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in

Porqueddu C. (ed.), Tavares de Sousa M.M. (ed.).
Sustainable Mediterranean grasslands and their multi-functions

Zaragoza : CIHEAM / FAO / ENMP / SPPF

Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 79

2008

pages 375-378

Article available on line / Article disponible en ligne à l'adresse :

<http://om.ciheam.org/article.php?IDPDF=800679>

To cite this article / Pour citer cet article

Zoghلامي Khélil A., Ben Youssef S., Ben Salem H., Hassen H. **Effect of the seeding rate on yield components and regeneration of a local variety of *Scorpiurus muricatus* L. in the semi-arid conditions of Tunisia.** In : Porqueddu C. (ed.), Tavares de Sousa M.M. (ed.). *Sustainable Mediterranean grasslands and their multi-functions* . Zaragoza : CIHEAM / FAO / ENMP / SPPF, 2008. p. 375-378 (Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 79)



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Effect of the seeding rate on yield components and regeneration of a local variety of *Scorpiurus muricatus* L. in the semi-arid conditions of Tunisia

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SUMMARY – With the aim of promoting *Scorpiurus muricatus* L. cultivar 'Haffouz' recently released at INRAT, we studied three seeding rates (25, 50 and 100 kg pods/ha) in comparison with a conventional rate of 12.5 kg scarified seeds/ha. The trial was conducted during two consecutive years (2006 and 2007) in Tunis in randomized blocks with three replications. The following aspects were determined: number of regenerated plants, pod yield, thousand seed weight, seed number, crude protein content and other reproductive traits such as racemes, flowers, leaves, internodes and branching number, length of longest stem and leaf to stem ratio. A significant effect of the seeding rate was observed, only during the second year, on pod yield, seed weight, regenerated plants, racemes and leaves number per longest stem, leaf to stem ratio and length of longest stem. An important year effect was observed on pod yield, seed weight and regeneration. The trial will continue for a third year.

Key words: *Scorpiurus muricatus* L., seed rate, regeneration, yield components, semi-arid.

RESUME – "Effet de la dose de semis sur les composantes du rendement et la régénération d'une variété locale de *Scorpiurus muricatus* L. dans les conditions semi-arides de la Tunisie". Dans le but de promouvoir le cultivar Haffouz de *Scorpiurus muricatus* L., variété nouvellement inscrite à l'INRAT, nous avons étudié trois doses de semis (25, 50 et 100 kg gousses/ha) en comparaison avec une densité conventionnelle de 12,5 kg/ha de semences scarifiées. L'essai a été conduit en sec à Tunis pendant deux années consécutives (2006 et 2007). Le protocole expérimental étant en blocs aléatoires complets à trois répétitions. Les paramètres mesurés sont : le nombre de plantes régénérées en automne, le rendement en gousses, le poids de 1000 graines, le nombre de graines par gousse, la teneur en protéine ainsi que d'autres paramètres tels que le nombre de fleurs, d'inflorescences, de feuilles, de ramifications et d'entre-nœuds, la longueur de l'axe le plus développé et le rapport feuilles sur tiges. Un effet significatif de la dose de semis a été observé uniquement en deuxième année sur le nombre de plantes régénérées en automne, le rendement en gousses, le poids de 1000 graines, le nombre d'inflorescences et de fleurs, le rapport feuilles sur tiges et la longueur de l'axe le plus développé. Un effet année important a été observé sur le rendement en gousses, le poids des graines et la régénération. L'essai sera poursuivi pour une troisième année.

Mots-clés : *Scorpiurus muricatus* L., densité de semis, régénération, composantes du rendement, semi-aride.

