# ROLE OF FERTILISERS ON PERENNIAL RYEGRASS SEED PRODUCTION AND FORAGE QUALITY

Skaidrite BUMANE[1], Aleksandrs ADAMOVICS[2]
[1]LatvianPlant Protection Research Centre
Struktoru iela14a, LV-1039, Riga, Latvia
[2]Latvia University of Agriculture
Liela street 2, LV-3001, Jelgava, Latvia
Emails: skbumane@inbox.lv, aleksandrs.adamovics@llu.lv

**Abstract.** *Perennial ryegrass is a short-lived bunch-grass with shallow root system and suitable for grazing. It is a major component in different seed mixtures that are used for grassland management and forage production. Ryegrass requires high fertility level for good production especially adequate nitrogen supply. The objective of presented research was to study the effect of fertilisers for seed yield and forage quality of perennial ryegrass. (Lolium perenne L.) 'Spidola' (4n) – a popular forage grass cultivar in Latvia – using different NPK fertiliser application rates. Field experiments was carried out at the Skriveri Research Institute of Agriculture on sod-podzolic sandy loam soil (LuvicPhaeozem, WRB 2014), pHKCl 6.5, plant available* $P_2O_5$ *95 and* $K_2O$ *132 mg* $kg^{-1}$ *(Egner–Riehm), soil organic carbon 20 g* $kg^{-1}$ *(Tyurins' method). The following mineral fertilizer rates were used: N and* $P_2O_2$*, each 0, 30, 60, 90, 120,* $K_2O$ *– 0, 40, 80, 120, 160 kg* $ha^{-1}$*. A randomised complete block design with four replications was used. Obtained 3-year average seed production was from 311 to 727 kg* $ha^{-1}$*, but in 2nd production years – from 102 to 617 kg* $ha^{-1}$*. The highest 3-year average was obtained usingN90 P30 K120 fertiliser application. Increases fertiliser rates increased lodging. The crude protein content in grass ranged between 80-118 g* $kg^{-1}$ *in dry matter (DM). At the end of heading stage, perennial ryegrass had comparatively high crude fibre content (267 to 289 g* $kg^{-1}$ *DM) at all treatments that significantly affected digestibility of forage. The average biomass yield from perennial ryegrass was 2.11-5.77 t* $ha^{-1}$ *(on DM basis). The average chemical composition (on DM basis, g* $kg^{-1)}$*: P 2.1-3.0; K 16.5-2.9; Ca 2.4-3.4; Mg 1.2-1.6.*

**Key words:** *perennial ryegrass, fertility levels, seed production, forage quality.*

## INTRODUCTION

Perennial ryegrass *(Lolium perenne* L.) is one of the most important grass species of temperate regions [1],[2]. The perennial ryegrass has several important performance characteristics, which account for their widespread use and popularity. Among them are high herbage yield, long growing season, tolerance to a wide range of environmental conditions and grazing practices, rapid seedling establishment, weed suppression, excellent persistence under close grazing, compatibility with white clover, and high seed and forage yield as well as palatability [3],[4].

Tetraploid ryegrass cultivar 'Spidola' has improved winter hardiness and its vegetative growth period from start of growth to seed maturation is 115 days. It has shorter plant length, with wider, darker leaves as compared with parent cultivar. This cultivar has excellent response to nitrogen fertilizer application and is suitable for the grass seed production. Growth and seed yield is very good. 'Spidola' is well suited for use in grass mixtures for late season forages and hay production. The objective of this research was to determine seed yield and forage quality for perennial ryegrass 'Spidola" at different rates of mineral nutrition.

## MATERIALS AND METHODS

Field experiments were conducted on sod podzolic sandy loam soil (Luvic Phaeozem, WRB 2014) [5], pHKCl 6.5, plant available P 48 and K 169 mg $kg^{-1}$ (Egner–Riehm), soil organic carbon 12.2 g $kg^{-1}$ (Tyurin's method). The plots were established according to randomised complete block design in four replicates. The plot size was 17 $m^2$. Perennial ryegrass cultivar 'Spidola' was planted after field preparation in the amount of 12 kg $ha^{-1.}$

The following mineral fertilizer rates were used: N and $P_2O_5$ each of them 0, 30, 60, 90 and 120 kg $ha^{-1}$, $K_2O$ – 0, 40, 80, 120 and 160 kg $ha^{-1}$.

