Development, status and possible improvement of yield and seed quality of forage grasses in Serbia

Rade Stanisavljević¹, Dragoslav Đokić¹, Jasmina Milenković¹, Dragan Teržić¹, Lana Djukanović²
¹Institute for forage crops Krusevac, Globoder 37251; rade.stanisavljevic@ikbks.com
²High School for agriculture, Sabac 15000

Abstract

Grass seed production in Serbia has a tradition of about fifty years, with very pronounced ups and downs. Serbia in some periods exported grass seeds, but nowadays all required quantity of seeds is imported.

During the period of many years of use, height and stability of seed yield were very variable. The advancement and improvement of breeding technology can influence on height and stability of yield. For forage grasses, immediately after harvest, seed dormancy is expressed and this inevitably influences the germination. In the post-harvest ripening and storage, storage conditions are important both for speed of release from dormancy and for maintaining seed viability during seed storage.

To reduce the number of dormant seeds and longer maintenance of high germination during the period of storage, different methods were used for different grass seeds. This suggests the existing need of determining the manner of seed storage for each type of grasses.

Key words: forage grasses, seed yield, seed quality, Serbia

Introduction

The agricultural area of meadows and pastures in Serbia is the one third of the total agricultural land (meadows and pastures 586 827; 715 407 ha) (Statistical yearbook of the Republic of Serbia, 2011).

About 2/3 of meadows and pastures are located in mountain areas. In this rural area are marked demographic trend of depopulation and each production have economical and social character. Therefore, the possibility of improving healthy safe feed and food for human consumption is a big chance in Serbia.

In total expenditure in ruminants, food participates with 50-70% and economical production of meat and milk will be possible with production of low cost food. In order to solve all these problems and improve the livestock feed base, adequate seed types and varieties of quality grasses are very important.

Also, there are the need for the type of seed varieties selected for ornamental purposes (parks, yards) and sports fields. Often grass seed are used to create a carpet of grass and preventing soil erosion on embankments, roadsides, railroads. For this purpose they are well proven grass species seed taken from the natural populations, in which Serbian nature has generously endowed.

First attempts of seed production of grass seed in Serbia date from the thirties of last century. At that extensive agriculture ruminant nutrition was based almost entirely on the fodder, so there was no need for grasses to improve in the meadows and pastures. However, in these circumstances we can not talk about an organized seed production of forage grasses.

The period after the fifties was the beginning of scientific and professional work in the grassland and grass seed. In 1951 the first university book (Đordjevic) was issued, and a doctoral dissertation
was defended in 1965 (Tešić). Scientific papers on the improvement of seed production of forage grasses (Mijatović, 1956; Dordjević, 1958; Ocokoljić, 1958; Stanojević, 1958.) were published, too. Specialized research institution for scientific research and professional work in the area of forage crops and grassland was established in 1961 (Department of Forage Crops).

After that, breeding programs started, and the first domestic varieties of forage grasses were created (cocksfoot K-6 and K-7 in 1976, red fescue K-14 in 1979, French ryegrass K-12 in 1979, and an ornamental grass for special purpose K-park). Yielding, well adapted, native varieties would require intense scientific and technical work on the improvement of seed production technology to achieve high and stable yields of quality grass seed. This seed has enabled improvements in growing technology and utilization of artificial grasslands, and repair of natural meadows and pastures (Stosić and Lazarević, 2007).

Scientists, professionals, workers in cooperatives and agricultural holdings in the period 1960-1970 failed to provide enough forage grass seed for the Serbian market and one part of seed was exported. After this period, the seed of grasses in the world market follows the lower price. In the former state was a regime of free trade, imports began to increase, and national production steadily declined. In the period 1971-1987, domestic grass seed production was enough for production in Serbia for major forage species. This trend continued until 1989. Since 1990, domestic production of forage grass seed is in steady decline. The seeds for sowing the multi-annual forage grasses used almost entirely from foreign varieties.

Production of seed grasses in Serbia re-started since 2000. In the next 12 years at the major forage grass species (cocksfoot, meadow fescue, tall fescue, and red fescue) the production of seed mainly satisfied domestic needs. In this period the number of sheep and cattle in the highland area is quite variable with a tendency to fall (Statistical yearbook of the Republic of Serbia, 2000-2011). It directly reflects the need for seed grasses.

