Responses of perennial ryegrass cultivars and their mixtures to white and red clovers as companions in swards

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**Abstract**

The yield potential of swards depends on local climate, soil properties, grass and legume species and their varieties, and management options. The aim of this study is to understand possible interactions between perennial ryegrass cultivars and cultivars mixtures, and growth prospectives in mixtures with clovers. The effects on yield of three tetraploid perennial ryegrass cultivars 'Elena DS', 'Raminta', 'Verseka' and these three in a cultivars-mixture, differed in the two years experiment. The most productive, as a two-year average, was cultivar 'Elena DS' at 8 t ha-1 dry matter yield (DMY). The cultivation of legumes in mixtures with perennial ryegrass was compared with the effect of mineral N fertilizers use in perennial ryegrass monoculture swards. Comparisons between the most productive single-species sward of perennial ryegrass with N150 and a mixture with white and red clover with N0, revealed the DMY was higher for the mixture by 6 %. Only trace amounts of white clover were detected in a mixture with perennial ryegrass and cultivars-mixture in the first year of sward use, and therefore the DMY was not increased significantly by these legumes. In summary, the results of the study suggest that a perennial ryegrass-clovers mixture could be used without additional N fertilizers because no significant differences were found compared with fertilized monoculture sward.

**Keywords:** legumes, nitrogen, monocultures, multi-species, yield-stability

**Introduction**

Gass-legume mixtures are usually higher yielding than unfertilized pure grass swards. The quantity and identity of species in a mixture are important for the mixture’s productivity (Komainda and Isselstein, 2020; Wiering et al., 2021). Cultivar-specific functional traits such as phenology or growth form affect the competitive ability and yield in mixtures (Prerostova et al, 2021). Cultivars and cultivar-mixtures with different functional traits affect productivity and forage quality in mixtures. Little is known about functional traits of different cultivars and cultivar-mixtures. This research reinforces the knowledge about perennial ryegrass cultivars and cultivar-mixtures ability to improve and maintain sward productivity and stability.

**Materials and methods**

An experiment was conducted at the Lithuanian Research Centre for Agriculture and Forestry. In spring 2018, three perennial ryegrass cultivars 'Elena DS', 'Raminta', 'Verseka' and a mixture of cultivars were sown in single-species swards and fertilized at 150 N kg ha-1 per year. Perennial ryegrass ‘Elena DS’ was selected in mixtures with white clover and also with white and red clover, and in cultivars-mixture with no additional fertilization. Each treatment was sown in a fully randomized design with four replicates. Pure seed rates of perennial ryegrass, white and red clover were 18, 10 and 15 kg ha-1. In 2019, the first year of sward use, there were 4 cuttings, and in 2020 there were 5 cuttings with 35 days longer vegetation period than 2019. All cuts were taken depending on the predominant plant species – before perennial ryegrass flowering stage. The swards of the seed mixture treatments consisted of 40% legumes and 60% grasses. The soil in the experimental site was loamy Endocalcaric Epigleyic Cambisol (WRB, 2014); soil P and K availability were high, according to Lithuanian evaluation methods. During this experiment, dry matter yield (DMY) was measured at every cut (harvest) and individual plant species were separated for the evaluation of the botanical composition of the swards. For evaluation of yield, the above-ground biomass including unsown species in a subplot of ≥15 m2 was cut to a height of 5 cm at each harvest. The samples were weighed to determine the fresh matter yield and samples then oven dried at 105 °C and dried samples were weighed to determine the dry matter weight and DMY. Other samples were taken and dried at 65oC for chemical analysis, were ground, to pass through a 2mm sieve. To analyse the effects of the treatment, an analysis of variance (ANOVA) was conducted. Significant differences between the experimental treatments were determined using Duncan’s multiple range test at the 5% probability level (*p* < 0.05).

**Results and discussion**

Comparisons of the differences in sward productivity between the single-species and multi-species swards revealed significant differences in DMY in both the first and the second year of the sward use (P < 0.05). During the two years of the experiment, different dry matter yields were obtained depending on the botanical composition of the swards. In the first year of sward use there was no significant differences between productivity of single ryegrass cultivars and the ryegrass-cultivars mixture, similar to the findings of Tubritt *et al.* (2021).

