Dry Matter Yield of Improved Alpine Grasslands Depending on Climate Conditions

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Abstract
Climate conditions in any land area have a direct influence on the productivity level of natural ecosystems and agroecosystems. To assess the yield per area unit, we took into account the amounts of dry matter depending on temperature (1^0C) and precipitations (1 mm) during vegetation. During the experimental period, the mean annual temperature during vegetation was 943^0C, with variations between 775^0C (1997) and $1,175^0$C (2012). This multiannual variation of the thermal constant also influenced the level of dry matter yield per 1^0C, which ranged between 2.14 kg DM/1^0C and 9.08 kg DM/1^0C. As for the amounts of precipitations, dry matter yield varied between 6.02 kg DM/1 mm (2002) and 29.11 kg DM/1 mm (2003).

Keywords: subalpine Nardus stricta grassland; improvement works; dry matter depending on climate conditions.

1. Introduction

The yielding ability of permanent grasslands is strongly correlated with the seasonal and annual evolution of climate conditions as a result of the diversity of the climate gradients (air temperature, precipitations) depending on a series of parameters: altitude, exposition, land orography [1-7].
The paper presents the dry matter yield in relation to the sum of active temperatures and precipitations during vegetation of some Nardus stricta grasslands in the sub-Alpine area of the Bucegi Mountains.

2. Materials and methods

Research was carried out over 17 years (1996-2013) in a complex experiment set out on Nardus stricta grassland in the Bucegi Mountains at 1800 m altitude. The experimental variants were as follows:
- A – natural grassland, not improved, and constantly grazed by cattle for 80 days/year on the average;
- B – natural grassland, improved with the following technology: $N_{150}P_{75}K_{75}$ (during 1996-1998) and cow folding (5 nights, 1 cow/6 m^2) in 2004 and 2010;
- C – natural grassland, improved with the following technology: amendments with CaO (7 t/ha) in 1995, fertilisation with $N_{150}P_{75}K_{75}$ (during 1996-1998) and cow folding (5 nights, 1 cow/6 m^2) in 2003 and 2009;
- D – natural super-sowed grassland improved with the following technology: super-seeding with a mixture of gramineae and perennial legumes (1995), fertilisation with $N_{150}P_{75}K_{75}$ (during 1996-1998) and cow folding (5 nights, 1 cow/6 m^2) in 2002 and 2008. The area of each experimental plot was 0.75 ha; the plot was surrounded by a fixed fence. To assess the yield of dry matter of the

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Nardus stricta grasslands per unit of climate resource, we took into account the amounts of dry matter produced by the active temperatures (1^0C) and precipitations (1 mm) during vegetation (1996-2013).

3. Results and discussion

During the entire experimental period (1996-2013), the mean amount of temperatures during vegetation was 943^0C with variations between 775^0C (1997) and $1,175^0$C (2012). This multi-annual variation of the thermal constant during vegetation also influenced the level of the yield of dry matter per 1^0C. Thus, the yield of DM/1^0C recorded very wide variations from one year to another within 2.14 kg/1^0C and 9.08 kg/1^0C. These variations are not directly correlated with the sum of active temperatures during vegetation; they vary more depending on the level of dry matter yields produced because of the improvement treatments of the Nardus stricta grasslands (Figure 1).