Weed control was performed using MCPA herbicides (l liter ha$^{-1}$ in the mixture with 8-10 g ha$^{-1}$granstar). Lodging of the perennial ryegrass stand was evaluated during the growing season using a scale from 1-9 (1 = the stand is completely lodged, 9 = lodging is not observable). The seed and straw yield was determined. Seed yield was recorded for the 1st year sward use.

## RESULTS AND DISCUSSION

The effect of NPK fertilisation on seed and straw yield is shown in Table 1. Application of N fertiliser had a pronounced effect on seed and straw yield over the average of 3-year period. Phosphorus and potassium application had little, if any, effect. Without N fertiliser, the seed yield ranged from 311 to 379 kg ha$^{-1}$. The addition of 30 to 120 kg ha$^{-1}$ of N annually increased the seed yield between 536 and 727 kg ha$^{-1}$.
Increased N application increased lodging as described in literature [6]-[8]. Seed yield response of cool-season grasses to spring-applied N is usually limited because of lodging. Lodging of perennial ryegrass (*Lolium perenne* L.) seed crops is a widespread problem. The estimated lodging resistance was 8.8 scores in perennial ryegrass plots receiving no fertiliser NPK (Table 1). Lodging resistance decreased in plots with increased NPK fertilizer rates. Relatively good perennial ryegrass seed yield could be attained if lodging resistance is around 6-7 scores.

Table 1

**Effect of mineral fertiliser application rates on seed and straw yield of perennial ryegrass 'Spidola'**

| Fertiliser, kg ha$^{-1}$ | | | Lodging resistance, points 1-9 | 1st year, kg ha$^{-1}$ | |
|---|---|---|---|---|---|
| N | $P_2O_5$ | $K_2O$ | | seed yield* | straw yield* |
| 0 | 0 | 0 | 8.8 | 311 | 1958 |
| 0 | 60 | 80 | 8.6 | 379 | 2224 |
| 30 | 30 | 40 | 6.9 | 536 | 3281 |
| 30 | 30 | 120 | 6.2 | 552 | 3633 |
| 30 | 90 | 40 | 6.8 | 538 | 3583 |
| 30 | 90 | 120 | 6.5 | 572 | 3775 |
| 60 | 0 | 80 | 5.4 | 598 | 4377 |
| 60 | 60 | 0 | 5.3 | 569 | 4267 |
| 60 | 60 | 80 | 4.8 | 617 | 4305 |
| 60 | 60 | 160 | 4.2 | 658 | 4892 |
| 60 | 120 | 80 | 4.4 | 594 | 4643 |
| 90 | 30 | 40 | 3.1 | 625 | 4756 |
| 90 | 30 | 120 | 2.5 | 642 | 5279 |
| 90 | 90 | 40 | 2.7 | 713 | 5060 |
| 90 | 90 | 120 | 3.1 | 693 | 5480 |
| 120 | 60 | 80 | 2.1 | 700 | 5822 |
| 120 | 120 | 160 | 2.3 | 727 | 5918 |
| Average | | | 4.9 | 591 | 4309 |
| $LSD_{0,05}$ | | | 0.9 | 52.8 | 576 |

*3-year average
9 – free from lodging

Perennial ryegrass tetraploid *cv.* 'Spidola' was developed at the Skriveri Research Institute of Agriculture of the Latvia University of Agriculture. Perennial ryegrass on the first cut produced the highest DM yield (2.1-5.8 t ha$^{-1}$) using increased mineral fertiliser rates. The ranges of data obtained are presented in Table 2.

