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Establishment and growth of seeded *Dactylis glomerata* in a *Pinus pinaster* silvopastoral system

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Summary: The idea of thinning forest stands with a well established cover of understory vegetation has gained ground recently. In a 17 years-old *Pinus pinaster* plantation, established at a density of 1200 trees/ha in a semi-arid mediterranean environment of Macedonia, Greece, three degrees of thinning (control, 50% and 75% of trees removed), two levels of fertilization (control and 1000kg/ha of NPK fertilizer) were applied. All the stands were seeded with 30kg/ha *of Dactylis glomerata* seed. Measurements included light intensity under trees canopy, density of *Dactylis glomerata* plants and herbage production. It was found that fertilization favoured the *Dactylis glomerata* growth and *Dactylis glomerata* was better established in low and in medium density stands with light intensities higher than 20%.

Key-words: Dactylis glomerata, Pinus pinaster, establishment, density, thinning.

INTRODUCTION

Silvopastoralism is a common land use system in the Mediterranean region involving the co-existence of trees and pasture. Pine silvopastoral systems may be improved if shade tolerant grass species are introduced. Such an introduction could provide better quality forage over an extended period for both livestock and wildlife and contributing at the same time to the soil organic matter build up. In the warm coniferous forests, the relatively high tree density results in increased competition for water and depression of the understory vegetation (Liacos, 1986). Thinning forest stands with a well established cover of understory vegetation to create conditions for supporting grazing animals has gained ground recently (Liacos 1986, Dupraz 1992, Dreyfus 1992). The initial establishment by seeds is the first problem of any species that has to survive on the forest floor. According to Crawford (1989), forest floor provides a predictable environment with many compensations for low-light intensities and where once established long-term survival is reasonably assured.

The objective of this paper was to investigate the establishment and growth of Dactylis glomerata under a Pinus pinaster canopy.

MATERIALS AND METHODS

The study was carried out in Kilkis, central Macedonia, northern Greece, in a 17 years-old Pinus pinaster plantation. Stand density was 1260 trees/ha. No silvicultural treatments were applied on the plantation since its establishment. Mean annual precipitation of the area in 505 mm, mean annual temperature 13 °C and mean minimum temperature of the coldest month below zero thus indicating a semi-arid mediterranean climate with cold winters (Le Houerou 1981). The soil is developed in metamorphic rocks (schists) and is shallow, with a sandy loam texture and acid.

The experimental layout was a split plot design with two replications. It included three degrees of thinning as whole plots: control (dense stands), 50% of the trees removed (medium stands) and 75% of the trees removed (low stands), and two fertilization levels as sub-plots: control and application of 1000 kg/ha of NPK fertilizer of the type 11-15-15.

The thinned stands were established in early spring 1989. Fertilization was applied in early April; then 30 kg/ha of the Greek cultivar "Chrysopigi" of *Dactylis glomerata* were also broadcasted on all experimental plots.

Light intensity was measured by a Lico quantum sensor (Li 190 SB). Ten systematic measurements were taken in each plot, on 10 permanent by placed sticks, on sunny days (Eber 1971a) every 30 days during the growing season. The average value of the understory light intensity in each plot was finally expressed as percent of the open area light intensity.

Measurements of the understory herbaceous plant density (number of plants/m²) were taken in May 1990 with 0.50 x 0.50 m quadrats applied on the 10 permanent sticks in each plot. Besides *Dactylis glomerata*, two other groups were separated: other grasses and forbs (broadleaves plants). Herbage production measurements were taken in June 1990 with the same way as the herbaceous plant density. Herbage production samples were weighed at the laboratory after ovendrying at 70 °C.

Data were subjected to analysis of variance. All tests were done at the 0.05 probability level.

RESULTS AND DISCUSSION

Very few seedlings of the seeded *D. glomerata* appeared by the end of the first growing season apparently due to the late sowing (April). On the contrary, spontaneous vegetation was established quite abundantly during the same period but only in the widely opened stands (low density).With the advent of the new (second)growing season after the autumn rains in 1989, seedlings of *D. glomerata* appeared now and then and especially in the medium and low density stands. This establishment became more apparent in the following spring when *D. glomerata* started to dominate the understory herbaceous cover. Actually, it was the only understory species in most stands. It was interesting to observe that seedling were established in a patchs pattern, namely in small depressions of the ground apparently due to the increased soil moisture and on shaded areas. Later in the season, the understory cover were uniform.

