Growth Parameters of Forages in a Cool Semi-Arid Climate

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Introduction Comparative studies have been conducted on yield performance of forages adapted to the Parkland region of the Northern Great Plains. However, these studies have failed to provide generalized descriptions of the seasonal growth patterns of these species. The objective of this study was to examine and compare the seasonal growth patterns of forage species in a cool, semi-arid environment.

Materials and methods The field study was conducted in northeast SK, Canada, with mean annual temperature of 1℃, total precipitation of 413 mm and approximately 105 frost free days. Forages (listed in Table 1) were planted in the year prior to the commencement of sampling, arranged in a randomized complete block design (4 blocks), and fertilized with 100 kg N ha^{-1} (except for alfalfa). The forages were sampled regularly from early May to August for 5 years; new plot areas were sampled each time and year to avoid effect of previous sampling. Analysis of variance was done with species as main plot and sampling date as subplot. Also, growth data was fitted to a non-linear Gompertz equation in order to characterize and calculate growth parameters for these species (DAFS is day after first sampling):

$$\text{Yield} = ae^{be(-k\times DAFS)}$$

Results Analysis of variance showed significant species x sampling date interactions. Results from fitted Gompertz equations for each species are presented in Table 1. Maximum growth rate occurred earliest (May 9) and was greatest (indicated by coefficient b) for CWG. Due to rapid early growth, CWG would be available for grazing (based on 1500 kg ha^{-1} standing biomass) about a week earlier than the other species. Growth rate of other perennial species peaked about a week later than CWG (May 16-21) whereas fall rye peaked May 26. Maximum growth rates (MGR) for all perennial species occurred at < 12℃ mean daily temperatures, which is lower than optimum for cool season grasses (15-25℃) (Nelson 1996). MGR occurs during the phenologically-determined stem elongation phase when there is a strong a sink for carbohydrates from the crowns and leaves. Maximum growth rate was lower for MB than CWG possibly due to a weaker sink associate with lower proportion of seed-forming reproductive tillers. The dominant cultivated grass in the region, SB, had an intermediate maximum growth rate. With their more rapid growth and discrete asymptotes (coefficient k), CWG and ALF reached 90% of maximum yield over three weeks before the other grasses, and both species had the lowest ADF and NDF at this milestone (not shown). These crops can be harvested earlier, whereas the optimum date of cutting is less distinct for SB, MB, IWG and AWR. Despite relatively large differences in b and k coefficients, the a (maximum yield) coefficients were similar for all grasses. Paradoxically ALF had the greatest growth rate and the lowest maximum yield, but ALF also has the greatest potential for regrowth after harvest. In this water limited region, early growth (CWG) benefits from lower vapour pressure deficits whereas later growth (IWG and MB) benefits from more abundant precipitation in late-June to early July.

Table 1 *Gompertz coefficients (SE) for fertilized grasses and alfalfa for a 5-yr period in Melfort SK. (a indicates asymptote, b indicates steepness of rapid growth and k reflects flatness of asymptote)*

		a	b	k
Crested wheatgrass (CWG)	*Agropyron cristatum* L. Gaertn.	3.6 (0.1)	6.9 (1.0)	2.7 (0.4)
Altai wildrye (AWR)	*Leymus angustus* Trin. Pilger	3.3 (0.2)	4.6 (0.9)	1.7 (0.3)
Smooth bromegrass (SB)	*Bromus inermis* Leyss.	4.4 (0.2)	5.4 (0.7)	1.9 (0.3)
Meadow bromegrass (MB)	*Bromus biebersteinii* Roem & Schult.	3.8 (0.4)	3.4 (0.7)	1.2 (0.3)
Inter. Wheatgrass (IWG)	*Elytrigia internedia* (Host) Nevski	4.0 (0.2)	4.5 (0.7)	1.6 (0.3)
Alfalfa (ALF)	*Medicago sativa* L.	2.4 (0.1)	9.4 (2.2)	3.4 (0.8)
Fall rye (FR)	*Secale cereale* L.	3.5 (0.2)	7.6 (1.2)	2.6 (0.4)

Conclusions The Gompertz coefficients were effective for describing average growth patterns over 5 years, and the equations were useful for calculating parameters such as dates of critical herbage biomass for grazing or harvesting. The shape of the growth curves reflected attributes of the species such as flowering synchrony and reproductive tendency.

Reference

Nelson CJ. (1996). Physiology and development morphology. pp. 87-126. Moser et al. (eds.) Cool Season Forage Grasses. *American Society of Agronomy Madison WI*.