EXTERIORIZATION OF QUANTITATIVE TRAITS WITH INFLUENCE ON FORAGE YIELD IN ITALIAN RYEGRASS

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Abstract. *The spread of Italian ryegrass culture worldwide is due to its large yield capacity, superior feed quality and the fact that it is an ideal blending partner. The Italian ryegrass (Lolium multiflorum Lam.) Is a very valuable forage plant with wide possibilities of use in animal feed (green mass, hay, silo) and has a very high capacity to adapt to different types of soils and climates. In this context, the aim of this research is to evaluate the differences between the growth traits and productivity of three varieties of Lolium multiflorum Lam. var. Westerwoldicum, sown in autumn in an area with cold winters. Two alternative tetraploid varieties (Linos and Ivan) and an alternative diploid variety - Sprint (Catalogo-zanandrea-sementi-en.pdf), recommended for green mass and silo, were used as biological material. In order to evaluate the three varieties, the basic green mass feed yield elements (number of tillers, their height and the weight of the bunch) and the green mass yield at the first harvest were taken into account. The results of the research show that the Linos variety recorded the highest weight of the bunch based on the large number of tiller and the height of the tillers. The variations are much larger between the Linos and Ivan varieties based on the number of tillers. The green mass yields of the three Italian ryegrass varieties studied are directly influenced by the values of the yield / bunch traits. Thus, the largest yield of green mass at the first harvest, of 28.9 t.ha-1, was also registered for the Linos variety. This study has a special practical importance, bringing a plus in the technology of cultivation of Italian ryegrass sown in autumn in the conditions of cold winters.*

Keywords*: Italian ryegrass, varieties, agrobiological traits, forage yield.*

INTRODUCTION

Lolium multiflorum Lam., also known as Italian ryegrass, native to southern Europe, it can be used successfully both in pure stands and in mixtures for the establishment of sown meadows. The spread of the Italian ryegrass crop over large areas, both in Europe and in other parts of the world (Piskin, 2007, Li and Nishino, 2013) is due to its large yield capacity, superior forage quality, and numerous opportunities to be cultivated, as well as the fact that this species can be exploited both by mowing and grazing.

Italian ryegrass (*Lolium multiflorum* Lam.) is a very valuable forage plant with a wide range of uses, such as those that need to be covered with a fast-growing vegetative mass, or when high-yielding fodder is needed in a short time (Moisuc A., Đukič D., 2002). In Romania, if it is sown in autumn, in spring it starts very early in the vegetation, so it can be administrated to the animals starting with mid-April (Moisuc et al., 1994).

Italian ryegrass is very well integrated in any livestock farm, having multiple uses: green mass (grazied or mown and administered in the stable), hay, semi-hay and silo.

Babu et al. (2021) reports that *Lolium multiflorum* Lam. silo increases the net yield of farms by increasing milk production on the one hand and saving the cost of additives on the other. Other studies (Lehel et al., 2011, Keles and Demirci, 2011,) have highlighted the clearly superior quality of the silo, which has an impact on animal performance (Baldinger et al., 2014).

The Italian ryegrass is a short-lived, high-yielding, high-quality forage plant (Simic et al., 2009), with varying degrees of palatability and digestibility depending on the stage of vegetation at harvesting (Filya, 2003, Coskun et al., 2014), which gives it a great importance and value in fodder systems (Ozkul et al., 2012).

The Italian ryegrass (*Lolium multiflorum*) grows best on fertile and well-drained soils, but has a very high capacity to adapt to different types of soils and climates (Abraha et al., 2015). However, the factors responsible for the increase of Italian ryegrass yield are water (Akmal and Janssens, 2004) and the nitrogen content of the soil (Wilman, 1970, Eckard, 1989). Being an intensive crop, ryegrass exports large quantities of nutrients, some of which are taken from soil reserves, and a significant part is provided by fertilization. (De Villiers and Van Ryssen, 2001). Italian ryegrass fertilization is done taking into account the nutritional richness of the soil (Rossi et al., 1994) and the intensity of photosynthesis. The latter is hereditarily determined and is equally conditioned by climatic factors, namely the supply of plants with water (Fessehazion et al., 2014) and the available thermal resources.