Introduction

The genus *Scorpiurus* is widespread in Tunisia. It represents a diversified phylogenetic patrimony. Species of this genus are appreciated by animals and may play an important role in rangeland improvement and fallows production (Ben Salem *et al.*, 1998). In addition to their forage and pasture potential, they would contribute to soil fertility through their nitrogen fixation and self-regeneration aptitude (M'hammed, 1989; Yahiaoui-Younsi *et al.*, 2000). The first cultivar's 'Haffouz' of *Scorpiurus muricatus* L. released in Tunisia, was selected among a local germplasm collected in central Tunisia and evaluated in two locations of arid and semi-arid bio-climates. In Tunisia, the species grows spontaneously on clay soils and low altitudes (Hassen *et al.*, 1994) and under various climates in Algeria (Ben Salem *et al.*, 1998). However, there is no information on the appropriate technical itinerary intended for *Scorpiurus muricatus* L. cropping. Farmers consider the rate of sowing the hardest aspects to control before the adoption of any pasture crop. Therefore, the objective of this study was to evaluate the effect of seeding rate on pod yield and its components as well as on the regeneration aptitude of this cultivar's grown under semi-arid conditions in Tunisia.

Material and methods

The trial was conducted under rainfed conditions in Tunis, at INRAT experimental field on clay soil, using the cultivar's 'Haffouz' of *Scorpiurus muricatus* L. The climate at Tunis is semi-arid with an average annual rainfall of 450 mm compared to 497 mm and 690 mm respectively, for experimental years 2006 and 2007. Three seeding rates, 25, 50 and 100 kg pods/ha were used and compared to a conventional rate of 12.5 kg/ha of scarified seeds. The experimental design was a randomized blocks with three replications. Plots were constituted by 6 rows, 2 m long and 30 cm apart and sown by hand in November 15th 2005. In 2006 and 2007, plants have naturally regenerated from pods left on soil surface after yield sampling. A 100 kg/ha of super phosphate was applied during the first year and weeds were removed by hand when necessary.

Field measurements

For both years, agronomic traits such as pod yield, seed weight, seed number per pod and regenerated plants were evaluated at pod maturity. Pod yield was determined by sampling from 40 x 40 cm quadrates on each plot. Seed weight and seed number were determined on 20 pods sampled randomly from each plot. At end autumn of each year, we determined the number of regenerated plants by sampling from 40 x 40 cm quadrates in each plot.

For second year only, the aboveground biomass was assessed by sampling from 40 x 40 cm quadrates from each plot to determine the dry matter yield at flowering time. In addition, five plants were removed from each plot to determine plant weight and height, branching, racemes, leaves, flowers and inter nodes number for longest stem as well as the length of longest stem. Mean values were then registered for these parameters. Leaf to stem ratio was also determined for each plot.

Chemical analysis

In the second year, from the harvested above ground biomass, a sample of 500 g per plot was dried at 50°C during 72 hours, then ground to pass through a 1 mm screen and stored until analyzed for ash and crude protein contents of biomass and pods.

Statistical analysis

For both years, data on agronomic parameters (pod yield, seed weight, seed number and regenerated plants) were submitted to analysis of variance (SAS, 1998). For the second year only, reproductive and chemical parameters as above mentioned were analyzed with ANOVA procedure of SAS Software (SAS, 1998). Differences between mean values were tested for significance using little significant difference test.

Results

Effect of seeding rate on agronomic traits

Among the four agronomic traits, only the seed number per pod was not affected ($P>0.05$) by the seeding rate during the second year (Table 1). The other three parameters were highly affected by seeding rate only in 2007. The regenerated plants reached the highest and lowest values with rates of 100 and 50 kg pods/ha (712 plants/m² vs 225 plants/m² respectively). The rate of 100 kg pods/ha induced a number of regenerated plants not significantly different from that obtained with 12.5 kg scarified seeds/ha (575 plants/m²). Pod yield ranged between 1200 and 640 g/m² for seeding rates of 100 and 25 kg pods/ha respectively, and seed weight ranged between 12.7 and 10 g for seeding rates of 25 and 50 kg pods/ha respectively.

Effect of seeding rate on dry matter yield and crude protein content

Seeding rate had no significant effect on dry matter yield and crude protein content ($P>0.05$). Dry

matter yield was about 5 t/ha for both rates of 50 and 100 kg pods/ha whereas crude protein content ranged between 22% for biomass and 20% for dry pods.

