



NOTE

Indirect selection of forage yield in Italian ryegrass

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ABSTRACT - *The objective of this work was to estimate correlations between some traits of plant architecture and vigor with dry matter yield, as well as to verify the possibility of indirect selection for forage yield in Lolium multiflorum Lam. Forty-five plants were individually evaluated 140 days after sowing for vigor, plant height, soil cover, fresh (FMY) and dry matter yield (DMY). The area and volume occupied by the plant were obtained based on height and diameter. Associations of intermediate value were found between most traits and FMY and DMY, except for height. The highest correlation values were between vigor and yield: FMY and DMY (0.90 and 0.84, respectively). Vigor is therefore a suitable trait for indirect preliminary selection of forage yield in this species.*

Key words: forage, correlations, vigor, height, dry matter yield.

INTRODUCTION

Italian ryegrass (*Lolium multiflorum* Lam.) is the most important winter forage grass in the South of Brazil. It attains high yields, has a high nutritive value and contributes significantly to maintain and improve the meat and dairy production in Brazil.

In ryegrass breeding, as in other forage plants, dry matter yield per area is always the key target trait to optimize land use results (Wilkins 1991). To determine dry matter yield, the conventional method which involves cutting is inconvenient for plant breeding programs because it does not allow seed production. Furthermore, it is a time-consuming and costly procedure to cut, identify, transport, dry, and weigh the collected samples. Therefore, the estimation of dry matter yield through associated traits that are easier to measure has a significant impact on breeding programs.

Among potential traits for the indirect selection of dry matter yield there are vigor, plant height, soil cover

diameter, tiller number and heading date. High correlation coefficients between plant height and dry matter yield were obtained in ryegrass, indicating that height is of special importance to estimate yield. In practice, height is widely used to adjust stocking rates, through estimates of herbage mass in pastures (Santillan et al. 1979, Tcacenco 1989, Tcacenco 1995).

A high correlation between height and dry matter yield was also found in a related species, *Festuca arundinacea* (Araújo et al. 1983). The authors further verified an association between heading date and dry matter yield, leading to the conclusion that both height and heading date are important traits associated with forage yield. Conversely, correlations between dry matter yield and height were not significant in clones of *Bromus riparius* Rehm (Araújo and Coulman 2004). Similar results for this species were also found by McDonald et al. (1952). Castro et al. (2003) observed positive correlations between dry matter yield and soil cover diameter (0.68) and tiller number

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(0.51) in Brazilian populations of Italian ryegrass, confirming that these traits are associated with dry matter yield.

The objective of this study was to estimate associations between some plant architecture traits and vigor with yield, and to verify the feasibility of indirect selection for forage yield.

MATERIAL AND METHODS

The experiment was conducted at the Low Land Experimental Station of Embrapa Temperate Agriculture in Capão do Leão, Rio Grande do Sul State, Brazil (lat 31° 52' 00" S, long 52° 21' 24" W, alt 13.24 m asl), in 2003. According to Köppen's classification, the regional climate is of the Cfa type, and the soil a low-land type (Hydromorphic Planosol). Forty-five plants from three local populations were evaluated.

Sowing was performed on May 9, 2003, on trays in a glasshouse. Sixty-nine days later, on July 17, the young plants were transplanted to the field, in 0.5 m rows and plant spacing, to allow for individual plant evaluation.

By September 29 the following traits were evaluated

- vigor: visual scores, from one to five, based on plant height, number of tillers and number and size of leaves (1 = low vigor, 5 = high vigor);
- natural height (NH, cm): measured with a sward-stick;
- height (cm): from soil surface to flag leaf bottom of the uprooted plant;
- soil cover diameter (diameter, cm): mean of two perpendicular measures.

On the same day, plants were cut at the ground level and individually weighed, to evaluate fresh matter yield (FMY). Afterwards they were oven-dried at 60 °C to constant weight, to establish dry matter yield (DMY).

The plant area was calculated as $A = \pi r^2$, where r is the radius resulting from diameter measures.

Volumes (V_1 and V_2) were calculated as follows

$$V_1 = \frac{1}{2} \left(\frac{4}{3} \pi r^3 \right) \quad V_2 = \pi r^2 h$$

where $h = NH$ (natural height), V_1 corresponds to the volume of half a sphere and V_2 corresponds to the volume of a cylinder.

Calculations of simple phenotypic correlation estimates were run on the standard statistical software package SAS (SAS Institute 1990).