If nitrogen helps to the increase of the vegetative mass of grasses (Hendrik et al., 2021), the presence of phosphorus and potassium in the soil causes an increased resistance of the plants to winter frost and diseases

(David et al., 2010, Agapie et al. al., 2016, Agapie et al., 2018). With a short vegetation period, it is resistant to diseases and pests (Swanepoel et al., 2021).

Doses of fertilizers, especially those with nitrogen, can be reduced if the Italian ryegrass follows rotation in the first year after a perennial legume or by growing in mixtures with a legume (Karakurt and Ekiz, 1999, Marian et.al., 2011, Rotar et al., 2016). In fact, blends of ryegrass have a double effect, both economically (Cojocariu et al., 2008, Marian et.al., 2009, Kusvuran et al., 2014, Iuga et al., 2017) and environmentally (Ranck et al., 2020). At the same time, it is a soil-improving plant with the ability to enrich the soil with organic matter (Luminița Cojocariu, 2005).

Achieving a high yield of Italian ryegrass, as well as other plants, consists primarily in using valuable varieties adapted to the area, the use of seeds conditioned and properly stored in warehouses (Duda and Imbrea, 2012) and respecting all technological links of the culture.

The aim of this research is to evaluate the differences between the growth traits and productivity of three varieties of *Lolium multiflorum* Lam. var. *Westerwoldicum*, sown in autumn in an area with cold winters.

MATERIAL AND METHODS

Experimental site

The experimental plot was located in the experimental field of the Forage Plant Improvement Laboratory, from Lovrin Agricultural Research and Development Station, Timiş County (fig. 1).

The experimental site is located in the Aranca Plain, a subunit of the Banat Plain.

From the altimetric point of view, the Banat plain is characterized by low altitudes comprised between 75 - 180 m and has a general inclination from east to west (Munteanu and Munteanu, 1998, Posea, 2006).

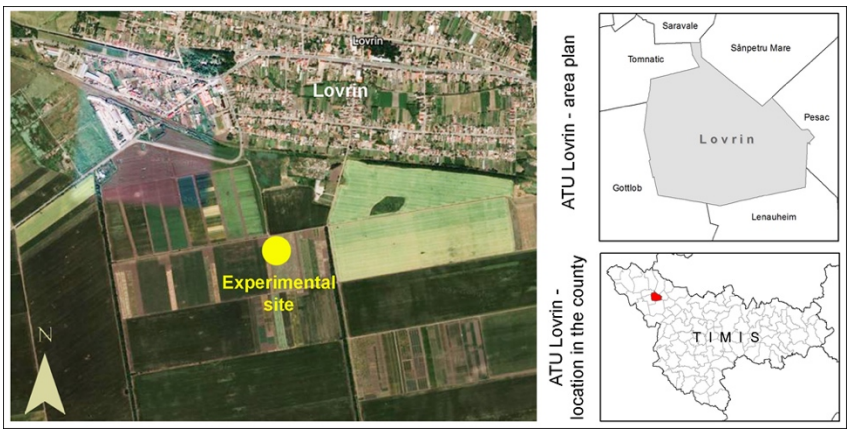


Figure 1. Location of the study area
(processed according to ANCPI, www.geo-spatial.org/, ArcGIS Documentation)

Analysis of environmental factors

In the analyzed area, the multiannual average temperatures recorded at the three nearby meteorological stations (Timişoara, Jimbolia and Sânnicolau Mare) didn't register significant variations compared with the average value of the last 10 years that was 12.3°C (https://rp5.ru/Vremea_%C3%AEn_Regiunea_Vest).

The shadow-thermal diagram (fig. 2), according to the Gaussen model, associates the two factors that influence the Italian ryegrass culture, respectively the temperatures and precipitations during the vegetation period. The model is based on the assumption that if the precipitations / temperature ratio is <2 in a certain month of the year, it shall be considered dry. In the case of the study area, all monthly average valueswere above this threshold.
Figure 2 shows the climatic conditions (fig. 2) durind the experiment.

