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Herbage quality in Rhodes grass (Chloris gayana Kunth). 2. Intra-variety variation in yield and digestibility of plants of similar heading date

J. G. Boonman

National Agricultural Research Station, Kitale, Kenya

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Summary

Twenty clones of similar heading date and selected from within Masaba Rhodes *(Chloris gayana* Kunth) were assessed at 3, 6 and 9 weeks of regrowth. Lengthening the period of regrowth increased yield of dry matter, yield of digestible organic matter, but decreased digestibility in vitro, of leaf, stem and whole-sward samples, and leaf/stem ratios, all significantly. Clonal effects were also significant for these characters except for leaf digestibility and leaf/stem ratio. No significant clone × regrowth period interactions were observed.

Stem and leaf digestibility fell by 0.20 and 0.17 units daily, respectively, while leaf/stem ratio dropped to 1.1 at 9 weeks regrowth which coincided with initial heading. At this stage whole sward digestibility had fallen to 53, at a rate of 0.22 per day.

Leaf digestibility was always higher than that of stem.

Clones differed significantly in digestibility showing a 5-unit range which had no relation to leaf/stem ratios. The 7 clones best in digestibility were among the 9 lowest in herbage yield. The ranking for yield of digestible organic matter did not differ from that for yield of dry matter, which showed a range of 1380 - 2450 kg per ha.

It is concluded that potential genetic gain in digestibility and leaf/stem ratio is offset by a corresponding decline in herbage yield.

Introduction

In a previous article (Boonman, 1978a) it was shown that *within* Kenya commercial varieties of Rhodes grass *(Chloris gayana* Kunth) a large variation, often many-fold, occurred between genotypes in seed and herbage yield and in leaf/stem ratios. However, much of this variation was secondary as it could be ex-

plained on the basis of an equally wide range in heading date, of 8 weeks or more. Early-heading plants were higher-yielding and at the same stage of maturity, initial heading, they were on average 7.6 units higher in digestibility than plants heading 8 weeks later. There was a progressive decline in yield and quality characters with every week of delayed heading.

The logical follow-up of these findings was to investigate the variation that would still remain when evaluating clones of similar heading date. Another study (Boonman, 1978b) dealt with clonal evaluation for seed yield while the present one concerns itself with clonal evaluation for herbage yield and digestibility. The object was to see if seed and herbage yield can undergo simultaneous improvement and what bearing selection for digestibility has on herbage yield in genotypes of similar heading date.

As Rhodes grass plants are stoloniferous and form swards of their own they present ideal material for such evaluation.

Materials and methods

The early-heading population of Masaba Rhodes of a previous study (Boonman, 1978b) was investigated in 1976. A split-plot design was adopted with three main plots for three regrowth periods, in two replicates, and with 20 clones as subplots, each of 2.25 m^2.

The swards were burnt on 21 March to destroy dead plant material as much as possible. A top dressing with ammonium sulphate nitrate at 100 kg N per ha was given on 15 April but good rains and good growth did not begin until 5 May. Handclipping was applied at 3-week intervals: 26 May, 16 June and 7 July. At each cut plots were harvested for yield of herbage and a 250-g sample was taken to determine % dry matter and digestibility in vitro (D-vitro; Tilley & Terry, 1963) of the unseparated sample of the whole plot. Another 250-g sample was hand-separated into leaf lamina, stem including leaf sheath, dead Rhodes material and weeds. The leaf and stem fractions were dried to determine leaf/stem ratio and digestibility in vitro.

The samples for digestibility in vitro were dried at 100 °C in a forced-draught oven and a grinder screen with 1-mm apertures was used.

Results

Increasing the regrowth period from 3 to 6 and 9 weeks brought about significant changes in yield of dry matter (YDM), yield of digestible organic matter (YDOM), digestibility of leaf (D_l), stem (D_s), whole sward (D_w) and in leaf/stem ratio (LSR).

Clonal effects were also significant for these characters except for D_l and LSR. However, no significant clone × cut interactions were found (Table 1).

YDM levels were low in this 4th year stand probably because of the burning. YDM had increased by 136 % at the last cut against an increase of only 101 % in YDOM, due to a drop in D_w from 62.2 to 52.9 at a daily rate of 0.22 units. D_s

Table 1. The effect of regrowth period and clone on herbage yield and digestibility.

