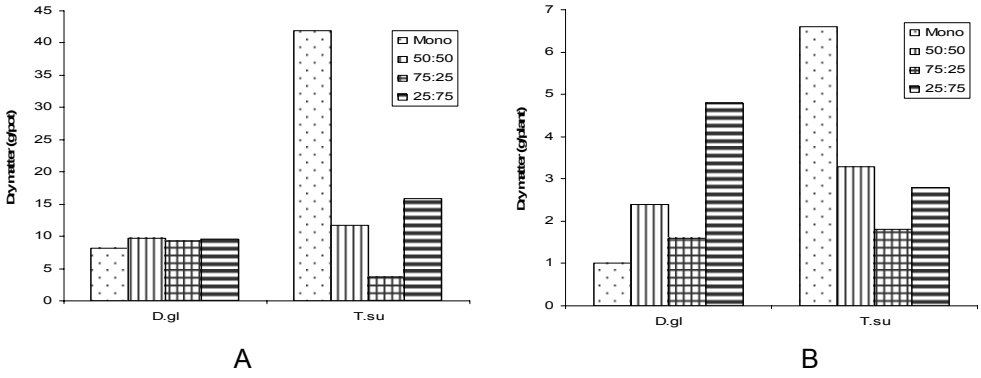

Fig. 1. Dry matter production of D.glom and T.sub in replacement series mixtures A) per pot and B) per individual.

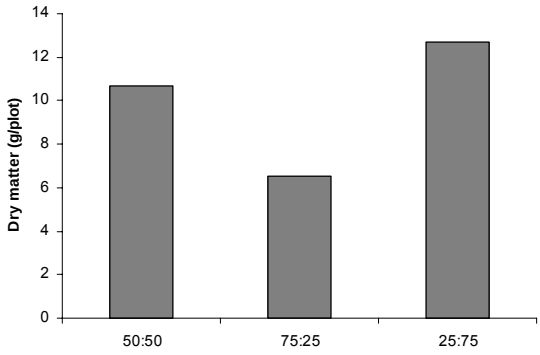

Fig. 2. Total dry matter production in replacement series mixtures per pot.

T.sub monoculture had significantly lower NDF and higher ADL compared to D.glom monoculture (Table 1), while there were no significant differences among the mixtures. On the other hand, crude protein (CP) content decreased as the proportion of T.sub in the mixture increased (Table 1).

Table 1. Chemical constituents (%) of D.glom and T.sub in replacement series mixtures

Chemical constituents	Replacement series mixtures										
	100:0		75:25		50:50		25:75		0:100		LSD
CP	18	c*	17	bc	17	bc	14	a	15	ab	2
NDF	59	b	57	b	60	b	58	b	45	a	7
ADF	34	ab	36	ab	33	a	35	ab	38	b	4
ADL	4	a	4	a	5	ab	5	ab	6	b	1

*Means in the same row within each year followed by the same letter are not significantly different (P≤0.05).

This is probably explained by the fact that D.glom was in the first year after sowing and its forage production consisted mainly by leaves and not by stems. Additionally, T.sub reaches maturity earlier than D.glom in the season. Thus, CP content was slightly higher in the 75:25% and in the 50:50% mixtures compared to the 25:75%. However, these results are of the first year after sowing and more

years of mixtures' observations could be necessary in order to obtained reliable conclusions about the proper mixture proportion.

Conclusions

T. subterraneum was a consistently weak competitor in relation to *D. glomerata*. Total herbage production independently of plant species was significantly higher in the 25:75% and in the 50:50% mixtures compared to the 75:25%, while the mixture affected the nutritive value only slightly. In order to avoid re-sowing of *T. subterraneum* 25:75% is probably the most suitable mixture.

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