The Italian ryegrass was sown in September 2020, a dry month with a p/t ratio of 2.1, a situation that is repeated in November. Since the establishment of the culture, the lowest temperatures were registered in December, the minimum value being -6.2^{0}C, on 02.12.2020. In the first months of 2021 the temperatures remain low in the interval 01.01.2021 - 31.03.2021, the lowest thermal value, of -12.20C being recorded on 18.01.2021.

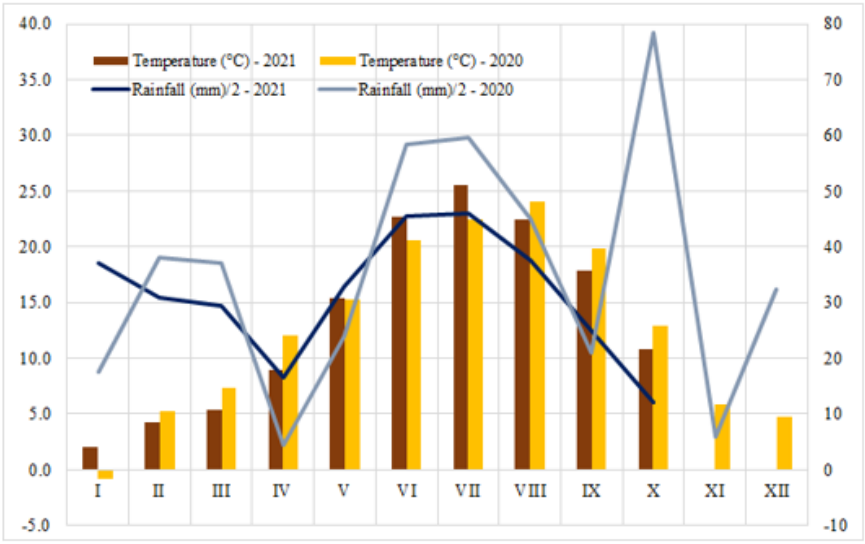


Figure 2. Monthly averages of the thermal values and monthly rainfall amounts during period 2020-2021
(processed according to https://rp5.ru/Vremea_%C3%AEn_S%C3%A2nnicolau_Mare)

During the vegetation period of the Italian ryegrass, in April and May (2021), temperatures were rising amid low rainfall, especially in April. However, Italian ryegrass plants have benefited from the winter water supply.

At the level of the study area, the chernisols class predominates, with the chernozem type.

Research material and methodology

In the research were used as biological material three varieties of Italian ryegrass (*Lolium multiflorum* Lam. var. *Westerwoldicum*), found in the catalog of the Company Zanandrea Sementi, respectively two alternative tetraploid varieties (Linos and Ivan) and an alternative diploid variety - Sprint (Catalogo-zanandrea-sementi-en.pdf), recommended for green mass and silo.

The experimental plots wer sown in September 2020, when weather was favourable. As the yield of green mass was pursued, it was sown with a distance between rows of 28 cm, thus providing a nutrition space corresponding to the development of Italian ryegrass bunches. The sowing material was obtained in the previous year at Lovrin. The seeding rate has been adapted to the requirements, considering a standard of 15 kg/ha^{-1}.

The experiment was based on the randomized block method, in three replicates, the surface of a plot being 20 sqm (4m x 5m). The rotation within the forage crop and the other technological links specific to the crop were observed both in terms of soil work and during the vegetation period. 100 kg of active element nitrogen (N) was applied to the crop, fractioned as follows: 50 kg N in autumn of 2020, after sowing, to help the Italian ryegrass plants to start growing and to accumulate the reserve substances necessary to pass the period of winter, and 50 kg N in March 2021 to stimulate plants to develop their vegetative mass.

The basic green mass forage yield elements, in assessing the productivity of the three varieties of Italian ryegrass, were: the number of tillers (plants) - NP and their height - HP , with an influence on the weight of the bunch (plants) - WP; in the paper being presented only the data recorded in the phenophase of earing (May 10). An average of thirty pre-harvest measurements were taken into account.