Regrowth period (cuts)	Dry matter yield (kg/ha)	Yield of digestible organic matter (kg/ha)	Digestibility			Leaf/stem ratio
			whole sward (D_w)	leaf (D_l)	stem (D_s)	
3 weeks	1165	725	62.2	64.7	60.8	2.12
6 weeks	2110	1240	58.8	61.2	55.7	1.61
9 weeks	2750	1455	52.9	57.6	52.3	1.09
Clonal average	2010 ± 203	1140 ± 109	56.7 ± 0.8	61.2 ± 0.6	56.3 ± 0.8	1.60 ± 0.20
Clonal range	1380 — 2450	820 — 1410	54.3 — 59.1	59.9 — 62.8	53.9 — 58.4	1.16 — 2.04
Source of variation						
regrowth period	**	**	**	*	*	*
clone	**	**	*	NS	**	NS
clone × regrowth period	NS	NS	NS	NS	NS	NS
Heritability (indiv.)	0.15	0.15	0.15	0.05	0.14	0.02

and D_l fell by 8.5 and 7.1 units, respectively, corresponding with a daily drop of 0.20 and 0.17.

LSR fell from 2.1 at 3 weeks to 1.1 at 9 weeks. At this stage an average of 5 heads were present per m^2. The % dead Rhodes grass material had increased by then from 3 to 9 % (data not presented) which might explain why D_w moved away from D_l and closer towards D_s than one would have anticipated in view of the values observed for D_l, D_s and LSR. D_l was 3.9 units higher than D_s at the first cut, a difference which increased to 5.5 and 5.3 units, 3 and 6 weeks later respectively (Table 1).

The range in clonal averages was over 70 % for YDM, YDOM and LSR, but less than 10 % for D. For instance, YDOM varied from 820 to 1410 kg per ha, but D_w varied only from 54.3 to 59.1 (Table 1).

The D_w clonal averages and ranges given in Table 1 are the weighted means, but the analysis of variance was necessarily based on straight averages. Clonal weighted averages were 1.2 units higher than the straight averages. For the various cuts, however, both averages worked out much the same.

The relationships between YDM and quality aspects are presented in Table 2 for each cut individually and also for the average of the three cuts as no clone × cut interaction had been established. Table 2 does not include YDOM as it varied almost entirely in line with YDM ($r_{18} = 0.99^{**}$). In the first cut no correlations were significant, in the second cut only between YDM and LSR, but in the third cut more important correlations were found. The main ones are the negative correlations between YDM on the one hand and D_w, D_s and LSR on the other. Also relevant was the absence of any correlation between LSR and digestibility, and between YDM and D_l.

Table 3 presents the correlations between the data of this study and those on seed yield characters of the same clones studied previously (Boonman, 1978b).

Table 2. Correlation coefficients: yield of dry matter (YDM); digestibility of whole sward sample (D_w), leaf fraction (D_l) and stem fraction (D_s); leaf/stem ratio (LSR).

Correlations in clones (r_{18})	Regrowth period (cut)			
	3 weeks	6 weeks	9 weeks	mean
YDM × D_w	—0.28	—0.29	—0.45*	—0.38
YDM × D_l	—0.22	0.20	—0.38	—0.09
YDM × D_s	—0.26	—0.19	—0.70**	—0.54*
YDM × LSR	—0.36	—0.67**	—0.36	—0.59**
D_w × D_l	0.08	0.29	0.67**	0.61**
D_w × D_s	0.25	0.30	0.75**	0.37
D_w × LSR	0.03	0.19	—0.01	0.04
D_l × D_s	0.14	0.33	0.58**	0.45*
D_l × LSR	0.01	—0.33	—0.25	—0.38
D_s × LSR	—0.37	0.21	0.18	0.01

Table 3. Correlation between herbage characters, measured in 1976 and seed yield characters, measured in 1973—74; r_{18}.

	Dry matter yield 1976	Leaf/stem ratio 1976	Digestibility 1976	
			whole sward (D_w)	stem (D_s)
Heading date 1973-74	0.34	0.34	0.10	0.14
Vigour 1973-74	0.56**	—0.43	—0.26	—0.56**
Head number 1973-74	0.39	—0.24	—0.31	—0.43
PGS yield 1973-74	0.47*	—0.26	—0.06	—0.33

Then, only visual scorings had been taken, but Table 3 confirms that vigour data were significantly correlated with YDM. Further, the narrow range in heading date (10 days) had no effect on D_w, while D_s was negatively correlated with vigour. YDM was closely and positively correlated with yield of PGS.