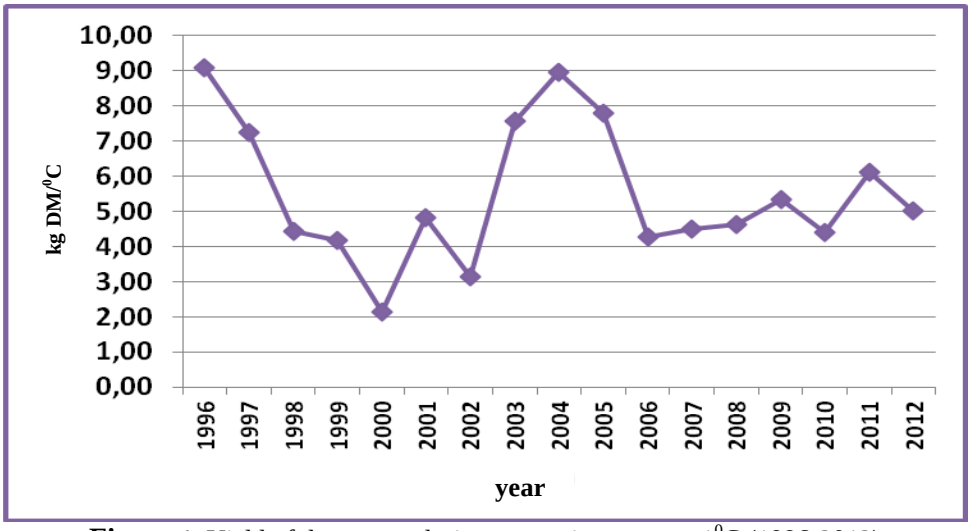

Figure 1. Yield of dry matter during vegetation years at 1^0C (1996-2012)

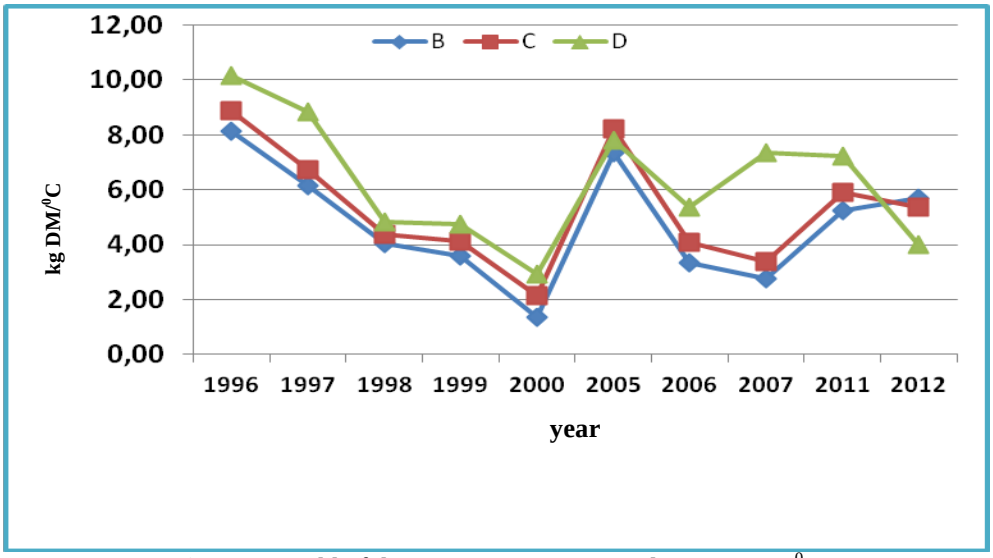

Figure 2. Yield of dry matter in experimental variants at 1^0C

In the experimental variants, dry matter yields depending on the level of active temperature (1^0C) recorded different variation limits depending on both the sum of active temperatures during vegetation and the degree of intensification of the improvement variants, as follows:

- In the variant B (fertilised), the limits ranged between 1.35-2.12 kg DM/1^0C;

- In the variant C (fertilised – amended), the limits ranged between 2.14-8.89 kg DM/1^{0}C;

- In the variant D (re-seeded – fertilised – amended), the limits ranged between 3.98-10.14 kg DM/1^{0}C (Figure 2).

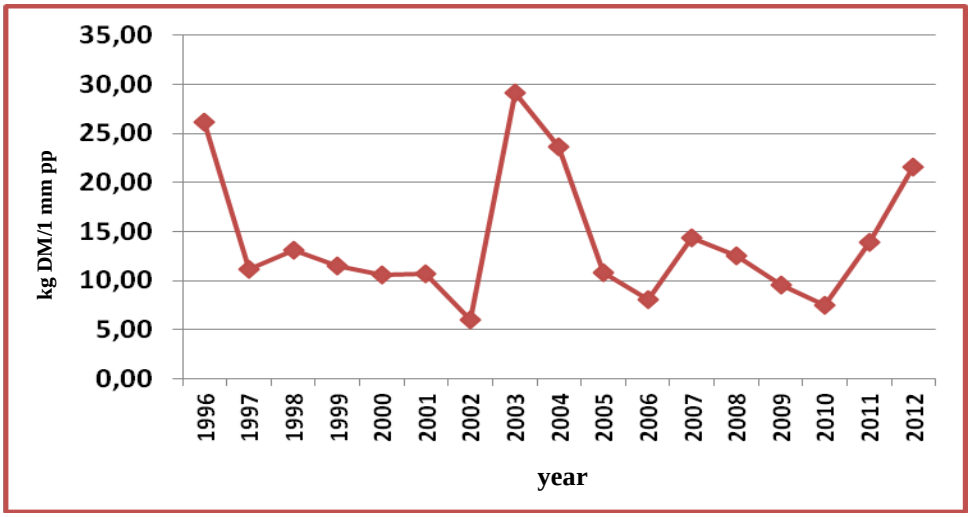

Figure 3. Yield of dry matter during vegetation years at 1 mm precipitations (pp) (1996-2012)

