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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 199-202

Effect of the environmental conditions on different morphological and agronomical characteristics of sainfoin

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SUMMARY – Morphological and agronomical characteristics of 45 Spanish sainfoin (*Onobrychis viciifolia* Scop.) entries grown at 3 locations of different altitude under irrigated or non-irrigated conditions in the NE of Spain were compared. Height, number and diameter of stems per plant, number and dimensions of leaflets per leaf, number of inflorescences per plant and forage production as well as flowering evolution in springtime were evaluate on individual plants. Most morphological and productive parameters of plants were reduced when grown in rainfed compared to irrigated areas. Dry matter yield per plant ranged from 153.7 g in rainfed to 557.2 g in irrigated land, similarly distributed in a 67, 21 and 11% for the first three cuts. Flowering and cutting dates seem to be affected by altitude.

Keywords: *Onobrychis viciifolia* Scop., rainfed land, irrigated land, altitude, dry matter yield.

RESUME – *"Effet des conditions environnementales sur différents caractères morphologiques et agronomiques du sainfoin". Les caractères agronomiques et morphologiques de 45 souches espagnoles de sainfoin ont été comparés sur un site irrigué et deux sites sans irrigation du nord-est de la péninsule Ibérique. La hauteur, le nombre de tiges par plante, le diamètre des tiges, le nombre de folioles par feuille, la longueur et la largeur des folioles, le nombre d'inflorescences par plante et la production de foin ainsi que l'évolution de la floraison au printemps furent évalués sur les plantes individuellement. L'absence d'irrigation entraîna une diminution de la plupart des critères morphologiques et de production. La production annuelle de matière sèche par plante fut de 153,7 g sans irrigation et de 557,2 avec irrigation. La répartition fut similaire : respectivement 66,.9, 21,4, 11,7% lors de la première, deuxième et troisième coupe sans irrigation, et 67,2, 19,4, 9,9, 3,5% lors de la première, deuxième, troisième et quatrième coupe sous irrigation. L'altitude affecte les dates de floraison et de coupe.*

Mots-clés : Onobrychis viciifolia *Scop., terrain non irrigué, terrain irrigué, altitude, production de matière sèche.*

Introduction

Sainfoin (*Onobrychis viciifolia* Scop.) is a perennial forage legume, very appreciated by farmers and breeders due to its rusticity, ability to restore soil fertility, feeding value and non-bloating properties (Delgado *et al*., 2002). This species prefers sub-humid, cold semiarid, calcareous and scarcely fertile soils above 600 m altitude in the Iberian Peninsula (Buendía Lázaro and García Salmerón, 1965). While there are not Spanish commercial varieties available, local landraces show differences in their morphological characters, growth habit, ability to flower in the sowing year and persistence (Michelena and Hycka, 1988).

Environmental conditions could also affect the morphological and agronomical characteristics of plants as well as their dry matter yield and distribution along the year as proved in other leguminous species like lucerne (Delgado, 1986). The evaluation of agronomical condition effects on the variation range of those characteristics could contribute to a better knowledge of sainfoin for future breeding programmes. This led us to explore to which extent the morphological and agronomical characteristics of a collection of local entries sainfoin could be altered when grown in different environmental conditions.

Materials and methods

Forty-five Spanish entries of sainfoin coming from the northeast of the Iberian Peninsula (Delgado

et al., 2002) were studied at three locations of different altitude under irrigated (Zaragoza) or non irrigated (Latre and Lagueruela) conditions during 2004. Climate and soil data are presented in Table 1.

Table 1. Climate and soil data for the three locations

Location	Lagueruela	Latre	Zaragoza
Longitude	41º 3' N	42º 25' N	41º 45' N
Latitude	1º 11' W	0º 28' W	0º 47' W
Altitude m	1066	698	225
Maximum mean temperature ºC	15,6	18,2	20,6
Minimum mean temperature ºC	7,8	4,5	8,6
Absolute minimum temp. ºC	-4	-9,7	-4,2
Annual rainfall mm	456	536,5	381,6
Texture	Clay-loam	Loam	Silty-loam
Water pH 1:2,5	8.11	8.15	8.26
Salinity CE 1:5 dS/m	0.24	0.21	0.41
Organic matter %	1.69	1.75	1.39
Phosphorus Olsen mg/Kg	8.38	7.03	4.16
Potassium (Ammonium acet.)mg/Kg	148	120	190

In 2002, three replicates of 12 plants/entry were sowed by direct drilling on a planting frame of 0.3 x 1 m and 0.5 x 1 m in non-irrigated or irrigated conditions, respectively.