Table 1. Means of agronomic parameters measured during 2006 and 2007 for each seeding rate

Parameters/ Seeding rate	Pod yield (g/m ²)	Regeneration (plants/m ²)	1000 seed weight (g)	Seed number
Year 2006				
25	183.3a	118.7 a	13.7a	7.83a
50	183.3a	181 a	13.7a	7.83a
100	366.7a	191.7 a	14a	9.83a
12.5*	287.6a	154 a	13.3a	9.8a
Year 2007				
25	1217.3a	334 bc	12.7 a	7.7a
50	616.5b	225 c	10 b	7.5a
100	644.8b	718.7 a	11.3 ab	7.6a
12.5*	484b	574.7 ab	10.7 ab	7.9a
Effect of year	**	**	**	NS
LSD (0.05)	549.6	332.0	2.4	5.43

*kg scarified seeds; means in the same column with different letters are not significantly different at P<0.05.

Responses of reproductive and qualitative traits to seeding rate

The response of reproductive traits was higher for the length of longest stem, leaves, racemes and flowers number (Table 2). These parameters were highest with 100 kg pods/ha and similar to those obtained using 12.5 kg scarified seeds/ha. The leaf to stem ratio was highest (0.97) with 25 kg pods/ha and lowest (0.75) with 100 kg pods/ha (Table 2). Significant correlations have been found between pod yield and racemes number ($r = -0.61$; $P < 0.05$; $n = 12$); between length of main stem and the traits such as racemes number ($r = 0.5$; $P < 0.05$; $n = 12$), internodes number ($r = 0.8$; $P < 0.01$; $n = 12$) and flowers number ($r = 0.87$; $P < 0.01$; $n = 12$) and between regenerated plants and seed weight ($r = -0.59$; $n = 24$).

Table 2. Analysis of variance for some traits measured during 2007 for each seeding rate

Parameters/ Seeding rate	Number of racemes by longest stem	Length of longest stem	Number of leaves by longest stem	Leaf to stem ratio
25	20.2 b	49.3 b	16.27 bc	0.97 a
50	30.07 b	54.87 ab	14.27 c	0.87 ab
100	50.5 a	77.9 a	21.87 a	0.75 b
12.5*	49.3 a	68.5 ab	19.9 ab	0.90 ab

*kg scarified seeds/ha; means in the same column with different letters are not significantly different at P<0.05.

Effect of year on agronomic traits

As shown in Table 1, the effect of year was clearly demonstrated for pods yield, regeneration and seed weight. The first two traits marked an increase from 2006 to 2007 while the third parameter declined. This was probably due to the high rainfall of spring and autumn 2007 (100 and 108 mm, respectively) which enhanced the pod production and regeneration. It is worth to note that rainfall in 2007 was more regular than in 2006.

Discussion and conclusions

This study showed that increasing seeding rate affected pod yield and its components only in second year where rainfall was above 500 mm. However, increasing seeding rate from 25 to 100 kg pods/ha resulted in decreased pod yield and decreased seed weight but has increased the natural regeneration of this cultivar's (720 seedlings/m²). This seedling density seems to be low compared to the required density of 1000 seedlings/m² suggested by Loi *et al.*, (2005) for pasture legumes. We also noted that both rates of 100 kg/ha pods and 12.5 kg/ha scarified seeds gave a similar number of regenerated plants. For that, it is practical to use 100 kg/ha of pods as the machineries for threshing pods are scarce or absent at farm level. We found also that plants sown at 12.5 kg scarified seeds/ha produced significantly more racemes and flowers than those sown at 25 kg pods/ha.

In conclusion of this study, it is suggested to use 100 kg of pods/ha in order to ensure an optimum growth and re-establishment of the cultivar's 'Haffouz' of *Scorpiurus muricatus* L. This also allows the crop to compete vigorously with weeds and to provide an early feed for animals. But to achieve an optimum pod yield which is important for the persistence of the pasture, it is recommended that farmers use the economical sowing rate of 25 kg pods/ha. This is also recommended for an optimum seed production. We suggest that the response of ruminants to this crop should be investigated.

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