Discussion

Even though there were significant clonal differences in digestibility (Table 1) and although YDM and D-vitro were negatively correlated (Table 2), the ranking of clones for YDM and YDOM was almost identical ($r_{18} = 0.99$**). YDOM showed a narrower clonal range (71%) than YDM (78 %) because of the negative correlation between yield and digestibility. Only one clone was found with a D_w being 0.5 unit above the overall average. Conversely, clones of similar yield levels had closely similar D_w.

From this it would appear that there is little point in attaching much practical importance to the marginal, however significant, differences that seem to prevail in digestibility among Rhodes plants of the same maturity type and selected from the same variety. The clonal range in D_w was 5 units, in D_l only 3, but depended much on yield level. The 7 clones best in digestibility were among the 9 lowest in herbage yield. Thus, by eliminating differences in heading date and yield levels, very little is left of the 17 unit range found in the original wide-based variety (Boonman, 1978a). Nevertheless, digestibility is likely to have been brought to a higher level in this early-heading population since earliness is positively correlated with digestibility (Boonman, 1978a).

Leaf digestibility was generally 4-6 units higher than that of stem in all cuts. In contrast, Terry & Tilley (1964) found in immature forage of temperature grasses that stem was always more digestible than the other components. Also van Wijk (1976) found this for 3-week old regrowth of *Setaria sphacelata,* while Laredo & Minson (1973) reported stem digestibility in Rhodes grass to be higher than that of leaf in each of 54, 75 and 88 days regrowth periods. However, the leaf fraction they used was only 78 % pure. On the other hand, Mowat et al. (1965) were also unable to show higher digestibility of cocksfoot stems than of leaves in immature stages.

Greater clonal variability in digestibility occurred among stems (4.5 units) than among leaves (2.9 units). Clonal effects for stems were significant while those for leaves were not (Table 1).

After 9 weeks regrowth 5 flowering heads were found per m^2. LSR had dropped to 1.1 and D_w to 53, values which are close to those found previously for early heading Rhodes grass plants, sampled at initial heading (Boonman, 1978a).

No clone $\times$ regrowth period interactions were found in this study. The correlations between the digestibility of clones in a particular cut and the digestibility overall were highly significant. Sleper (1974), however, found no correlaton between digestibility of 2-week and 6-week regrowth of 88 Rhodes grass introductions. From the data of Table 2 it would appear that digestibility differences come out better at initial heading than at younger stages. At later stages stem digestibility becomes more prominent.

LSR was not correlated with digestibility (Table 2). Raymond (1969) has questioned the usefulness of leaf/stem ratios in selection for nutritive value. He quoted various research reports on temperate grasses which showed that differences in digestibility between plants *within* a variety resulted from differences in digestibility of the plant fractions rather than from different leaf/stem ratios, which agrees with this paper. Milford & Minson (1968) also found that the nutritive value of Rhodes grass varieties was not related to leafliness. Minson & Milford (1967) showed that the rate of dry matter digestibility in vitro was related to the voluntary intake of two varieties of Rhodes grass. However, the method proved incapable of recognizing differences in voluntary intake between leaf and stem (Laredo & Minson, 1973). Laredo & Minson's findings indicate that differences in voluntary intake are likely between plants with significant differences in LSR, as the voluntary intake of leaf was much higher than of stem of the same digestibility. In the present study LSR failed to show significant clonal effects and was very much a function of YDM (Table 2). The best 4 clones as far as LSR was concerned were among the 5 lowest in YDM, while the top yielding clones had none that was high in LSR.

Heritability (individual) estimates were about 0.15 for YDM, YDOM, D_s and D_w (Table 1), i.e. almost the same as the one found for PGS yield (Boonman, 1978b). This would indicate that genetic variance within maturity classes is still high enough for practical selection purposes.

The clonal range in heading date within this population was 10 days which had some effect on PGS yield (Boonman, 1978b). However, it did not affect dry matter yield, leaf/stem ratio, nor digestibility (Table 3).

It is concluded that in selected Rhodes grass plants, of the same maturity and *within* a variety, digestibility can be increased significantly, but that to increase the yield of digestible organic matter selection to increase yield of dry matter is more effective. Any potential genetic gain in digestibility or leaf/stem ratio is offset by a corresponding decline in herbage yield.

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