Table 2

**Dry matter yield and chemical composition of perennial ryegrass 'Spidola' (first cut, mean 2 years)**

| Fertiliser rate, kg ha$^{-1}$ | | | DM yield, t ha$^{-1}$ | Content in DM, g kg | | | | |
|---|---|---|---|---|---|---|---|---|
| N | $P_2O_5$ | $K_2O$ | | CP | CF | Ash | Fats | Digestibility |
| 0 | 0 | 0 | 2.1 | 77.4 | 266.7 | 4.38 | 2.25 | 59.65 |
| 0 | 60 | 80 | 2.4 | 80.3 | 273.6 | 4.47 | 2.26 | 58.65 |
| 30 | 30 | 40 | 3.3 | 83.3 | 263.2 | 4.53 | 2.44 | 60.83 |
| 30 | 30 | 120 | 3.8 | 83.3 | 260.0 | 4.49 | 2.56 | 61.02 |
| 30 | 90 | 40 | 3.6 | 81.4 | 255.5 | 4.35 | 2.58 | 60.69 |
| 30 | 90 | 120 | 3.8 | 83.8 | 272.8 | 4.74 | 2.68 | 59.40 |
| 60 | 0 | 80 | 4.1 | 85.6 | 255.9 | 4.57 | 2.73 | 60.66 |
| 60 | 60 | 0 | 4.1 | 85.9 | 258.4 | 4.36 | 2.44 | 61.78 |
| 60 | 60 | 80 | 4.4 | 82.1 | 264.4 | 4.63 | 2.65 | 62.46 |
| 60 | 60 | 160 | 4.6 | 91.3 | 272.8 | 5.05 | 2.70 | 60.23 |
| 60 | 120 | 80 | 4.2 | 86.5 | 257.9 | 4.78 | 2.92 | 62.44 |
| 90 | 30 | 40 | 5.1 | 93.3 | 275.5 | 4.50 | 2.72 | 57.52 |
| 90 | 30 | 120 | 5.0 | 101.0 | 272.4 | 5.22 | 2.82 | 57.52 |
| 90 | 90 | 40 | 4.7 | 95.9 | 274.9 | 5.31 | 3.09 | 60.73 |
| 90 | 90 | 120 | 5.5 | 95.9 | 272.8 | 5.31 | 2.85 | 60.77 |
| 120 | 60 | 80 | 5.8 | 107.1 | 289.2 | 5.64 | 3.34 | 58.76 |
| 120 | 120 | 160 | 5.4 | 118.1 | 272.2 | 6.09 | 3.62 | 59.38 |
| $LSD_{0,05}$ | | | 0.5 | 9.4 | 17.3 | 0.37 | 0.45 | 3.37 |

Table 3

**Chemical compositionof perennial ryegrass 'Spidola' (first cut, mean 2 years)**

| Fertiliser rate, kg ha$^{-1}$ | | | Chemical composition, g kg$^{-1}$ | | | |
|---|---|---|---|---|---|---|
| N | $P_2O_5$ | $K_2O$ | P | K | Ca | Mg |
| 0 | 0 | 0 | 2.1 | 16.5 | 2.4 | 1.2 |
| 0 | 60 | 80 | 2.1 | 16.5 | 2.4 | 1.3 |
| 30 | 30 | 40 | 2.1 | 17.6 | 2.6 | 1.3 |
| 30 | 30 | 120 | 2.0 | 17.8 | 2.8 | 1.3 |
| 30 | 90 | 40 | 2.1 | 17.0 | 2.7 | 1.3 |
| 30 | 90 | 120 | 2.4 | 18.3 | 2.5 | 1.3 |
| 60 | 0 | 80 | 2.0 | 18.0 | 2.7 | 1.3 |
| 60 | 60 | 0 | 2.2 | 16.8 | 2.8 | 1.4 |
| 60 | 60 | 80 | 2.1 | 17.7 | 2.6 | 1.3 |
| 60 | 60 | 160 | 2.4 | 20.9 | 3.0 | 1.4 |
| 60 | 120 | 80 | 2.5 | 18.8 | 2.5 | 1.4 |
| 90 | 30 | 40 | 2.2 | 17.6 | 2.9 | 1.3 |
| 90 | 30 | 120 | 2.3 | 20.4 | 2.9 | 1.4 |
| 90 | 90 | 40 | 2.4 | 19.7 | 2.9 | 1.5 |
| 90 | 90 | 120 | 2.5 | 20.5 | 2.9 | 1.4 |
| 120 | 60 | 80 | 2.6 | 19.8 | 3.2 | 1.6 |
| 120 | 120 | 160 | 3.0 | 22.9 | 3.4 | 1.5 |
| $LSD_{0,05}$ | | | 0.2 | 1.5 | 0.3 | 0.1 |

