Changes in Biomass Accumulation and Soil Properties After Fertilization of Ryegrass.

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Abstract

A containers experiment was carried out in four variants with fertilization of ryegrass: 1th and 2nd trials, with the addition of 1ml and 5ml of organic fertilizer "Siapton" and 3th and 4th trials: a combination of Siapton (0.5 ml fertilizer in 50 ml of water) with the mineral fertilizer "Kristalon" in quantity of 0.5 and 2 grams respectively. There was used also a control. It is accounted a higher accumulation of organic matter (content of C% and N%) in leaves of ryegrass after fertilizing in comparison with the control. Accumulation of dry matter also is higher in fertilized variants (27.09 ÷ 37.62) compared to the control (25.99g). This difference is not confirmed and does not recorded in relation to the roots of ryegrass. Acidification of soils is changed towards a higher pH (5.5 ÷ 6.4) in fertilized variants in comparison with the control (pH = 5.2). The humus composition was studied by the method of Kononova - Belchikova, but apparent differences were not accounted in relation to the use of organic and mineral fertilizers. The content of humic acids extracted with pyrophosphate calculated according the weight of soil samples is lowest in control (1.02%), where the content of fulvic acids is high (0.40%).

Key words: organic mass, dry weight, humic and fulvic acids

Introduction

Ryegrass (*Lolium Perennel L.*) is a short-lived grassy species. It is used as a forerunner of many crops as it develops a powerful root system and thus improves the soil structure, increases overall soil moisture and nitrifying ability. Ryegrass has a special place in the cities, the landscaping of recreational areas and sports grounds. It also participates in improving the aesthetic features of gardens, parks, family houses and amusement facilities. As a one-year-old grassy species, ryegrass also has a place into the composition of many fodder mixtures. Rich in protein and energy quality high-quality fodder is obtained by cross-sowing of ryegrass and white clover (Mihovski and Sabeva, 2011). As a forage culture, it can also be used in a number of agroforestry systems (Kachova et al., 2018). And this: increasing the yield and quality of forage and creating weed-free areas is an important part of the tasks in modern agriculture. Ryegrass is also used for afforestation of lead-contaminated lands to cover the objectives of phytoremediation (Bgantzova, 2009). Petrova (1992) uses the fertilization of ryegrass during its cultivation on heavy metals contaminated substrates of phosphogypsum and pyrite sludge in order to improve its state. Ryegras reacted violently after the fertilizers were brought into. Fertilization has a positive effect on its state. In general, it can be affirmed that the use of fertilizers in ryegrass cultivation leads to an increase in yield, improvement of its condition and reduction of negative effects (Vassilev, 2004, 2006, Dimitrova, 1995). Fertilization can also improve soil properties (Valchovski et al., 2014).

The aim of the present study is to trace the effect of fertilization of ryegrass with organic and mineral fertilizers on the accumulation of biomass and the soil properties.

For this purpose organic fertilizer are used - "Sapton", which is new for the Bulgarian market and mineral fertilizer "Kristalon", rich in N, P, K and other nutrients.

Material and Methods

In the spring of 2017, ryegrass (*Lolium Perennel* L.) was seeded in containers of 500ml volume in a dose of 0.2 grams seeds per container. The soil was sieved and cleaned up by roots. Soil type is *Vertisols* and it was taken from the yard of the Forest Research Institute - BAS. After 29 days fertilizers were applied and after 30 days treatment was repeated. The following experimental variants were used:

- Treatment1. Fertilizing with 1 ml of "Siapton" organic fertilizer dissolved in 50 ml of water.
- Treatment 2. Fertilizing with 5 ml of "Siapton" organic fertilizer dissolved in 50 ml of water.
- Treatment 3. Fertilizing with 0.5ml organic fertilizer "Siapton", dissolved in 50ml of water and 0.5g „Kristalone" mineral fertilizer.
- Treatment-4. Fertilizing with 0.5ml organic fertilizer "Siapton", dissolved in 50ml of water and 2g "Kristalone" mineral fertilizer.
- Treatment 5 - control without fertilizing.

Each treatment was repeated in 7 repetitions. The control was in 14 repetitions. Thus, all containers with the control were 49 in numbers.

Throughout the experiment, constant moisture was maintained, with even watering of all containers. The organic fertilizer "Siapton" was developed on the basis of naturally hydrated proteins from firm "Chemtura Europe Limited", UK. This organic fertilizer is specialized in increasing yield and quality of production and activating protection forces of crops. The composition given by the manufacturer is: total organic ammonium nitrogen up to 4%; organic carbon - 25%; amino acids with animal origin - 54.34%. The "Kristalon" mineral fertilizer is a production of firm "Hydro Agro Rotterdam", the Netherlands. Contains N, P, K, Mg as the main ingredient and other trace elements.

