CHAPTER 38

About Tillers, Maturity and Forage Quality

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Perennial grass herbage is comprised of a mix of two types of tillers: those that produce seed heads (floral) and those that do not produce seed heads (non-floral). The meristems (growing points) of floral tillers switch from production of leaves to production of floral structures that become the inflorescence, while meristems of non–floral tillers continue to produce leaves. Floral induction begins before the internodes elongate and the meristem is still in the plant crown, but the seed heads emerge from the sheaths of the flag leaves once stem elongation is near completion. Stems of non-floral tillers also elongate with each node producing a new leaf. Induction of flowering is triggered by increasing day-length. In some grasses previous vernalization (cold temperature trigger) is required for flowering to occur while in others no vernalization is needed. Grasses such as timothy and perennial ryegrass that do not require vernalization will flower a second time in the summer after harvest, whereas grasses that require vernalization such as smooth bromegrass, crested wheatgrass, orchardgrass and tall fescue will not flower after harvest.

The proportion or density of floral tillers depends on the variety (see top photo) and the age of stand, and on growing conditions such as soil fertility. In general, smooth bromegrass has more floral tillers than meadow bromegrass and hence produces more seed. The proportion of floral tillers declines as the stand ages, which is a challenge for grass seed growers. In northern regions, smooth bromegrass varieties with a southern origin like Rebound tend to have fewer floral tillers (Fig. 1A) and produce fewer seed than varieties that have a northern origin like Signal (Fig. 1B).

We studied the influence of the proportion of floral and non-floral tillers in northern and southern type smooth bromegrass varieties on forage quality in northeast Saskatchewan (Bittman et al. 1989). In our trial, the southern variety Rebound had 52% floral tillers compared to 76% for the northern variety Signal which had been selected by Dr. R.P Knowles in Saskatchewan for high seed yield (Table 1). As would be expected, Rebound is not a prolific seed producer in Saskatchewan.

Because floral tillers cease to produce new leaves after floral induction, they have a much lower proportion of leaves compared to non-floral tillers which continue to generate new leaves. Also, the floral tillers tend to lose more of their lower leaves by senescence, especially under drought conditions (see Chapter 6). The ratio of leaf to stem is fairly stable within tiller types in both prolific and non-prolific bromegrass varieties; in floral tillers, leaves comprised 28.3 to 35.2% of total tiller weight, whereas in non-floral tillers leaves comprised 76.0 to 80.8% of tiller weight (Table 1). Due mainly to a higher proportion of floral tillers, the proportion of leaves was only 40% in the prolific variety Signal

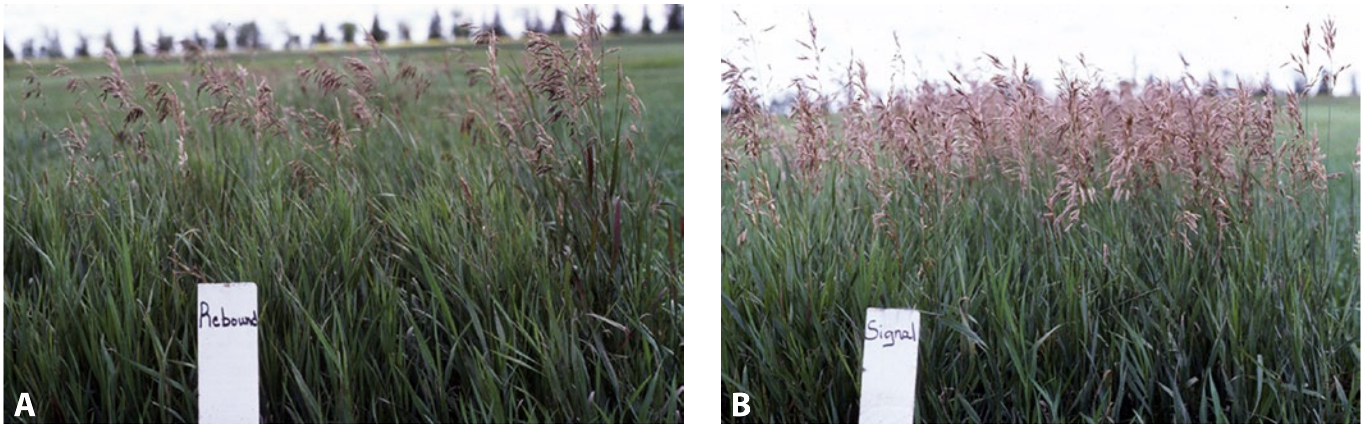

Figure 1. Contrasting abundance of floral tillers in smooth bromegrass varieties with A. southern (Rebound) and B. northern origins (Signal), at similar maturity stage in northeastern Saskatchewan.

while it was 58% for the non-prolific variety Rebound.

