ULUDAĞ ÜNİVERSİTESİ
ZİR. FAK., 2(1), 1983.

HAY YIELD AND LEAFINESS COMPONENTS IN SMOOTH BROMEGRASS (Bromus inermis Leyss.)

Esvet AÇIKGÖZ*
A. Servet TEKELİ**

SUMMARY

Hay yield and leafiness components of spaced plants were evaluated for six cultivars of smooth bromegrass. All morphological traits showed significant correlations with hay yield. However path analysis showed that hay yield was a direct function of tillers/plant and plant height. Plant height was also negatively associated with leafiness. It was concluded that selection based on tillers/plant may improve hay yield without adverse affect on leafiness. It appeared that plant height was one of the most distinguishing characters of smooth bromegrass cultivars.

ÖZET

Kılçıksız Brom (Bromus inermis Leyss.) da Ot Verimi ve Yapraklılık Komponentleri

Bu çalışmada altı kılçıksız brom çeşitinin ot verimi ve yapraklılık oranı komponentleri incelenmiştir. Değerlendirilen bütün morfolojik özellikler ile ot verimi arasında olumlu ve önemli ilişkiler bulunmasına karşılık path analizlerinde ot verimini sadece bitkideki kardeş sayısı ile bitki boyunun doğrudan etkiledikleri saptanmıştır. Bitki boyunun aynı zamanda yapraklılık ile olumsuz yönde ilişkili olduğu bulunmuştur. Araştırmalar sonunda bitkideki kardeş sayısı yönünde yapılacak seçmeler ile yapraklılık oranını olumsuz yönde etkilemeden ot veriminin artırılabileceği sonucuna varılmıştır. Kılçıksız brom çeşitlerinin değerlendirilmesinde bitki boyunun en önemli karakterlerinden birisi olduğu anlaşılmıştır.

INTRODUCTION

Smooth bromegrass is widely grown for hay, pasture, and seed crop in semiarid regions. Two distinc types of smooth bromegrass is generally recognized. Sout-

* *Associate Professor of Agronomy, Faculty of Agriculture, Uludağ University, Bursa.*
** *Associate Professor of Agronomy, Faculty of Agriculture, Trakya University, Tekirdağ.*

hern types are more aggressive, drought tolerant and produce good forage yield. Northern types have less hay yield but are excellent seed crops (Newell and Andersen 1966, Knowles et al. 1974).

Several criteria have been emphasized in the evaluation of forage grasses, however hay yield is a general aim in grass beeding programmes (Knowles 1969). The leaves of grasses are clearly superior to the other portions of plants in crude protein, minerals, and in digestibility (Movat et al. 1965, Smith 1973, Bakır and Açıkgöz 1976). High leaf percentage, therefore is considered an indicator of forage quality. Nevertheless less information is available on relationships between morphological traits with hay yield and leafiness. Earlier Tsiang (1944) found significant relations between plant height and hay yield; leaf width and leafiness in creeping type bromegrass but not in Parkland brome. In later studies with bromegrass, plant height, spread, fall vigor exhibited some associations with hay yield (Knowles 1950, McDonald et al. 1952, Lebsock and Kalton 1954). Tiller number showed highly significant correlations with hay yield per plant or per unit area in ryegrass (*Lolium* sp.) (Lazenby and Rogers 1962, Silsbury 1966, Rhodes 1971). In crested wheatgrass (*Agropyron cristatum* L. Gaertn.) close relationships between tiller number and hay yield; leaf width and leafiness were also reported (Elçi and Açıkgöz 1976).

The main objective of this study was to evaluate interrelationships between some morphological traits and their relative contributions to forage yield and leafiness in smooth bromegrass. A second interest was to determine what extent cultivars of smooth bromegrass differed morphologically which might serve to identify cultivars under breeder rights regulations.

