Adaptability and Stability of Alfalfa Cultivars

Ana C. Ruggieri
Instituto de Zootecnia, Brazil

Alda L. G. Monteiro
Universidade de Marilia, Brazil

R. Gualberto
Universidade de Marilia, Brazil

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ADAPTABILITY AND STABILITY OF ALFALFA CULTIVARS

A. C. Ruggieri[1] A.L.G.Monteiro[2], R. Gualberto[3]

[1]Estação Experimental de Zootecnia, Instituto de Zootecnia, Sertãozinho, São Paulo, Brasil

[2]Dept. de Zootecnia, Universidade de Marilia, Marília, SP, Brasil, 17525-000,

alda.lgm@zaz.com.br

[3]Dept. de Agronomia, Universidade de Marilia, Marília, SP, Brasil, 17525-000

Abstract

Yield adaptability and stability of thirty five alfalfa genotypes (*Medicago sativa* L.) were evaluated at Sertãozinho, SP, Brazil, considering different environments (seasons of year) from 1996 to 1999. A randomized complete block design with three replications was used. Scott-Knott's test was performed to compare genotypes averages. Adaptability and stability were determined by Eberhart and Russell's procedures. Two diverse groups of genotypes with mean dry matter yield were identified: Araucana, F686, MH4 e BR2 were more responsive under favorable environments, but SW 8210, Alto, Monarca SP, Victoria SP, Florida 77, P5888, MH15, BR1, BR3, SW 9210A presented broad adaptability and high predictive stability for diverse environments. It was concluded that several studied genotypes compared to cv. 'Crioula', which is traditionally used in Brazil, and these genotypes can be grown in these environments, showing high yielding and broad adaptability associated to phenotypic stability.

Keywords: genotypes x environments interaction; lucerne, alfalfa, genotypes, yield

Introduction

In Brazil, for a long time, alfalfa crop was grown only in the South region. But, for last two decades, farmers over the whole country have shown been interested in this crop, considering satisfactory practical and research results. There is a well-adapted cultivar in Brazil, widely used, named ‘Crioula’. This is considered a native cultivar, with broad genotypic basis in South of Brazil (Oliveira et al., 1993). Other genotypes have been introduced, mainly from diverse environments like Argentine and North America. Rumbaugh and Heichell (1984) indicated that, historically, the approach about higher alfalfa crop yields may be supported, firstly by improvement of environmental characteristics, but also by looking for a genotype that could totally express its potential performance in the referred environment.

Evaluation of adaptability of genotypes to environments is very important to reach high yields and stand persistence, improving all forage system (Putnan, 1998).

Presently, breeders accept that the ideal genotype does not exist. It might be one that shows high productivity under unfavorable conditions, such as low quality soil or inadequate climate but, on the other side, it might highly productive in favorable environments (Veronesi, 1995).

Our objectives were to evaluate adaptability and phenotypic stability of dry matter yields for alfalfa genotypes under different climatic conditions (environments) in Sertãozinho, São Paulo, Brazil.

Material and Methods

This investigation is part of the National Evaluation Program of Alfalfa Cultivars (RENACAL) coordinated by the Brazilian Agricultural Research Corporation (EMBRAPA). This network trial started in 1994 and is carried out over the country.

Data on the evaluation tests of thirty five alfalfa genotypes were analyzed. They were Valley Plus; WL 516; Alfa 200; Falcon; SW 8210; SW 8112 A , Alto; Rio; ICI 990; Monarca SP INTA; Victoria SP INTA; Esmeralda SP INTA; Costera SP INTA; Semit 711; Semit 921; Araucana; Maricopa; Sutter; P 30; P 205; F 708; F 686; El Grande; P5929; Florida 77; P5888; P5715; MH4; MH15; BR1 and BR2. All genotypes were grown at Animal Science Experiment Station, at Sertãozinho, SP, Brazil, located at 21^{o} 08'S and 47^{o} 59' W on Oxissoil type. According to Köppen classification, the climate is an AW Humid Tropical with annual temperature and rainfall 22^{o} C and 1200 mm, respectively.

Alfalfa was sown on April 11th, 1996, in a randomized complete blocks design with three replications. Plot size was 2,8 m^{2} with 0,20 m between seeding lines. Plants were cut at early flower stage or when basal stubble had emerged. Dry matter yield was evaluated in each cutting time, on summer and winter seasons. These seasons correspond to: September, 1996 to March, 1997; May, 1997 to August, 1997; October, 1997 to April, 1998; May, 1998 to August, 1998; October, 1998 to April, 1999 and May to July, 1999.

Average genotypes dry matter yield (kg/ha) were analyzed by Scott-Knott' test. To estimate adaptability and stability parameters, Eberhart and Russell's procedure (1966) was applied. In this case, each season was considered a distinct environment, independent of agricultural year.