The green mass yield, at the first harvest, of the three varieties was determined by mowing a square meter per sample, weighing and reporting per hectare (Cojocariu, 2005).

Statistical evaluation of the experimental results

Several programs were used for the statistical analysis of the experimental data: Excel 2010, Statistics 10 (free version).

RESULTS AND DISCUSSIONS

Vegetative mass analysis on the bunch

The genotype and the complex interactions with the environmental factors influence the grass yield, and highlights the need to know the architecture of yield components (Ciulcă et al., 2011).

Under the conditions of Lovrin, the main yield traits with a role on the yield of green mass / plant were analyzed, in the varieties of *Lolium multiflorum* var. *Westerwoldicum* Linos, Sprint and Ivan.

The graphic representation of the development areas of the main yield traits, for the three Italian ryegrass varieties analyzed is presented in Fig.3.

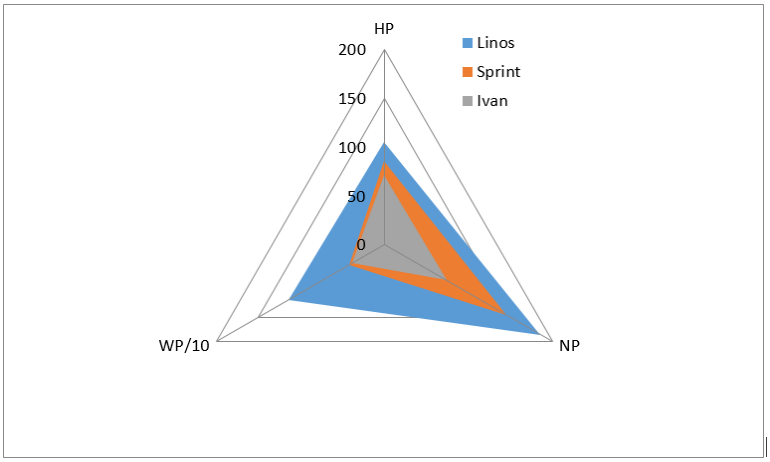


Figure 3. Representation of areas of development of plant traits in Italian ryegrass
[Legend: plants height (HP), number of tillers, plants (NP) and the weight of the bunch, plants (WP/10)]

Figure 3 shows that the variety Linos recorded the highest bunch weight based on the large number of tillers and the great height of the tillers. The variations are much larger between the varieties Linos and Ivan based on the number of tillers.

The Italian ryegrass varieties Ivan and Sprint registered, in the conditions of 2021, the weakest development in terms of bunch weight, compared to the Linos variety (Fig.4). In the range of values 50-100 are the variety Ivan and Sprint for the trait height of the tillers (71.5 cm, respectively 85.3 cm) and for the trait the number of tillers variety Ivan (73.9). The Linos variety in terms of the height of the tillers (105.6 cm) and the Sprint variety in terms of the number of tillers (145.4) are in the range 100-150. In the last class 150-200, the Linos variety stands out in terms of the number of tillers (185.2).