We determined that *in vitro* dry matter digestibility of Rebound was almost 3% greater than Signal, despite a similar growth stage at harvest (Table 1). Hence, harvesting of non-prolific varieties can be delayed to a somewhat later growth stage than prolific varieties, with less sacrifice in quality. This is analogous to delayed harvesting of later maturing varieties, but the non-prolific varieties can also be harvested early. Although there was some difference between varieties in digestibility of non-floral tillers, the overall difference between the varieties was due mainly to the proportion of tiller types. It is evident that higher seed production is associated with lower leaf production and tends to result in lower feed quality. Despite its comparatively poor seed production, the variety Rebound was one of the first forage grass varieties to be registered in Canada, primarily on its nutritional quality attributes.

Delaying first cut of perennial grasses, because of poor harvesting weather or other factors, will invariably lead to lower quality of forage due to advancing maturity which results in a higher proportion of stem tissue and a higher proportion of lignin. However, farmers observe that the degree of quality decline is not consistent from year to year, even if the maturity of the crop is the same. In part, this is due to a difference in weather conditions. But another often overlooked factor is the proportion of floral tillers in the crop. Newer stands will often have a higher proportion of floral tillers and will be more susceptible to decline in quality with delayed harvest, but this is not always the case. In a recent trial in coastal BC, we found that the decline in orchardgrass quality due to delayed harvest was greater in the year 2010 than it was in either 2008 or 2009 despite a similar time delay and a similar growth stage (flower) at harvest in all years (Table 2). The greater quality decline in 2010 than 2008 or 2009 can be attributed to more flowering tillers. For seed producers, 2010 would have been a banner year. But for dairy producers who depend on high quality forage, a delayed harvest in 2010 was potentially more costly as it would have necessitated more added concentrate to balance the ration, or the lower quality grass might have been fed to dry cows (see Chapter 25). It is important for farmers to be aware of the proportion of tiller types and they should plan to harvest at an earlier growth stage in years with abundant floral tillers.

The decline in quality with time is well known and well documented in the literature. It is less clear how environmental factors affect the change in forage quality because in field research the effects of environment are difficult to tease out from effects of time and maturity. For example, there have been relatively few controlled studies that isolate the effects of drought on forage quality. It is apparent that drought hastens the rate of leaf senescence and this is an indicator of maturity, but what is the effect on a community of floral and non-floral tillers?

We conducted a field study over two years to examine specifically the effect of drought on forage quality. We subjected three grasses, crested wheatgrass (*Agropyron cristatum*), smooth bromegrass and Altai wildrye (*Elymus angustus*) to either irrigation or drought using

Table 1. Percent of floral tillers, leaves and dry matter digestibility (*in vitro*) of a prolific seed producing variety and a non-prolific seed producing variety of smooth bromegrass in northeast Saskatchewan.

	Signal (northern type) %	Rebound (southern type) %
Proportion of floral tillers	76.4	52.0
Leaf proportion		
In non-floral tillers	80.8	76.0
In floral tillers	28.3	35.2
In all herbage	40.2	58.0
Digestibility	63.0	65.7

rain-exclusion shelters from late May until mid-August.

The results shown on Figure 2 combine the data for all three grasses over the two years because the trends were consistent. It is apparent that the effect of drought was opposite for the two quality indicators. Drought accelerated the decline in crude protein concentration in line with an increasing rate of leaf senescence. This effect of drought on crude protein was expected as N was translocated away from the senescing tissue to seed or crowns of plants. We did not distinguish the effect of the floral and non-floral tillers because the trends were similar across the species with widely different proportions of tiller type (crested wheatgrass having the most floral tillers and Altai wild rye having the least).