At the end of this period some abroad seed companies organized forage seed production in Serbia. The largest grass seed producers (forage and ornamental) in Europe are: Denmark, Germany, France, Netherlands, Sweden, Finland and Poland, with yields mostly from 600-1600 kg ha⁻¹ (Jensen, 2010). However, the areas under grass seed are reduced in EU countries. Main competition for this production is grain production (wheat, barley, corn) with the stable yields and raising prices. The price of grass seed is on the decline, and the interest of farmers for seed production of grasses decreased. All this affects in recent years, that the EU countries becomes an importer of significant quantities of Forage and ornamental grass seed (Jensen, 2010).

Technology of growing grasses for seed

Forage grasses generally have modest demands of the land. However, due to the large number of species of grasses and requires knowledge of every kind we can choose the most suitable type of soil conditions, altitude and climatic conditions. For example, timothy seed gives poor yields in the lowlands, but gives good results at higher altitudes. Requirements of Italian ryegrass are the opposite. Proper selection of species and varieties can improve the quality and seed yield of forage grasses (in Serbia was granted 32 varieties by 12 different types of grasses (www.sorte.minpolj.gov.rs)). It is possible to significantly improve seed production of grasses by adjusting the choice of varieties, soil conditions and climatic conditions.

Conveniently for this production, the final seed filling occurs mainly in late May and early June. Thus, the harvest is completed before the start of adverse weather conditions with high summer temperatures and drought, which is common in Serbia in this period (http://www.hidmet.sr.gov.yu/eng/meteorologija/klimatologija_srbije.php). However, despite these favorable Environmental conditions yields of forage grasses are variable and generally low, which is mainly attributable to inadequate technology for growing (Vučković et al., 2003; Stanisavljević et al., 2010c).
Sowing grasses for seed production is possible in the autumn period (August-September). At this time, a frequent lack of rainfall or precipitation is late and seedlings have time to develop enough before the winter. Autumn sowing obtains seed yield in the following year. On the other side, sowing in spring (March-April) is safer because there is no danger of frosts or lack of precipitations, but there will be no seed in the current year.

**Vegetation area**

For perennial forage crops (grasses and legumes) extinction of plants and crop thinning is biologically expected during many years of use (mostly 4-5 years). These species have both vegetative and generative stems that are excellent carriers of forage yields, but are unwelcome in the production of seed. The number and ratio of vegetative and generative stems are directly depending on row spacing and seed rate in the establishment. This, together with the different weather and soil conditions during the use of the crop, optimal planting density of plants for seed production seems very complex (Vučković et al., 2003; Sимиć et al. 2009; Stanisavljević et al., 2009a, b, 2012a, b; Stevović et al. 2012).

Very low seeding rate and big row spacing lead to generative stems and problems with weeds, which reduces the yield. In contrast, too dense crop competition for space between plants causes a lot of vegetative stems, shorter and less branched inflorescences, which also negatively affects seed yield (Kusvuran and Tansi, 2011; Darwent and Smith, 1982; Gossen et al. 2002).

Flowering, successful fertilization and seed filling are of great importance for seed formation and high yield of seed. Seed yield also depending on the number of generative stems, inflorescence length, number of branches and the number of fertilized flowers in the branches (Stanisavljević et al. 2007, 2010b).

<table>
<thead>
<tr>
<th>Type - growing conditions</th>
<th>Vegetation area</th>
<th>Seed yield (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cocksfoot-eastern Serbia</td>
<td>seeding rate 12.5 kg ha⁻¹, spacing 25 cm</td>
<td>414</td>
</tr>
<tr>
<td>Cocksfoot-eastern Serbia</td>
<td>Seeding in homes 40 cm x 40 cm.</td>
<td>1469</td>
</tr>
<tr>
<td>Tall fescue-eastern Serbia</td>
<td>seeding rate 12.5 kg ha⁻¹, spacing 25 cm</td>
<td>632</td>
</tr>
<tr>
<td>Italian ryegrass-Srem</td>
<td>seeding rate 20 kg ha⁻¹, spacing 40 cm</td>
<td>1070</td>
</tr>
<tr>
<td>Ryegrass-Srem</td>
<td>seeding rate 20 kg ha⁻¹, spacing 20 cm</td>
<td>656</td>
</tr>
<tr>
<td>Meadow fescue-Srem</td>
<td>seeding rate 8 kg ha⁻¹, spacing 50 cm</td>
<td>745</td>
</tr>
</tbody>
</table>