In September, the ryegrass was removed with the roots, washed and dried at 105 ° C to a constant dry weight. Plant samples (roots and leaves) for C and N content were taken. Carbon was determined with a bichromic mixture (0.4N K2Gr2O7 + k.H2SO4) in a plant sample of 0.05g through the method for determination of carbon in soil samples (Donov et al., 1974). The nitrogen in the plant samples was burnt with k.H_2SO_4 and H_2O_2 and determined with a Parnas-Wagner apparatus with 50% NaOH and titrated with 0.02N H_2SO_4. Soil samples were analyzed for C - Thurin method, N - Keldahl method, and composition of humus - by the method of Kononova - Belchikova (1961).

Results and Discussion

After dry weight measurement, it has been found that fertilization produces a corresponding effect in the accumulation of biomass in the grassland. The results are presented in Fig. 1. On the figure are also given the weight of the roots.

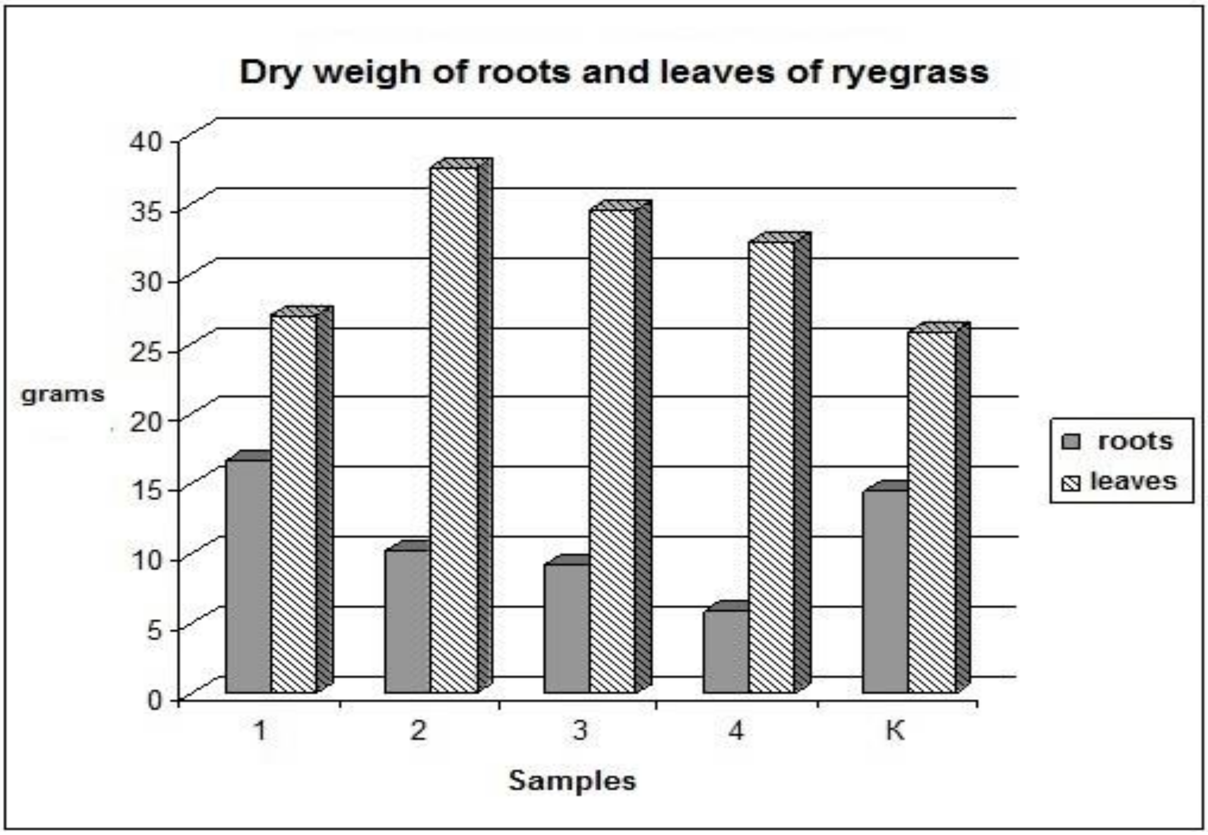

Figure 1. *Dry weigh of roots and leaves of ryegrass*

The biomass of the roots far exceeds that which is accumulated in the leaves. It confirms the fact that ryegrass develops a powerful root system. The lowest is the weight in the unfertiliezed variant - the control. The best is accumulated leaf biomass in the ryegrass of Treatment 2, in which we used the largest amount of organic fertilizer "Sapton" - 5 ml, dissolved in 50 ml of water. In the roots, this effect is not observed. Fertilization, including with mineral fertilizer, does not affect the accumulation of biomass in the roots. On the contrary, the untreated variant (the control) also accumulates a large amount of root mass.