The analysis of variance showed that the density of the understory herbaceous plants was dependent of stand density (F=13.6, p=0.001) and independent of fertilisation.

Densities of seeded grass *Dactylis glomerata* was higher in all stand densities (LSD= 62.01) as compared to the other group species (fig.1). In the medium and low density stands no significant differences were observed in the number of individual plants, of *Dactylis glomerata* but both of them had higher density than the control (dense stands). No significant differences were observed in all old stand densities between other group species (other grasses and forbs).

In Table 1, the average mean light intensity (% of the open area) during the growing season in the stand densities is shown. Light intensity was significantly higher in the low and medium density stands than in the control.

In Table 2, the average mean of understory production (kg/ha) in the stand densities under fertilization is shown. The analysis of variance showed that herbage production was depended of stand density (F=21.48, p=0.001) and fertilization (F=29.5, p=0.001) with a significant interaction between these two factors (F=3.9, p=0.05). Herbage production in the low and in medium stand densities was higher (LSD= 399.7) than that in the control. Fertilisation increased the herbage production in both stand densities with significant differences between them.

According to Coyne and Bradford (1985) successful establishment of forage grasses from seed depends on numerous environmental factors which interact with the plant's genetic component during germination, emergence and post-emergence growth. Establishment by seeds of a good stand the first growing season is critical to continued persistence (Watson et al. 1984).

The tree leaf canopy alone is capable of preventing germination in a number of small seeded species (Taylorson and Borthwick 1969, King 1975, Silvestown 1980). This may be due to a reduction in the ratio of red (R660) to far -red (FR730) radiation. Cumming (1963) offered evidence that germination would be restricted on heavily shaded sites.

In open or thinned forests, however, the negative effects of trees canopy seem to be offset. Noitsakis et al. (1993) studied the effects of thinning on the internal water status of *Pinus brutia* understory herbaceous vegetation and found that it was not affected apparently because it has the ability of reducing water loss. On the other hand, Maranon and Bartolome (1994) have found that *Dactylis glomerata* was favoured by a reduction in the early summer drought stress under oak trees. Braziotis (1992) working in the same experimental area, has found that soil water content (%) at 0-10 and 10-20 cm depths was higher in the low and medium density stands than in the control during the growing season. Our results are in agreement with all these reports and suggest that the better establishment of *Dactylis glomerata* in low and medium density stands could be due to their better conditions in light intensity and soil moisture content. It seems that light intensity lower than 20% negatively affect the *Dactylis glomerata* establishment and growth even with fertilisation.

Table 1: Means of light intensity (% of the open area) in the different stand densities at the end of the growing season in fertilised plots and the control

	Stand density		
Treatments	**Control (dense stand)**	**Medium density (50% of trees removed)**	**Low density (75% of trees removed)**
Fertilisation	6.72	25.67	40.80
Control	13.55	32.83	46.98

LSD = 8.22

Table 2: Means of herbage production (kg/ha) in the different stand densities at the end of the growing season in fertilised plots and the control

	Stand density		
Treatments	**Control (dense stand)**	**Medium density (50% of trees removed)**	**Low density (75% of trees removed)**
Fertilisation	6	807	1738
Control	2	295	472.4

LSD = 399.7

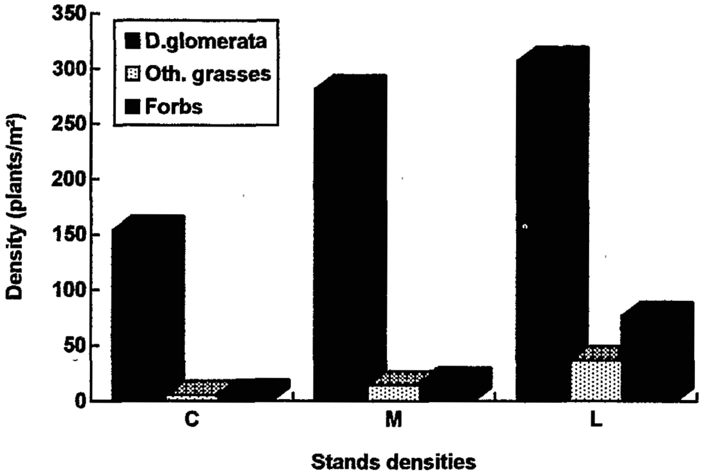

Figure 1: Means of herbaceous plants density (number of plants/m²) in stand densities (Control = C; Medium density = M; Low density = L) at the end of the growing season.

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