For cocksfoot in Krusevac highest seed yield (1469 kg ha⁻¹) was achieved by seeding at the distance 40 x 40 cm, which is 45% of the sowing in rows at 40 cm (Tesić, 1965). In east Serbia, at the same species higher yield by 10% was obtained at a density of 25 cm between rows in relation to planting density of 12.5 cm row spacing (Stanisavljević et al., 2010a). In the same conditions and the same testing methods for establishing tall fescue, the distance of 25 cm was also significantly affected the yield increase (Stanisavljević et al., 2009b).

The greatest potential for seed yield in agro ecological conditions of Srem showed Italian ryegrass (1070 kg ha⁻¹) based with 20 kg ha⁻¹ and the spacing of 40 cm (Simić 2009). At the same environmental conditions and with similar spacing (50 cm) and seeding 8 kg ha⁻¹ meadow ryegrass achieved 745 kg ha⁻¹, the ryegrass gave the highest yield (656 kg ha⁻¹) by establishing a 20 kg ha⁻¹ seed in the spacing of 20 cm (Vučković et al., 1998, 2002).
According to Mladenović and Tešić - Jovanović (1983a), when establishing seed crop grasses with optimal spacing during four years of use, yield was not significantly reduced. In the seventh year yield is drastically reduced, which was most pronounced in Phleum pratensis, Poa pratensis and Agrostis alba, while the Arrhennatherum elatius, Festuca pratensis and Festuca arundinacea had a lower decrease in seed yield.

In the world, the results of the effect of optimum spacing on achieved seed yield of grasses are very different. According to Deleuran et al. (2009), in Lolium perenne L. in Denmark (located 55 ° 19’N, 11 ° 24’E), seed yields were in the range from 1139 to 1218 kg ha\(^{-1}\) in cultivar Allegro, from 1286 to 1316 kg ha\(^{-1}\) in cultivar Borvi, and from 1606 to 1733 kg ha\(^{-1}\) in cultivar Tivoli. The best yield was at row spacing of 24 cm and 6 kg ha\(^{-1}\) seed of the cultivar Allegro, while in the other two cultivars, influence of row spacing had no significant effect on yield.

In terms of Canada (55 ° 12’N, 119 ° 23’E) in Festuca arundinacea, seed yield ranged 1171 kg ha\(^{-1}\) to 2576 kg ha\(^{-1}\). Crops planted at 80 cm row spacing obtained significantly higher yields than those sown at the 40 cm and 20 cm (Fairey and Lefkovitch, 1999). In terms of Turkey (Cukurova Region, the area around the city of Adana) on the species Lolium multiflorum, highest seed yield (357 kg ha\(^{-1}\)) was obtained from crop-based spacing of 25 cm (Kusvuran and Tanase, 2011). In eastern Norway (Landvik 58°N and 10 m asl), the highest seed yield was achieved (260 kg ha\(^{-1}\)) of crop-based with 2.5 kg ha\(^{-1}\) seed on Agrostis capillaries (Aamlid and Jonassen, 2007).

**Mineral nutrition**

At the start of the grass seed production in Serbia, scholars and experts have realized the importance of mineral nutrition and started working on the balance of the mineral nutrients and finding optimal rates of application to achieve high and stable seed yield of forage grasses. Crucial time for supply with mineral fertilizers is in the fall, time of differentiation of generative stems (Young, 1978).

However, results of research on mineral nutrition are various due to the changing conditions of soil fertility, different environmental conditions, particularly the lack of rainfall in the autumn. Cocksfoot seed production on poor soils showed a greater effect of potassium than phosphorus and nitrogen (Tešić-Jovanović, 1969).

