Yield progress of perennial ryegrass and silage maize – genetic gain or climate change?

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Introduction Gains in annual dry matter yield (DMY) from breeding achieved during the last decades are reported to range between 2.5 and 6% per decade for perennial ryegrass (Wilkins & Humphreys, 2003). In contrast, accelerated progress in improving DMY has been achieved for silage maize, varying between 8 and 13% per decade (Lauer *et al*., 2001). These gains are mainly attributed to (i) genetic yield potential increase, (ii) improved crop management and (iii) increased stress tolerance. The potential impact of climate change on yield progress, however, is disregarded in most studies. The objective of this study therefore was to quantify the contributions of climate change and breeding on yield progress of perennial ryegrass and silage maize by comparing results of long-term simulation studies with data from official variety tests.

Materials and methods Twenty-five year long-term simulations (1979-2003) using the weather-driven *FOPROQ* model (Kornher *et al*., 1991) were run for an early (Gremie) and a late (Vigor) perennial ryegrass grown at a site in northern Germany. A 4-cut system for silage production was assumed together with N fertiliser application of 360 kgN/ha (120/80/80 /80). Corresponding *FOPROQ* simulations for silage maize comprised three early cultivars at two sites (Kiel, Schuby) in northern Germany and two mid-early varieties at five sites (Augsburg, Freising, Nürnberg, Regensburg, Ulm) in southern Germany. Model calibrations are based on multi-year, multi-site field trials. Official variety tests comprise 25 and 18 years of data for perennial ryegrass and silage maize, respectively.

Results and discussion Over the last 25 years mean annual temperature increase ranged between 0.04 °C (Augsburg) and 0.07 °C (Kiel), which was mainly caused by higher temperatures during the vegetation peiod and was accompanied by slightly reduced precipitation. Due to the lower temperature optimum for growth of ryegrass compared to silage maize, temperature increase resulted in less positive effects for ryegrass (Figure 1). Climate-driven yield gains of 0.02 t/ha per year are in the range reported, but variety tests on the other hand show a yield decrease. However, comparability was somewhat limited since the N fertiliser regime was not constant over years. Variety tests for silage maize production in northern Germany indicate yield gains of 0.13 t/ha per year over the last two decades, which, however, can completely be attributed to climate change. Yield gains in southern Germany were substantially lower, caused by a lower temperature increase and a consistently higher temperature. Overall, the study indicates a low contribution of breeding to yield progress of maize and perennial ryegrass. Our results are confirmed by Duvick & Cassman (1999), who found little evidence for an increase of maize grain yield in north-central United States.

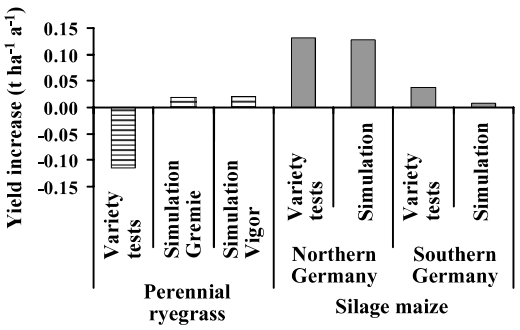

Figure 1 Trends in simulated and observed yield of perennial ryegrass (1979-2003) and silage maize (1986-2003)

Conclusions The yield gains observed for silage over the last two decades can be attributed mainly to climate change, i.e. temperature increase. Simulations for perennial ryegrass showed a slight, climate-driven yield gain, which, however, was not reflected in the variety tests.

References

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