Particularly well fertilization influences the content of carbon and nitrogen in the leaves - fig. 2, especially that of carbon.

The control has the lowest amount of carbon stored in the leaf mass of ryegrass. Fertilizing with “Siapton” organic fertilizer improves the carbon and nitrogen accumulation in the leaves, especially when using more fertilizer - Treatment 2 (5ml). Especially advantageous is the use of “Kristalon“ mineral fertilizer (Treatment 3 and Treatment 4). The maximum amount of carbon and nitrogen we have at the experiment with the lower dose of “Kristalon“ (Treatment 3). Perhaps the higher dose is not well combined with the use of the organic fertilizer "Siapton".

This is not the case with the accumulation of carbon and nitrogen in the roots of ryegrass - fig. 3. Even on the contrary, the control also has significant carbon and nitrogen content in the roots. Here we found a lack of effect from fertilization with here used specific fertilizers with specific doses on biomass accumulation and carbon and nitrogen content in the ryegrass roots.

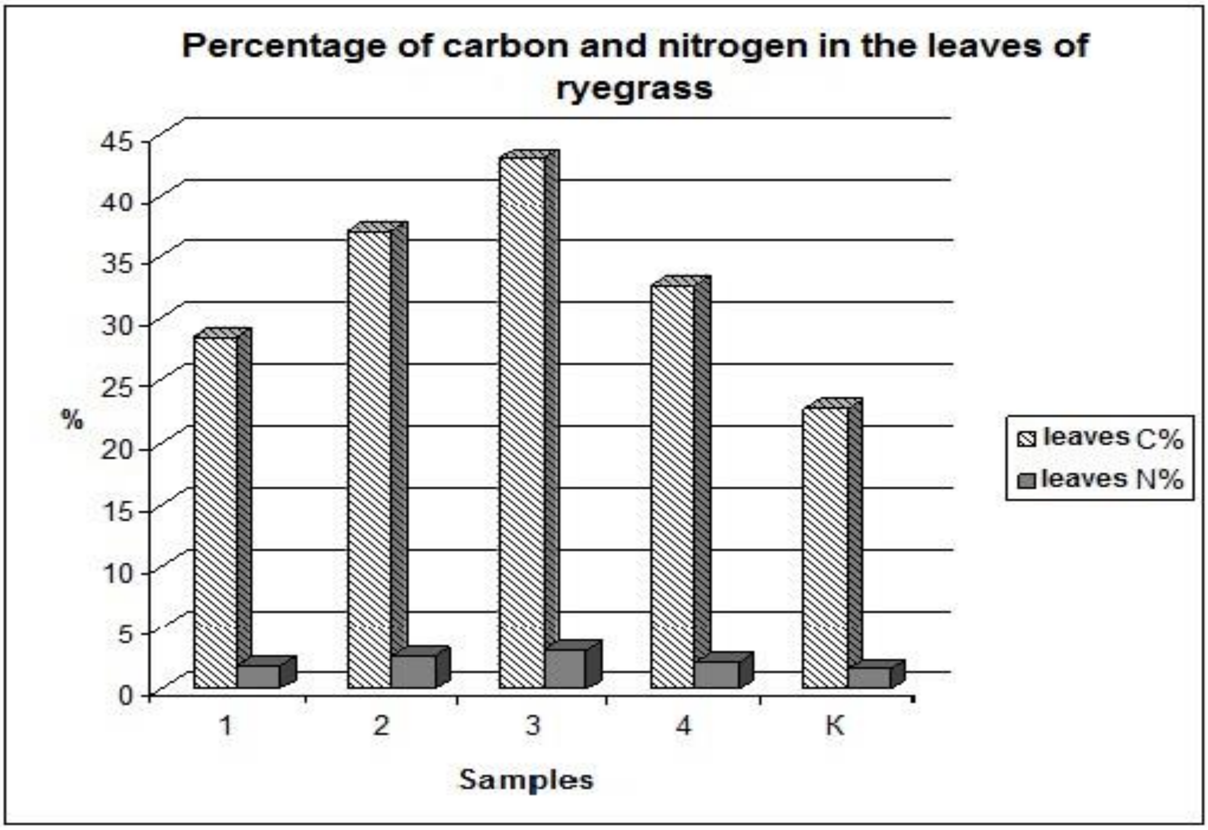

Figure 2. *Percentage of carbon and nitrogen in the leaves of ryegrass*

In soil studies the main results are given in Table 1. The results are mean values of the 7 repetitions.