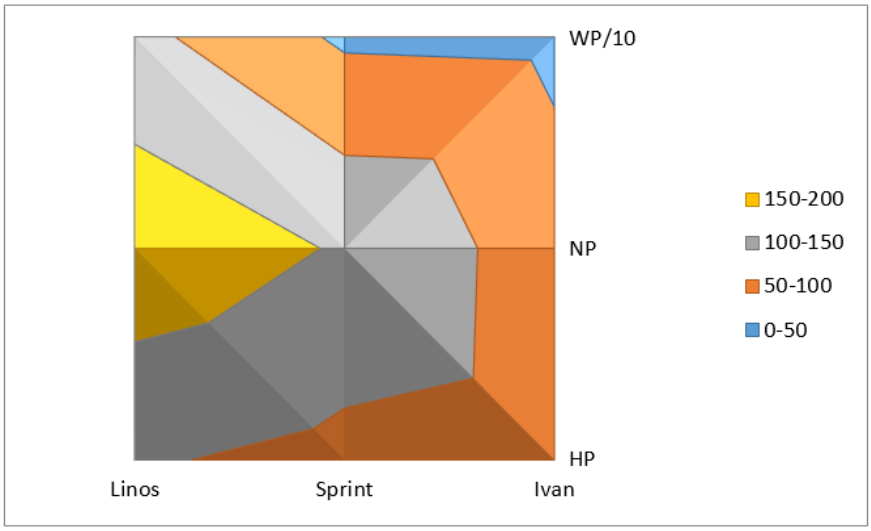


Figure 4. Spatial representation of data
[Legend: plants height (HP), number of tillers, plants (NP) and the weight of the bunch, plants (WP/10)]

In the Italian ryegrass, an important role is played by research undertaken in the field of agro-biology of the species (Varga et al., 1998, Moga and Schitea, 2005, Choi et al., 2005), which highlighs the ecological and agrotechnical factors that condition development of tillers, with implications on the yield.

Green mass yield results

The green mass yields for the three studied Italian ryegrass varieties (Fig.5) were directly influenced by the values of the yield traits. Thus, it was found that the highest yield of green mass at the first harvest, in the conditions from Lovrin was recorded in the Italian ryegrass variety Linos (28.9 $t.ha^{-1}$). This indicates that this variety has a high genetic stability and has managed to successfully pass the autumn-winter period (2020 – 2021); winters in Romania being much harsher than in Italy, the country in which it was created this variety.

In the same agrofond and climatic conditions, the Italian ryegrass variety Sprint obtained an average yield of 26.5 $t.ha^{-1}$ green mass and the variety Ivan recorded an average yield of 25.4 $t.ha^{-1}$ green mass..

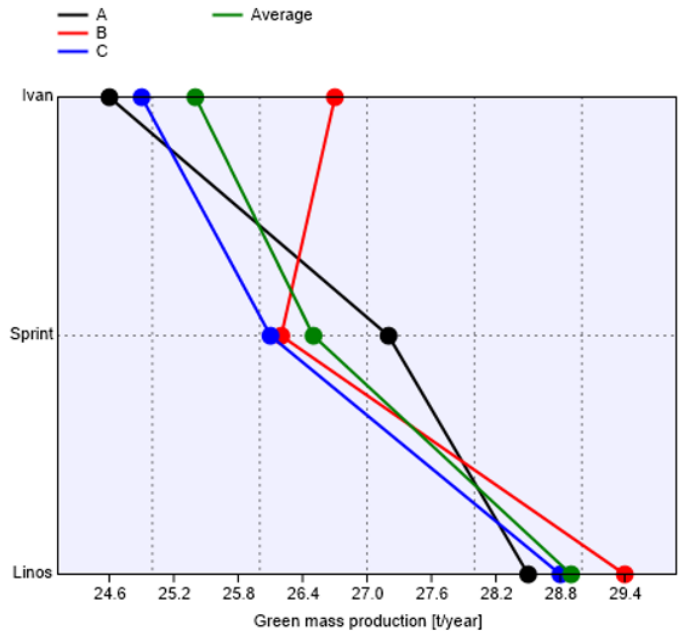


Figure 5. Graphical liniear representation of green mass yield for three varietis or Italian ryegrass