In the first year of sward use there were significantly higher DMY from single-species swards with different cultivars, and the cultivars-mixture of perennial ryegrass sward fertilized with N at an annual N150 rate, compared with mixtures that contained white clover. The perennial ryegrass cultivar ‘Elena DS’ and white clover mixture showed 24% lower yield, and the cultivars-mixture with white clover a 28% lower yield, compared with average yield of monocultures. Meanwhile, the yield of mixture of perennial ryegrass ‘Elena DS’ with white and red clover did not differ significantly from fertilized single-species swards.

Table 1. The effect of grass mixtures on the productivity, crude protein content and botanical composition of each treatment in each year of the 2-year experiment.1

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | Botanical composition, kg ha-1 | | | | | | | |
| Treatments | Total annual DMY,  kg ha-1 | Crude protein % in DMY | | Perennial ryegrass 'Elena DS' | Perennial ryegrass 'Raminta' | Perennial ryegrass 'Verseka' | Cultivars-mixture E+R+V | White clover | Red clover | Forbs |
| 2019 | | | | | | | | | | |
| 1 (N150) | 7320d | 11.8a | | 7253 |  |  |  |  |  | 68 |
| 2 (N150) | 6940bcd | 12.8ab | |  | 6628 |  |  |  |  | 312 |
| 3 (N150) | 7213cd | 12.1a | |  |  | 7150 |  |  |  | 63 |
| 4 (N150) | 6917bcd | 12.4a | |  |  |  | 6862 |  |  | 56 |
| 5 (N0) | 5392a | 13.4abcd | | 4664 |  |  |  | 648 |  | 80 |
| 6 (N0) | 5139a | 13.4abcd | |  |  |  | 4511 | 476 |  | 152 |
| 7 (N0) | 6695bcd | 14.5bcd | | 3967 |  |  |  | 123 | 2427 | 178 |
| 8 (N0) | 6088ab | 14.7d | |  |  |  | 3940 | 66 | 1783 | 300 |
| 2020 | | | | | | | | | | |
| 1 (N150) | 8699bcd | 10.8a | | 8603 |  |  |  |  |  | 96 |
| 2 (N150) | 6999a | 11.0a | |  | 6935 |  |  |  |  | 64 |
| 3 (N150) | 7492ab | 11.4a | |  |  | 7327 |  |  |  | 166 |
| 4 (N150) | 7981ab | 10.9a | |  |  |  | 7890 |  |  | 92 |
| 5 (N0) | 7423ab | 15.0b | | 4732 |  |  |  | 2617 |  | 74 |
| 6 (N0) | 7271ab | 15.2bcd | |  |  |  | 3934 | 3251 |  | 86 |
| 7 (N0) | 10308d | 16.2d | | 3681 |  |  |  | 732 | 5802 | 92 |
| 8 (N0) | 8243ab | 15.9bcd | |  |  |  | 3150 | 309 | 4723 | 61 |

1Different combinations of letters indicate significantly different means in different years (*P*<0.05, Duncan’s test).

The perennial ryegrass cultivar ‘Elena DS’ here gave higher yield than a three cultivar-mixture grown together with legumes; the yield with white clover, and white and red clover, was higher by 6 and 9% in the first year, and 2 and 20% in the second year of sward use. These results are consistent with results reported in the literature (Lowry et al., 2020). In the second year of sward use the most productive sward was the perennial ryegrass ‘Elena DS’ mixture with white and red clover: this was 1,610 kg ha-1 higher yielding than the most productive monoculture sward which was fertilized. No significant differences were found between other treatments. These two swards were the only treatments that differed significantly in dry matter yield compared with other treatments.

Further analysis showed that, in both experimental years, herbage from the grass-legume mixtures contained significantly more crude protein than that of the other four single-species swards (significant at P=0.05). Assessing the average dry matter yield of the two experimental years, the mixture of perennial ryegrass ‘Elena DS’ with white clover plus red clover was the most productive and had a 6% higher dry matter yield than the most productive fertilized single-species sward of perennial ryegrass ‘Elena DS’.

**Conclusion**

This study has shown that reduction of mineral-N fertilizer use on swards is possible by selecting suitable legumes that, in association with perennial ryegrass cultivars and their mixtures, can help maintain good sward productivity and improve forage quality. Increasing the proportion of legume plants in the sward will contribute to the nitrogen supply of perennial ryegrass and reduce the need for N-fertilization.

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