Why did drought have the effect of improving digestibility relative to the well watered plants or, more accurately, why did drought reduce the rate of decline of digestibility? The decline in digestibility with maturity is caused by the synthesis of fiber associated with lignin in stems and leaves. Drought reduced the rate of metabolic processes, hence the rate of synthesis of compounds that reduce digestibility. The soluble carbohydrates that would have gone into fiber and lignin synthesis were instead stored in the living cells to provide substrate for recovery growth if conditions were to improve or to support cell respiration if drought was to persist.

Our study also helps to explain the observation by some graziers that animal performance on drought-stressed grass may be greater than expected. Because the effect of natural senescence on quality is quite different from the effect of drought-induced senescence, visual cues are not always reliable for assessing forage quality and therefore it is often wise to test forage quality and to use this information in combination with careful observations.

The overall implications of these studies and observations are that it is very helpful for farmers to be mindful of tiller types in their grass fields to minimize risk of crops with unexpectedly poor quality:

1) Young grass swards generally produce more floral tillers than an older sward, with some species such as meadow bromegrass declining less rapidly than others such as crested wheatgrass or smooth bromegrass.
2) Certain weather and management factors trigger more flowering in certain years; if the crop is unusually stemmy, the crop should be harvested sooner to prevent sharp quality decline.
3) It is better to choose varieties with fewer seed panicles although it is safe to say that seed producers do not prefer them; seed may also be a little more costly.

Table 2. Effect of growth stage on nutritional quality of orchardgrass in years with normal (2008-2009) and abundant (2010) reproductive (floral) tillers.

Harvest Stage	Early (Boot) *2008-2010*	Delayed (Flower) *2008-2009*	Delayed (Flower) *2010*
Crude protein (% DM)	14.9	12.7	12.7
NDF (% DM)	58.9	62.8	60.9
Lignin (% NDF)	6.2	6.7	8.6
IVFD (30h)	68.5	62.3	52.5
CH3 - Kd (%/h)	4.9	4.2	3.5

References available online at www.farmwest.com

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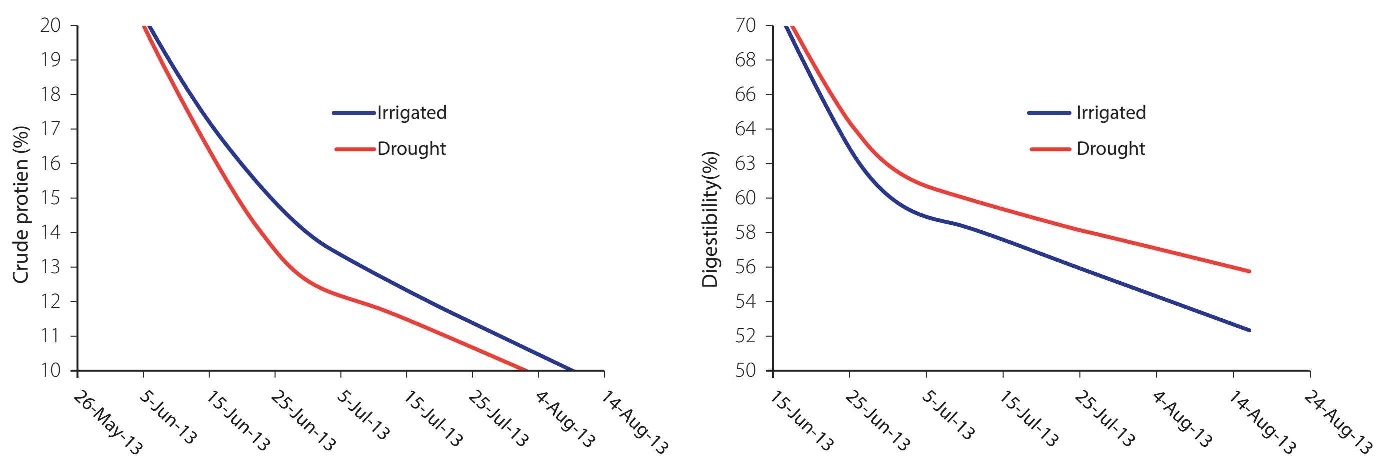

Figure. 2. Drought has an opposite effect on decline of crude protein concentration and digestibility in three forage grasses measured over two years in northeast Saskatchewan (Bittman and Simpson 1988).