The annual mean amount of precipitations during vegetation and during the experimental period (1996-2013) was 256 mm, with variations between 191 mm (2000) and 607 mm (2010). Data processed and presented in Figure 3 show that the yield of DM per 1 mm of precipitations varied within very wide limits, i.e. between 6.02 kg DM/1 mm (2002) and 29.11 kg DM/1 mm (2003). Results show there is no direct relationship between the total amount of precipitations during vegetation and the yield of dry matter. This was also seen in the yield calculated depending on the sum of active temperatures during vegetation.

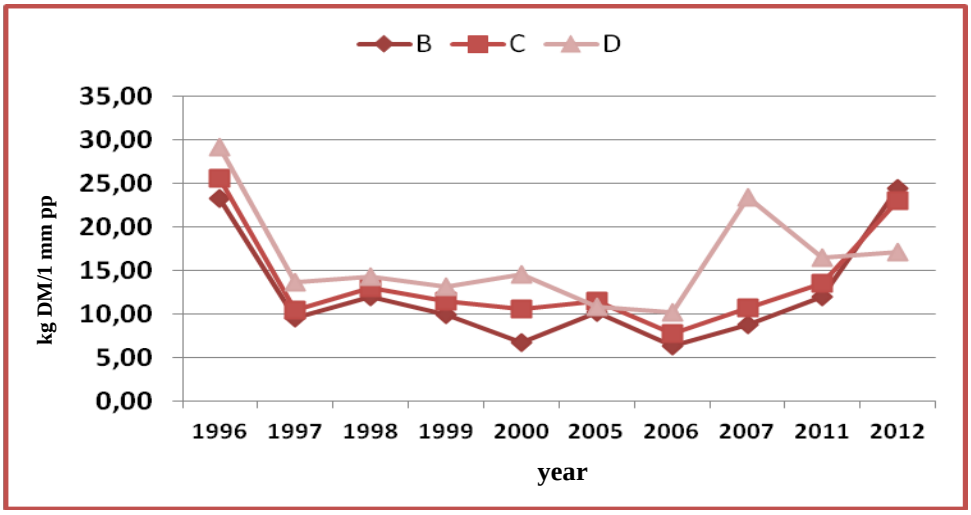

Figure 4. Yield of dry matter in experimental variants at 1 mm precipitations (pp)

The yield calculated depending on the amount of precipitations during vegetation was strongly influenced by the level of dry matter yield after application of improvement treatments on the grasslands, as follows:

- In the variant B (fertilised), the limits ranged between 7.71-25.57 kg DM/1 mm;
- In the variant C (fertilised – amended), the limits ranged between 7.71-25.57 kg DM/1 mm;

- In the variant D (re-seeded – fertilised – amended), the limits ranged between 10.17-29.17 kg DM/1 mm (Figure 4).

In conclusion, in high altitude areas, the yield of natural grasslands is influenced by the interference of the climate factor (temperature, precipitations) and of the improvement technology applied.

4. Conclusions

The yield of DM/1^{0}C recorded very wide variations from one year to another oscillating between 2.14 kg/1^{0}C and 9.08 kg/1^{0}C. These variations are not directly correlated with the sum of active temperatures during vegetation; they vary more depending on the level of dry matter productions after the application of improvement treatments on the *Nardus stricta* grasslands.

Data processed and presented above show that the DM yield per 1 mm or precipitations varied within very wide limits between 6.02 kg DM/1 mm (2002) and 29.11 kg DM/1 mm (2003). As shown by these results, there is no direct relationship between the total amount of precipitations during vegetation and the yield of dry matter. This aspect was also seen in the dry matter yield depending on the sum of active temperatures during vegetation.

In conclusion, in high altitude areas, the yield of natural grasslands is influenced by the interference between the climate factor (temperature, precipitations) and the influence of the improvement technology applied.

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