MATERIALS and METHODS

Six smooth bromegrass (*Bromus inermis* Leyss.) cultivars from different world resources (Table 1) were used in this study. These cultivars are well adapted to typical continental climate of Inner Anatolia and excelled in spring vigor, hay yield and leafiness (Açıkgöz and Tekeli 1980, Elçi and Açıkgöz 1980).

Seeds of all entries were germinated in petri dishes and seedlings were transplanted into wooden flats filled with mixture rotted manure, soil and sand (1: 2: 1). Three month-old seedlings were transplanted on the experimental plots of Grassland and Animal Husbandry Research Institute, Ankara in spring of 1979 in a completely-randomized block design with three replications. Rows and plants in the row were spaced 1 m apart. Each plot consisted of 60 plants. No data were taken during the establishment year.

Ten individual plants were randomly selected from each plot for analysis i.e. 30 plants for each cultivar were evaluated. At full heading stage plants were cut at soil surface and morphological traits were measured. Ten tillers were taken randomly from each plant and fractionated into stem + head, sheath and blade. Whole plant and fractions were separetely dried at 70°C for 24 hours and weighed.

Blade and blade + sheath percentages in whole plant weight were calculated. A very close relationship ($r = 0.98^{**}$) was established between these two leafiness

criterion. Therefore only blade percentage was used as a leafiness criterion in further discussions.

Simple correlation coefficients among morphological traits, hay yield and leafiness were calculated. Their direct and indirect effects on hay yield and leafiness were computed by path analysis as described by Wright (1968) and as applied in the previous study with smooth bromegrass (Açıkgöz and Tekeli 1980).

RESULTS and DISCUSSION

Wide variation was observed among individual plants for all morphological traits. However mean differences between cultivars for some morphological traits were nonsignificant (Table 1). The cultivars Baragan-5 and Lincoln had clearly higher hay yield than other cultivars tested. Superiority of these cultivars under dryland conditions was noted earlier (Açıkgöz and Tekeli 1980). The cv. Göle was significantly lower yielding but it showed significantly higher leafiness (Table 1).

Table: 1
Variation in Morphological Traits, Hay Yield and Leafines Among Cultivars of Smooth Bromegrass

Cultivars and Origin	Tillers/ Plant	Stem Diameter cm	Leaf		Plant Height (cm)	Hay yield g/plant	Leafiness (%)
			Length cm	Width cm			
Baragan-5 (Rumania)	62.6 a	0.33 a	26.5 a	1.08 b	126.9 a	193.2 a	20.6 b
Orfeu (Rumania)	56.3 a	0.32 a	22.4 a	1.03 b	100.9 d	121.2 c	18.8 b
Göle (Turkey)	60.6 a	0.31 a	25.3 a	1.09 b	71.8 e	64.2 d	37.7 a
Lincoln (USA)	50.9 a	0.34 a	27.0 a	1.34 a	125.7 a	177.9 a	19.7 b
Lyon (USA)	64.7 a	0.35 a	25.0 a	1.20ab	120.1 b	168.6 ab	19.7 b
Sac (USA)	49.4 a	0.34 a	23.1 a	1.37 a	107.0 c	131.0 bc	21.8 b
Grand Mean	56.9	0.33	25.0	1.21	109.2	142.8	23.2
Min	16.0	0.23	13.8	0.50	43.0	18.5	10.9
Max	155.0	0.52	57.2	2.00	153.0	478.4	56.3

By a simple correlation coefficient method, all morphological traits measured were significantly correlated with hay yield. However only correlations of tillers/plant and plant height with hay yield were highly pronounced (Table 2). Path analysis also indicated that these characteristics had great direct effects upon hay yield with P = 0.474 and P = 0.524, respectively. Despite significant correlations, the other traits were less directly linked with hay yield. In earlier studies with smooth bromegrass Tsiang (1944) and Lebsock and Kalton (1954) established small but significant associations between plant height and hay yield. Recently Walton (1976) found that hay yield significantly correlated with the plant height. Effect of tillers/plant on hay yield for bromegrass has not been widely investigated previously. The