In 2004, the following parameters were evaluated: Flowering evolution till first cut in springtime; height, number and diameter of stems per plant, number and dimensions of leaflets per plant, number of inflorescences per plant and number of flowers per inflorescence in all cuts; dry matter yield and its distribution all along the year.

Morphological characteristics and dry matter yield were evaluated on 30 plants chosen at random. Plant height was measured from the base where most stems came out. The number of stems per plant was counted, the 3 most developed ones removed and the diameter at their base and number of inflorescences per stem recorded. The leaf and inflorescence at the first flowering knot were removed from those three stems. The number of leaflets per leaf was counted and the length and width of two intermediate leaflets measured. The number of flowers present in each inflorescence was recorded as well. The average data obtained from three stems were used for comparison between locations. The forage produce per plant was collected, weighed and at 60ºC until constant weight. Data were compared by a variance analysis by the ANOVA procedure and the LSD test, both with the SAS statistical package (1998).

Results and discussion

The evaluations made on 30 plants in the four cuts carried out at the three locations considered are given in Table 2.

Altitude affected the start of flowering and cutting dates. The start of flowering in the first productive cycle took place on 6 April at Zaragoza, 6 May at Latre and 20 May at Lagueruela. The date when 50% of the stems showed open flowers at the lowest half of the flowers stem (full flowers stage) was established for each entry. As different entries did not take longer than 8 days to reach a full flower stage, the plants were harvested at each location when most of them were at this phenological state. The flowering stage was assessing by visual estimation for the following cuts.

Table 2. Mean results from 30 sainfoin plants, in four cuts at three locations from Aragón in 2004

Cut Location (date)	Phenolog. state	g DM plant^{-1}	Height cm	Stems plant^{-1}	Diameter mm	Inflor. stem^{-1}	Flowers inflor^{-1}	Leaflets leaf^{-1}	Leaflet length	Leaflet width	Width length.$^{-1}$
1st cut											
Zaragoza (21.05)	PF-FF	374 a	105.4 a	55.5 a	7.5 a	6.6 a	50.6 a	12.2 a	26.3 a	8.9 a	0.34 a
Latre (2.06)	PF-FF	102.8 b	96.8 b	29.8 b	6.5 b	4.4 b	56.3 a	10.5 b	25.8 a	7.7 b	0.30 b
Lagueruela (15.06)	PF-FF	101.1 b	92 b	48 a	6.1 b	3.9 b	51.6 a	10.8 b	23.9 b	6.8 c	0.28 b
Significance		***	**	***	***	***	NS	***	*	***	***
2nd cut(1)											
Zaragoza (21.06)	FF	108.2 a	64.2 a	54.5 a	3.9 a	4.3 a	37.1 a	8.3 a	23.6 a	6.7 a	0.29 a
Latre (1.07)	FF-SV(3)	32.9 b	55.4 b	21.6 b	3.1 b	3.3 b	29.9 b	7.2 b	22.6 a	6.2 a	0.28 a
Significance		***	**	***	***	***	*	**	NS	NS	NS
3rd cut (2)											
Zaragoza (23.08)	V-SV	55.4	48.5	34.1	3.4	3.6	15.6	8.3	24.6	6.8	0.28
4th cut(1)											
Zaragoza (21.10)	V	19.6 a	23.7 a	0	0	0	0	9.5 a	19.7 a	8.9 a	0.45 a
Latre (19.10)	V-SV(4)	18 a	22.9 a	12.3	3.1	2.3	9.8	7.2 b	20.5 a	7 b	0.34 a
Significance		NS	NS	-	-	-	-	***	**	***	***

(1) = Evaluation from Lagueruela lost by accident; (2) = Only in irrigated land (Zaragoza); (3) = 28 plants flowered; (4) = 4 plants flowered; V = No flowering; PF = Full flowering; FF = End of flowering; SV = Green seed; MS = Dry matter; NS = P>0.05; * = P<0.05; ** = P<0.01; *** = P<0.001. Numbers followed by equal letters within each column are not significantly different (P<0.05).