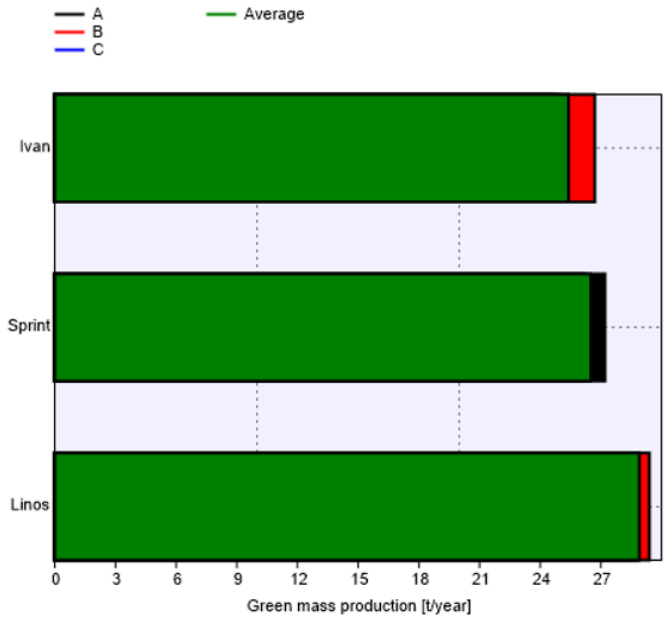


Figure 6. Barchart representation of green mass yield

Figure 6 shows that the largest variation in green mass yield was determined for the Italian ryegrass variety Ivan for variant B, followed by Sprint variety for variant A and Linos for variant B.

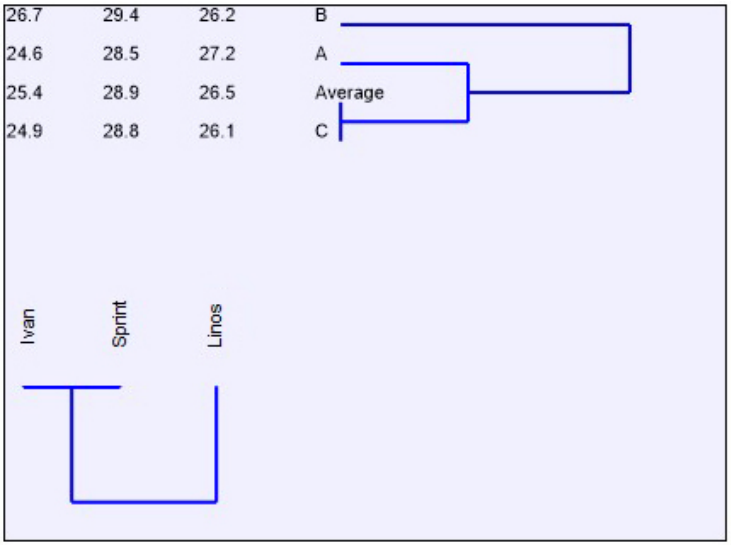


Figure 7. Cluster analysis of data

The cluster analysis of green mass yields (Fig.7.) was performed using the correlation similarity measure based on the pair group algorithm. The graph shows that the Italian ryegrass varieties Sprint and Ivan behave similarly in terms of green mass yield, while the variety Linos shows great differences.

Italian ryegrass has been the subject of numerous researches in various ecological areas, where the main technological elements of cultivation have been addressed (Iacob et al., 2000, Van der Colf, et al., 2014, Charné et al., 2020).

CONCLUSIONS

Analysis of the three varieties of *Lolium multiflorum* Lam. var. *Westerwoldicum*, of Italian origin, grown under the conditions of the A.R.D.S. Lovrin points out that the Linos variety has the highest bunch weight based on the large number of tillers and the grat height of the tillers. The variations are much greater between the Linos and Ivan varieties in terms of the number of tillers.

The green mass yields of the three Italian ryegrass varieties studied are directly influenced by the parameters of the yield traits. Similarly, the highest green mass yield at the first harvest was recorded in the Italian ryegrass variety Linos of 28.9 $t.ha^{-1}$. This variety has managed to successfully pass the autumn-winter period (2020 - 2021); winters in Romania being much harsher than in Italy, the country in which the variety was created.

In the same conditions of agrofond and climate, the Italian ryegrass variety Sprint obtained an average yield of 26.5 $t.ha^{-1}$ green mass and the variety Ivan recorded an average yield of 25.4 $t.ha^{-1}$ green mass.

This study has a special practical importance, bringing a plus in the technology of cultivation of Italian ryegrass sown in autumn. All three varieties analyzed have successfully passed the winter season and provided green mass forage in the first part of spring.

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