At the end of heading stage, perennial ryegrass 'Spidola' gave comparatively high crude fibre content (256 to 289 g $kg^{-1}$ DM) at all investigated mineral fertiliser rates that significantly affected the chemical composition and digestibility of forage. Crude protein content in perennial ryegrass at this developmental stage is 77-118 g $kg^{-1}$ DM and mineral content is 43.8-60.9 g $kg^{-1}$ DM.

Optimal values for ruminants nutrition for K (20 g $kg^{-1}$ DM), Ca (3-7 g $kg^{-1}$ DM) and P (2 g $kg^{-1}$ DM) are realized through forage obtained. Mg concentration exceeding 2.0 g $kg^{-1}$ DM, is given as a critical value for hypomagnesaemia in farm animals. In our investigations P, K and Ca changed within the range of these parameters, but Mg content accounted only for 1.2-1.6 g $kg^{-1}$ DM (Table 3).

## CONCLUSIONS

Fertilisation especially the use of nitrogen stimulates plant growth and development and as a result increases of seed and straw yield.

Higher seed yield was obtained at minimal (6-7 point) sward lodging.

The first year seed yield of perennial ryegrass cultivar 'Spidola' was in the range 311-727 kg $ha^{-1}$ depending on weather conditions and fertilisation.

Application of balanced quantities of N, P and K fertilisers provides comparatively high DM yield of perennial ryegrass with good herbage quality.

## REFERENCES


1. Wilkins P.W. (1991) Breeding perennial ryegrass for agriculture. *Euphytica* 52, pp 201-214.
2. Gutmane I., Adamovich A. (2007). Productivity and persistency of *Festulolium* and *Lolium × boucheanum* swards. *In: Permanent and Temporary Grassland: Grassland Science in Europe*, Vol. 12, p. 59-62.
3. Tilvikienė V., Venslauskas K., Navickas K., Župerka V., Dabkevičius Z., Kadžiulienė Ž. (2012) The biomass and biogas productivity of perennial grasses, *Žemdirbystė=Agriculture*, Vol. 99, No. 1, pp. 17-22.
4. Kennedy E., O'Donovan M. (2014) Early season dry matter production of three hybrid ryegrass *(Lolium boucheanum)* and two perennial ryegrass *(Lolium perenne)* cultivars. *Grass and Forage Science*. Volume: 69 Issue: 3, pp. 425-430.
5. World Reference Base for Soil Resources. (2014) International soil classification system for naming soils and creating legends for soil maps. *World Soil Resources Reports* No. 106. FAO, Rome, 181 p.
6. Slepetys J. (2001) Changes in the chemical composition of grass seed and stem during the period of ripening. *Biologija*. No. 2, pp. 57-61.
7. Young W.C., Chilcote D., Youngberg H.W. (1999) Chemical dwarfing and the response of cool-season grass seed crops to spring-applied nitrogen. *Agronomy Journal 91* (2) Oregon state Univ., Corvallis, OR 97331-3002, USA, pp. 344-355.
8. Heinsoo K., Melts I., Sammul M., Holm B. (2010) The potential of Estonian semi-natural grasslands for bioenergy production, *Agriculture, Ecosystems and Environment* 137, pp. 86-92.