Results and Discussion

Average dry matter yield (mean yield, kg.ha^{-1}), linear regression coefficient (b_i), deviation mean square (S^2_{di}) and coefficient of linear determination (R^2) of thirty five studied genotypes are presented on Table 1. There was significant difference (P<0,05) among genotypes by Scott-Knott's test, with general average 1440 kg.ha^{-1}. So, the genotypes were thus classified as high and low yielding ones.

Genotypes Araucana, F686, BR2 and MH4 presented high yields and the regression coefficient was above one (b_i >1), so they were classified as having adaptability to favorable environments. Another genotype, P5715, grouped among high yielding genotypes, showed b_i <1,0, and so would be considered as adapted to unfavorable conditions or low yield conditions. Among genotypes described above, just MH4 had significative deviations coefficient (S^2_{di}), thus was considered unstable to environmental change under Eberhat and Russell's definition.

Moreira et al. (1990) defined desirable genotypes as high yielding ones with broad adaptability and phenotype stability. Genotypes SW 8210, Alto, Monarca SP INTA, Victoria SP INTA, Florida 77, P5888, MH15, BR1, BR3 e SW 9210A can be classified as well adapted to favorable and unfavorable environments (b_i = 1) and predictive capacity (S^2_{di}),thus can be considered phenotypic stable and with dry matter yield above average (1440 kg.ha^{-1}). Though genotype Rio was broadly adapted to favorable and unfavorable environments and is a high yielding one (1517,7 kg.ha^{-1}), it would be classified as phenotypic unstable (S^2_{di}), with means, low predictive behavior.

Determination coefficient R^2 revealed that, except for ICI 990 (R^2=0,7786), sums of squares would be attributed to linear regression model used in these analyses.

Cultivar Crioula, mostly grown in Brazil, showed broad adaptability to all studied environments as expected, therefore it was found to be unstable for this trait with low yields (1421,8 kg.ha^{-1}).

This investigation demonstrates that several genotypes could be grown under tropical conditions, achieving crop adaptability and phenotypic stability, thus showing its potential efficiency.

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Table 1- Adaptability and stability parameters for dry matter yield of 35 alfalfa genotypes (1996 - 1999).

Genotypes	Adaptability and Stability Parameters			
	Mean yield kg/ha	Regression coeficient b_i	Mean Squares Desviations from regression S_{di}^2	Coeficient of linear determination R^2 (%)
Valley Plus	1370.0 b	0.895897	14288.6933*	96.85
WL 516	1385.2 b	0.858064**	4607.1098	98.49
Alfa 200	1450.3 a	0.877508*	834.0266	99.29
Falcon	1372.0 b	0.767700**	523.0266	99.15
SW 8210	1580.8 a	1.029921	-1895.5150	99.87
SW 8112 A	1423.2 b	0.961309	-361.8482	99.60
Alto	1509.2 a	0.909705	2981.9851	98.95
Rio	1517.7 a	1.019411	13085.0683*	97.72
ICI 990	1405.8 b	0.695334**	87324.9453**	77.86
Monarca SP INTA	1553.5 a	1.071723	4499.4018	99.04
Vctoria SP INTA	1520.5 a	1.077039	5644.3183	98.90
Esmeralda SP INTA	1399.5 b	0.993125	-651.1399	99.67
Costera SP INTA	1330.2 b	1.237411**	16756.4023**	98.09
SEMIT 711	1388.5 b	1.082309	7883.7348	98.63
SEMIT 921	1322.8 b	0.823198	3524.5683	98.60
Araucana	1488.5 a	1.127868*	1593.4017	99.48
Maricopa	1413.2 b	1.041143	2391.3183	99.27
Sutter	1347.3 b	0.983132	6003.4433	98.63
P 30	1333.2 b	1.138158**	6293.4848	98.94
P 205	1232.3 b	1.157494**	15042.4013**	98.00
F 708	1419.3 b	1.076811	-1956.7650	99.89
F 686	1450.5 a	1.146327**	8801.1513	98.67
El Grande	1361.0 b	1.003387	8332.8603	98.34
5929	1400.0 b	0.857928*8	7518.6933	97.91
Florida 77	1551.0 a	1.093699	9141.2353	98.50
5888	1520.5 a	0.911370	7929.9018	98.07
5715	1542.3 a	0.826532**	2602.6516	98.81
MH 4	1462.7 a	1.135666**	13356.7353*	98.13
MH 15	1562.8 a	1.048663	6305.4018	98.75
BR 1	1477.3 a	1.065848	5124.8183	98.95
BR 2	1551.2 a	1.123118**	-1649.3482	99.86
BR 3	1459.2 a	1.018157	3158.3183	99.13
BR 4	1399.5 b	0.982167	-940.3483	99.71
SW 9210 A	1491.7 a	0.975431	10372.4853	97.93
Crioula	1421.8 b	0.987446	17316.0273**	96.95
$\overline{X}$	1440.4	1.000000		

*,** Significant at P = 0.05 or 0.01, respectively.

Means followed by the same letter were not statistically different according to Scott Knott's test at $\alpha = 0.05$.