Four cuts were carried out in irrigated and three in rainfed lands at the following dates: 21 May, 21 June, 23 August and 21 October at Zaragoza; 2nd June, 21 July and 19 October at Latre and 15 June at Lagueruela where the two remaining cuts could not be evaluated. Therefore, the discussion of results was carried out between results obtained at Latre and Zaragoza. However, given that the data from the first cut obtained at Lagueruela are similar to those from Latre, the latter could be considered as representative of rainfed crops from both locations (Table 2).

The location and irrigation conditions affected the dry matter yield and most of morphological characteristics of the plant. The annual dry matter yield per plant was 557.2 in irrigated *vs* 153.7 g per plant in rainfed land that represents 27.6% from the irrigated land's one. The distribution of the forage production along the year was nevertheless similar, being 66.9%, 21.4% and 11.7% for the 3 first cuts, respectively, in rainfed areas, and 67.2%, 19.4%, 9.9%, and 3.5% for the four cuts carried out in irrigated areas. This distribution of the production in rainfed areas agrees with a comparative trial of forages made at Fortanete (Spain) by Delgado *et al.* (2007) and Cirencester (UK) by Koivisto and Lane (2001).

The height, number and diameter of stems per plant appeared associated with dry matter yield, particularly in irrigated lands, with the exception of the number of stems per plant at Lagueruela that did not show any difference with Zaragoza. In other species such as Lucerne, these characteristics were also proved to be highly correlated with forage yield (Portabella *et al*., 1982) The number and dimensions of leaflets per leaf were significantly higher in irrigated than in non-irrigated areas. However, the leaflets length did not increase, proportionately, as much as its width. Thus, leaflets showed a more rounded appearance when plants were grown in irrigated than in non-irrigated conditions. The number of flowers per inflorescence did not change significantly between the studied locations.

Conclusions

Results show that the localization of plants in rainfed reduces the dimensions of most morphological and productive parameters with respect to those grown in irrigated lands. Flowering and cutting dates are delayed with altitude. Annual distribution of forage yield is similar in all locations: 67% is obtained in springtime and the rest is distributed between summer and autumn.

References

Buendía-Lázaro, F. and García-Salmerón, S. (1965). *Estudio botánico, ecológico y pascícola de las principales especies espontáneas de los pastizales de montaña de nuestras regiones semiáridas.* Monografía del género *Onobrychis*. (Ed.) Ministerio de Agricultura, Madrid.

Delgado, I. (1986). Characterization of wild luzernes (M. sativa L.) from Aragón (Spain). In: *Proc. of International Meeting Eucarpia Group "Medicago sativa"*, Pleven, Bulgaria, 1986, pp. 91-98.

Delgado, I., Andrés, C., Sin, E. and Ochoa, M.J. (2002). Estado actual del cultivo de la esparceta (*Onobrychis viciifolia* Scop.). Encuesta realizada a agricultores productores de semilla. *Pastos*, XXXII (2): 235-247.

Koivisto, J. and Lane, G.P.F. (2001). www.fao.org/ag/agp/agpc/doc/Gbase/data/Pf000347.htm.

Michelena, A. and Hycka, M., (1988). Diferenciación y caracterización de dos tipos de esparceta (*Onobrychis viciifolia* Scop,) cultivada en España. *Investigación Agraria: Producción y Protección vegetales*, 3 (3): 285-290.

Portabella, C., Casañas, F., Alboquers, J. and Bosch, Ll. (1982). Variabilidad fenotípica, correlaciones entre caracteres morfológicos y agronómicos en la alfalfa Aragón. *An. Est. Exp. Aula Dei,* 16 (1/2): 159-171.

SAS (1998). *SAS user's guide: Statistics version 6.12*. SAS Institute Inc., Cary, N.C. USA.