Research on cocksfoot shows that the application of mineral nutrients N: P: K 90:60:60 -60:60:60 in the autumn, compared to the spring application significantly affected the yield components and yield increase. Also, the application of nitrogen of 90 kg ha\(^{-1}\) compared to the application of 60 kg ha\(^{-1}\) in all treatments increased the yield (Stanisavljević et al., 2009). At the same species using only nitrogen of 50 kg ha\(^{-1}\) increased the seed yield by 100% compared to the treatment without nitrogen (Tešić - Jovanović, 1968).

In Italian ryegrass, in soils with poorly secured phosphorus, nitrogen application of 50 kg ha-1, 100 kg ha-1, 150 kg ha-1 and control without it, in three years trial significantly more seeds were produced using 50 kg ha\(^{-1}\), and in one year (drought conditions) treatments did not show a significant effect on the yield (Simić et al., 2012).

According to Mladenović and Tešić - Jovanović (1983b) optimum quantity of NPK for cocksfoot was 120:80:80 kg ha\(^{-1}\), red fescue 80:80:80 kg ha\(^{-1}\), for timothy 90:50:50 kg ha\(^{-1}\). By examining the optimal time of application of NPK different species respond differently: spring application gave the highest seed yield in Phleum pratense and Agrostis alba, fall in Bromus inermis, Festuca rubra, Poa, and Dactylis glomerata, Arrhenatherum elatius, Festuca pratensis, Festuca arundinacea, Trisetum flavescens have yielded the best results using 1/2 in the fall 2/2 in the spring Mladenović and Tešić-Jovanović (1983a).
The quality of seed and seedling vigor

Immediately after harvest dormant seeds are present and that seeds did not germinate, but the application of acids and temperature can decrease the level of dormancy and increase the germination (Stanisavljević et al., 2012d, 2013). After required ripening period dormant seeds germinate and give normal seedlings. The level of dormancy is determined by complex of physiological and biochemical processes in the seeds, which are different from the kinds of plants (Bewley, 1997), the environment during seed maturation (Fenner, 1991), and even the position of seeds per plant (Andersson and Milberg, 1998).

Immediately after harvest grasses largely express dormancy (Simpson 1990). In studies on the seed guarded in classical warehouse conditions in Serbia according to the type, the seeds need different ripening period after which normally germinate in a high percentage. Phleum pratense seeds for releasing of dormancy take 3 months and germination achieves maximum, seeds of Lolium italicum take 9 months. Seeds of Lolium italicum retain good germination after 27 months, Dactilys glomerata after 21 months, Phleum pratense to 9 months. In each species during period of storage, high seed germination was accompanied by strong seedling vigor (Stanisavljević et al., 2011a).

Arrhenatherum elatius seeds need 7-9 months to get rid of dormancy and achieve maximum germination. The best seedling vigor had obtained in the best germination (Stanisavljević et al., 2008, 2010a). Tests on the same genus (Festuca) showed different initial germination (F. pratensis 60%, F. arundinacea 65%, F. rubra 61%), which was followed by the weaker seedling vigor.

After 8 months the seeds of F. pratensis had a germination of 79%; F. arundinacea 89%, F. rubra 84%. By increasing the germination, proportion of seedlings with better vigor is greater. (Stanisavljević et al., 2010).

Different packaging can affect on post harvest ripening and germination in F. pratensis seed (Stanisavljević et al., 2011b). Packaging also has a significant impact for maximum germination processes of aging and loss of seed germination (Stanisavljević et al., 2012c).

Vegetation area did not show a significant effect on seed germination of perennial ryegrass (Vučković et al., 1998), orchard grass and tall fescue (Stanisavljević et al., 2009 a, b), the Italian ryegrass (Simić et al., 2010), but the effect in all cases was significant for seed germination.

Acknowledgement

Research was financed by the Ministry of Science and Education of Republic of Serbia, project TR31057.

References


http://www.sorte.minpolj.gov.rs


Development, status and possible improvement of yield and seed quality of forage grasses in Serbia


Young H (1978). Plant forage and seed production research at Oregon state. University Corvallis, USA.