Table: 2

Simple Correlation Coefficients of Hay Yield and Leafiness Components in Smooth Bromegrass (d.f. = 178)

	2	3	4	5	6	7
1. Hay yield	-0.75^{++}	0.55^{++}	0.20^{++}	-0.15^{+}	0.18^{+}	0.64^{++}
2. Leafiness		0.04	-0.24^{++}	-0.05	0.01	-0.61^{++}
3. Tillers/plant			-0.18^{+}	-0.43^{++}	0.05	0.16^{+}
4. Stem diameter				0.38^{++}	0.24^{++}	0.31^{++}
5. Leaf length					0.08	0.07
6. Leaf width						0.24^{++}
7. Plant height						

+, ++ Significant at 0.05 and 0.01 levels of probobility, respectively.

close relationships however were found between these traits in other grass species (Silsbury 1966, Elçi and Açıkgöz 1976).

It was found that leafiness was negatively associated with stem diameter and plant height (Table 2). However only plant height exerted great direct effect on leafiness (P = — 0.662) in path analysis. Direct effect of stem diameter was negligable (P = — 0.078) but it affected leafiness indirectly via plant height (Table 3).

A strong negative correlation (r = — 0.75**) was established between hay yield and leafiness. In former studies Knowles (1969) reported a similar relationship in slender wheatgrass (*Agropyron trachycaulum* Link and Maelte). This negative correlation comes from the fact that plant height was one of the important compo-

Table: 3

Path Coefficients for Hay Yield Components of Smooth Bromegrass

Tillers/plant vs hay yield	r =	0.550	Leaf width vs hay yield	r =	— 0.151
Direct effect		0.474	Direct effect		— 0.042
Indirect via stem diameter	—	0.026	Indirect via tillers/plant		— 0.203
Indirect via leaf width		0.018	Indirect via stem diameter		0.055
Indirect via leaf length		0.000	Indirect via leaf length		0.000
Indirect via plant height		0.084	Indirect via plant height		0.039
Stem diameter vs hay yield	r =	0.202	Leaf length vs hay yield	r =	0.176
Direct effect		0.143	Direct effect	—	0.003
Indirect via tillers/plant	—	0.086	Indirect via tillers/plant		0.023
Indirect via leaf width	—	0.016	Indirect via stem diameter		0.034
Indirect via leaf length	—	0.001	Indirect via leaf width	—	0.003
Indirect via plant height		0.162	Indirect plant height		0.125

Plant height vs hay yield	r =	0.640
Direct effect		0.524
Indirect via tillers/plant		0.076
Indirect via stem diameter		0.044
Indirect via leaf width	—	0.003
Indirect via leaf length	—	0.001

nents of both hay yield and leafiness. But it was positively associated with hay yield while being negatively associated with leafiness. This would pose some difficulties in simultenous selections for hay yield and leafiness. Although plant height was found to be one of the major components affecting hay yield, greater plant height adversely affects leafiness. Therefore tillers/plant may be more valuable criterion than plant height in improving hay yield without adverse affect on leafiness.

It appeared that plant height was one of the most distinguishing characters of smooth bromegrass cultivars, and it may be used in identification of smooth bromegrass cultivars under breeder right regulations. Other traits measured differed little to distinguish the cultivars.

Table: 4

Path Coefficients for Leafiness Components of Smooth Bromegrass

Tillers/plant vs leafiness	r = 0.042		Leaf width vs leafiness	r =	— 0.050
Direct effect	0.161		Direct effect		0.084
Indirect via stem diameter	0.014		Indirect via tillers/plant		— 0.069
Indirect via leaf width	— 0.035		Indirect via stem diameter		— 0.030
Indirect via leaf length	0.009		Indirect via leaf length		0.014
Indirect via plant height	— 0.106		Indirect via plant height		— 0.049
Stem diameter vs leafiness	r = — 0.237		Leaf length vs leafiness	r =	0.014
Direct effect	— 0.078		Direct effect		0.176
Indirect via tillers/plant	— 0.029		Indirect via tillers/plant		0.009
Indirect via leaf width	0.032		Indirect via stem diameter		— 0.019
Indirect via leaf length	0.042		Indirect via leaf width		0.006
Indirect via plant height	— 0.204		Indirect via plant height		— 0.158
	Plant height vs leafiness	r = — 0.612			
	Direct effect	— 0.662			
	Indirect via tillers/plant	0.026			
	Indirect via stem diameter	— 0.024			
	Indirect via leaf width	0.006			
	Indirect via leaf length	0.042			

