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Yield production of two *Trifolium* species at different habitats of a Mediterranean island

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Abstract: Natural and semi-natural grasslands comprise a major part of Mediterranean ecosystems and they are mainly used for livestock grazing. However, legume species are not usually found there, probably due to poor management practices. The present study aimed to evaluate the capacity for establishment of two introduced legumes (*Trifolium michelianum* and *Trifolium subterraneum*). The two species were introduced at two different habitats, an abandoned field (AF) and an olive grove (OG) on the island of Lesvos, both destined for sheep grazing. The above ground dry matter biomass produced was measured for two years. The above ground dry matter biomass of *T. michelianum* and *T. subterraneum* did not significantly differ at both habitats the first year. On the contrary, the above ground biomass on average (across the species) was significantly higher at the OG compared to the AF the second year. *T. subterraneum* had significantly higher production than *T. michelianum* at the OG, while their production did not significantly differ at the AF. In the second year, biomass production of both species declined at both experimental areas. It seems that *T. michelianum* is more robust in its adaptation to different habitats, while *T. subterraneum* response is more susceptible to habitat characteristics.

Keywords: Legumes – Mixtures - Biomass production - Agropastoral systems.

Rendement productif de deux espèces de* Trifolium *dans différents habitats d'une île de la Méditerranée

Résumé: *Les prairies naturelles et semi-naturelles comprennent une grande partie des écosystèmes méditerranéens et sont principalement utilisées pour le pâturage du bétail. Cependant, on n'y trouve généralement pas les espèces de légumineuses, probablement en raison de mauvaises pratiques de gestion. La présente étude visait à évaluer la capacité d'établissement de deux légumineuses introduites (*Trifolium michelianum *et* Trifolium subterraneum*). Les deux espèces ont été introduites dans deux habitats différents, un champ abandonné (AF) et une oliveraie (OG) sur l'île de Lesbos, tous deux destinés au pâturage des moutons. La matière sèche de la partie aérienne de la biomasse produite a été mesurée pendant deux ans. La matière sèche de la partie aérienne de la biomasse de* T. michelianum *et* T. subterraneum *ne différait pas significativement dans les deux habitats pour la première année. Au contraire, la biomasse au-dessus du sol (en moyenne pour les espèces) était significativement plus élevée dans l'OG par rapport à l'AF pour la deuxième année.* T. subterraneum *avait une production significativement plus élevée que* T. michelianum *dans l'OG, alors que sa production ne différait pas significativement dans l'AF. Dans la deuxième année, la production de biomasse des deux espèces a diminué dans les deux zones expérimentales. Il semble que* T. michelianum *soit plus robuste dans son adaptation aux différents habitats, tandis que la réponse de* T. subterraneum *est plus sensible aux caractéristiques de l'habitat.*

Mots-clés: *Légumineuses – Mélanges – Production de biomasse – Systèmes agropastoraux.*

I – Introduction

Natural and semi-natural grasslands comprise a major part of the Mediterranean habitats and they are mainly used for grazing (Cosentino *et al.*, 2014; Perevolotsky, 2005). At recent decades overexploitation of grasslands has been observed as the demand for animal products increased due to changes in consumers' choices. Forage legumes adapted to a wide range of soil types, climatic conditions and management systems, are expected to become increasingly

important components of sustainable agricultural production systems in Europe. In Mediterranean regions, the commercial pasture seed mixtures commonly consist of a small number of annual legume species, few subclover varieties etc (Maltoni *et al*., 2006).

During the last decades the annual self-reseeding legumes, mainly subclovers and annual medics, have been increasingly utilized in the Mediterranean areas for the improvement of low quality native pastures, in agropastoral systems (Porqueddu and Maltoni, 2006). Farmers usually don't prefer the establishment of pure legume swards. They establish them in mixture with grasses or cereals in order to ensure satisfactory biomass production rich in carbohydrates, but with adequate protein content (Abbas *et al*., 2014). The introduction of legumes may positively influence the botanical composition of grasslands and nutritive value of produced forage, improve forage quality and add fixed nitrogen (N) to grasslands, which decreases the need for mineral N (Komárek *et al*., 2007).

Lesvos island in the North-East Aegean has a long tradition in sheep farming towards the production of Protected Designation of Origin cheeses (Hadjigeorgiou *et al*., 1996). However, grasslands of the island are of poor productivity and often in need for restoration (Hadjigeorgiou *et al*., 2009). The objective of the present study was to evaluate the capacity of two introduced legume species (*Trifolium michelianum* and *Trifolium subterraneum*) to thrive and persist at two different but typical Mediterranean habitats on Lesvos island.

II - Materials and methods

The experiment was conducted at two different habitats on the island of Lesvos, North east of Greece. These were: (i) an abandoned field (AF) for several years (at 76 m. a.s.l.) which has never been irrigated and mainly used for sheep grazing and occasionally for horses; and (ii) a cultivated olive grove (OG) (at 3 m. a.s.l.) as an agropastoral ecosystem. The climate of the study area is classified as subhumid (Mavromatis, 1980): mild and dry autumn, cool and slightly rainy winter, wet spring, hot and dry summer. Region belongs to the Oleo-ceratonion vegetation zone. The average annual rainfall during study period was 907.6 mm, while mean air temperature over the year was 16.3^{o}C.