RESULTS AND DISCUSSION

The height of the evaluated plants varied from 19 to 55 cm and the natural height from 12 to 28 cm. Soil cover diameter varied from 20.50 to 61.25 cm. All vigor values were represented, as expected for a comparative trait.

The correlations were significant, except for height x vigor, NH x height, NH x diameter, NH x area and NH x V_1 (Table 1). Moreover, there was no significant correlation between natural height and fresh matter or dry matter yield, or between height and the visual scores for vigor ($r = 0.25$). Mittelman et al. (2004) found intermediate values for the correlations between these traits (0.66). Height was correlated with area, V_1 and V_2 , with intermediate values ($r = 0.56, 0.54$ and 0.53 , respectively). A low correlation estimate was obtained for height x NH ($r = 0.27$). The associations were similar and of intermediate value between vigor and the traits diameter, area, V_1 and V_2 , ($r = 0.66, 0.64, 0.62$, and 0.66 , respectively). The last four traits were based on the

Table 1. Simple phenotypic correlations among plant architecture traits, vigor and forage yield in Italian ryegrass

Traits ¹	Height	NH	Diameter	Area	V_1	V_2	FMY	DMY
Vigor	0.25	0.46**	0.66**	0.64**	0.62**	0.66**	0.90**	0.84**
Height		0.27	0.57**	0.56**	0.54**	0.53**	0.21	0.14
NH			0.24	0.25	0.26	0.56**	0.52**	0.50**
Diameter				0.99**	0.96**	0.90**	0.61**	0.54**
Area					0.99**	0.92**	0.60**	0.52**
V_1						0.93**	0.57**	0.50**
V_2							0.66**	0.59**
FMY								0.96**

** P < 0.01

¹ Height: plant height (uprooted); NH: natural height; Diameter: soil cover diameter; Area: plant area; V_1 : plant volume 1 (half-sphere); V_2 : plant volume 2 (cylinder), FMY= fresh matter yield, DMY= dry matter yield

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diameter measures. Likewise, area, V_1 and V_2 were strongly correlated with soil cover diameter.

The highest correlations were found between fresh or dry matter yield and vigor, with values of 0.90 and 0.84, respectively. These estimates were much higher than the other correlations, including the second highest between V_2 and fresh matter yield (0.66). NH, diameter, area and V_1 showed intermediate associations with fresh and dry matter yield. Castro et al. (2003) found intermediate values for diameter x dry matter yield (0.68). NH had high correlations with dry matter yield (0.87) in row plots.

Besides the high association with yield, vigor scores can be visually attributed and are simple and quick to evaluate. It is the easiest trait to evaluate of all used in this study. It takes plant height, number of tillers and number and size of leaves into account and is an intuitive selection

index. According to our experience, it is easily understood and repeated by people that work together, with little divergence after training. Similar measures, sometimes called agronomic value, are used to estimate grain yield in species such as soybean, with associations of similar magnitudes to those found in the present study (Lopes 2002). On the other hand, as a comparative trait, it is unsuitable for genetic estimation, since the estimates would be difficult to interpret. Its use is more adequate in mass selection or in preliminary selection trials involving a large number of families or populations.

Vigor is an adequate trait for the indirect preliminary selection of forage yield in annual ryegrass. All other traits, in spite of being positively associated with fresh and dry matter yield must not be used alone as forage yield estimates.

Seleção indireta da produção de forragem em azevém

RESUMO - O objetivo deste trabalho foi estimar as associações entre alguns caracteres de arquitetura de planta, vigor e produção de matéria seca, e verificar a possibilidade de seleção indireta para produção de forragem em *Lolium multiflorum* Lam. Foram avaliadas 45 plantas individualmente para os caracteres vigor, altura de planta e diâmetro médio de cobertura do solo, produção de matéria verde (FMY) e matéria seca (DMY), medidos 140 dias após a sementeira. Com base no diâmetro e na altura, foram calculados a área e o volume ocupados pela planta. Correlações de valor intermediário foram encontradas entre os caracteres de arquitetura da planta e de produção, exceto para altura. As maiores correlações foram entre vigor e FMY e DMY (0,90 e 0,84, respectivamente). Assim, pode-se afirmar que a avaliação do vigor é uma forma adequada de seleção indireta preliminar para produção de forragem nesta espécie.

Palavras-chave: forrageiras, correlações, vigor, altura, produção de matéria seca.

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