REFERENCES

Açıkgöz, E. and A.S. Tekeli, 1980. Seed yield and its components in smooth bromegrass (*Bromus inermis* Leyss.) cultivars. Euphytica 29, 199-203.

Bakır, Ö. and E. Açıkgöz, 1976. Variation of chemical composition in various parts of crested wheatgrass at different growth stages. Yearbook of Faculty of Agriculture, Ankara 26, 346-353.

Elçi, Ş. and E. Açıkgöz, 1976. The relationships between some morphological characteristics with hay yield and leafiness ratio of crested wheatgrass Yearbook of Faculty of Agriculture, Ankara 26, 339-345.

——— and ———, 1980. Important agronomic traits of some domestic and foreign smooth bromegrass (*Bromus inermis* Leyss.) cultivars. The Scientific and Technical Research of Turkey, Rep. No. 12, 34 pp.

Knowles, R.P., 1950. Studies in combining ability in bromegrass and crested wheatgrass. Sci. Agr. 30, 275-302.

———— 1969. Breeding of grasses. In Canadian Forage Crops Sym. Ed. K.F. Nielsen. Modern Press, Saskatoon, p. 263-276.

————, D.A. Cooke and C.R. Elliott, 1974. Producing certified seed of bromegrass in Western Canada. Canada Dept. of Agric. Publ. 866.

Lazenby, A. and H.H. Rogers, 1962. Selection criteria in grass breeding. J. Agric. Sci. Cam. 59, 51-66.

Lebsock, K.L. and R.R. Kalton, 1954. Variation and its evaluation within and among strains of *Bromus inermis* Leyss. I. Spaced-plant studies. Agron. J. 46, 463-467.

McDonald, E.D., R.R. Kalton and M.G. Weiss, 1952. Interrelationship and relative variability among S_1 and open pollination of selection Brome clones Agron. J. 44, 20-25.

Mowad, D.N., R.S. Fulkerson, W.E., Tossell and J.E. Winch, 1965. The in vitro digestibility and protein content of leaf and stem portions of forages. Canad. J. Plant Sci. 45, 321-331.

Newell, L.C. and K.L. Anderson, 1966. Smooth bromegrass, In Forages Eds. H.D. Hughes, M.E. Heath and D.S. Metcalfe. The Iowa State Univ. Press, Ames. Iowa p. 229-238.

Rhodes, I. 1971. The relationship between productivity and some components of canopy structure in ryegrass. J. of Agric. Sci. Camb. 77, 283-292.

Silsbury, J.H. 1966, Interrelations in the growth and development of *Lolium*. II. Tiller number and dry weight at low density. Aus. J. Agr. Res. 17, 841-847.

Smith, D. 1973. Distribution of dry matter and chemical constitution among the plant parts of six temperate origin forage grasses at early anthesis. Res. Rep. Univ. of Wisconsin, No. R 2552.

Tsiang, Y.S. 1944. Variation and inheritance of certain characters of bromegrass (*Bromus inermis* Leyss.). J. Amer. Soc. Agron. 36, 508-521.

Walton, P.D., 1976. A genetic study of the factors which constitute forage yield in *Bromus inermis* Leyss. Z. Pflanzenzuchtung 77, 43-55.

Wright, S. 1968. Evolution and genetics of populations: Vol. 1. Genetic and biometric foundations. Univ. of Chicago Press.