The two fields were fenced in order to prevent unplanned animal grazing during the experimental period for two consecutive years 2014-15. After the end of the growing season both fields were grazed by sheep. Each experimental field was divided into three plots depending on vegetation distribution in each field. Plot size was of 0.05 ha at the AF and of 0.07 ha at the OG, respectively. Both fields were ploughed in late November 2013, after the first rainfall. Drill seeding was made in the AF on an area of 0.6 ha. In the OG direct sowing has been made by hand on an area of 0.4 ha. The seeds mixture used in the two cases, was: a) at the AF: *T. subterraneum* (cv Seaton Park - 5 kg/ha), *T. subterraneum* (cv Woogenellup - 7.5 Kg/ha) and *T. michelianum* (cv Paradana - 17.5 kg/ha) b) at the OG: *T. subterraneum* (cv Dalkeith - 9.3 kg/ha), *T. subterraneum* (cv Antas - 13.5 kg/ha) and *T. michelianum* (cv Paradana - 37.1 kg/ha).

Forage production was measured by harvesting the above ground biomass when the inflorescence percentage of sowed species was at least at 50-60%. This was made in order to ensure satisfactory combination between biomass production and nutrient contents. Three samplings quadrats of 0.5 m x 0.5 m were used in each of the experimental plots. After that, above ground biomass of *Trifolium* species was separated from the herbage production of native vegetation and oven-dried at 50 ^{o}C for 48 h.

For all measured parameters differences between the biomass productions were calculated using two-way ANOVA (Steel and Torrie, 1980). All statistical analyses were performed using the GenStat v.11 application. The LSD at the 0.05 probability level was used to detect the differences among means (Steel and Torrie, 1980).

III - Results and discussion

The above ground dry matter biomass of *T. michelianum* and *T. subterraneum* did not significantly differ at both habitats the first year (Fig 1). However, *T. michelianum* tended to produce more at the AF than *T. subterraneum* and less at the OG respectively. The above ground biomass on average (across the species) was significantly higher at the OG compared to the abandoned field (Table 1) the second year. The two species responded differently in terms of forage production at the two habitats during the second year. *T. subterraneum* had significantly higher production than *T. michelianum* at the OG, while their production did not significantly differ at the AF (Fig 1).

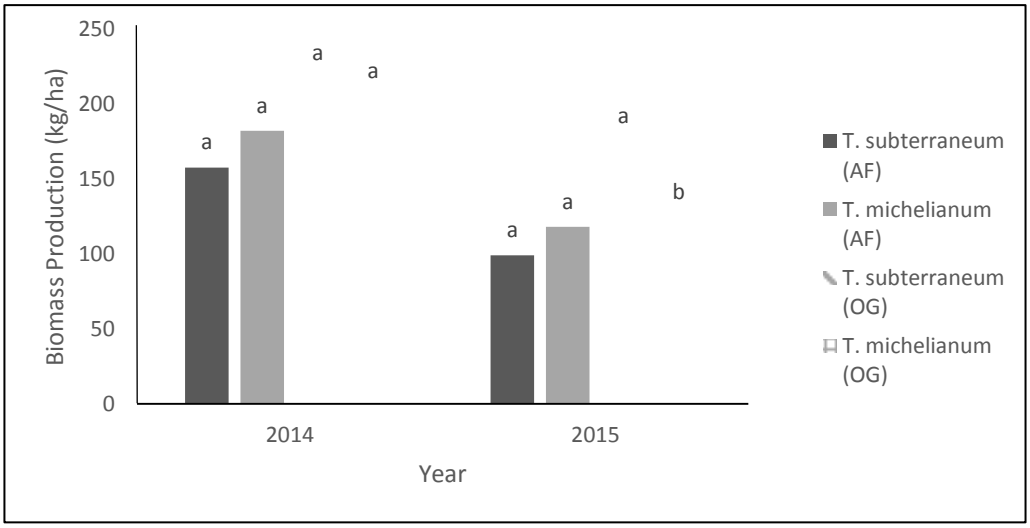

Fig. 1. Above ground dry matter biomass production (kg/ha) of *T. michelianum* and *T. subterraneum* in both habitats for the two experimental years. *Means followed by the same letter in each year and habitat are not significantly different (P≥0.05).

Additionally, there was a general reduction of biomass production from the first year to the second for both species. Yield decline rate was slightly higher at the abandoned field (AF) compared to that at the olive grove (OG) (Table 1).

Table 1. The above ground biomass production of the two habitats (across species) and proportional changes within two years

	2014	2015	Change (kg)	Rate (%)
Abandoned Field (AF)	170a	108b	62	-36.4
Olive Grove (OG)	211a	150a	61	-28.9

*Means of each parameter followed by the same letter in the column are not significantly different (P≥0.05)

Although, the native vegetation density was high in both areas (data not shown) and the climate conditions are expected to have a strong effect at this expansion, the introduced species had a good response to their habitat adaptation. Habitat has the major role in species growth. The main environmental factors affecting growth and herbage production are temperature, light as well as soil nutrients and moisture (Hopkins, 2000). Legumes are strongly influenced in this respect by environmental stress factors (Kadžiulienė and Kadžiulis, 2007). Apart from that,

adaptation of each introduced species depends on its special characteristics. For example, it is well known that *T. subterraneum* is a shade tolerant species (Koukoura *et al*., 2009; Bellon, 1995) therefore it can thrive well under olive trees.

IV – Conclusion

Both introduced species had higher biomass production at the olive grove, although their production was less in the second year. However, it seems that *T. michelianum* is a lesser habitat dependent species, while *T. subterraneum* is much more influenced by its habitat, taking also into account its tolerance to shading. Further monitoring could confirm these responses.

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