Table 1. *Main characteristics of soil*

Experiment	pH	C%	N%	C/N
1	5.55	4.6	0.5	9.2
2	6.14	3.9	0.4	9.8
3	6.34	3.9	0.4	9.8
4	6.29	3.8	0.4	9.5
K	5.24	3.8	0.4	9.5

Soil acidity is favorably influenced by fertilization with organic and mineral fertilizers. From a moderate acidic reaction in the control (pH = 5.24), the acidity decreases to a slightly acidic (Treatments 2, 3, 4) which acidity is more favorable for vegetation development. The carbon and nitrogen content of the soil is also affected by fertilization. Particularly beneficial is their content in Treatment 1. But the t-test done did not show statistical proven differences between contents of C and N in fertilized variants in relation to the control. Overall, however, in all Treatments, the C/N ratio is very low (<16), indicating that the mineralization processes in this soil are delayed and the humus formation proceeds at a low speed.

The analysis of humus composition according Cononova - Balchikova was also made. It determines the total content of humic and fulvic acids using a mixed solution of 0.1 M $Na_4P_2O_7$ and 0.1M NaOH (Table 2).

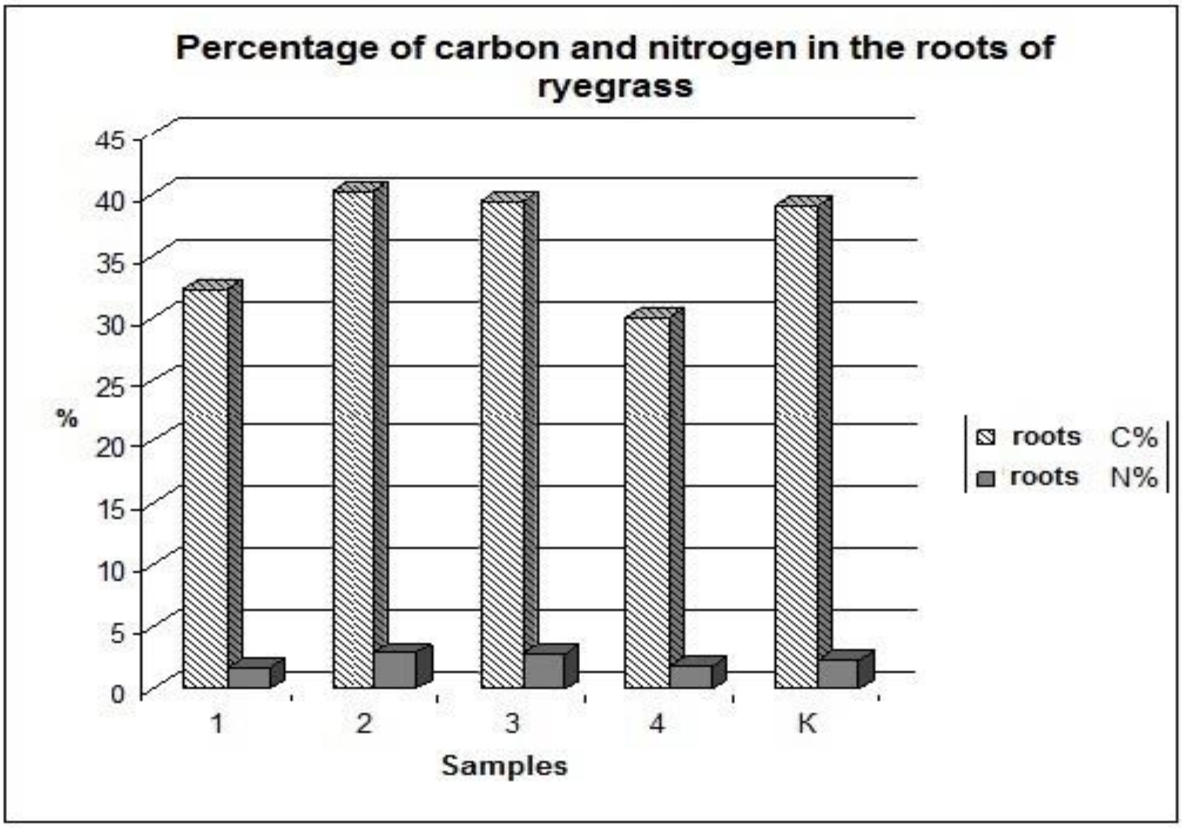

Figure 3. *Percentage of carbon and nitrogen in the roots of ryegrass*

The table shows the percentages of the total carbon extracted with the pyrophosphate extract; the amount of humic and fulvic acids; “aggressive” fulvic acids and carbon in the residue. Each percentage is calculated towards the weight of soil sample, taken for analysis.

Table 2. *Humus composition*

Experiment	C in pyrophosphate extract %	Humic acids %	Fulvic acids %	C in the residue %	“Aggressive” Fulvic acids %
1	1.59	1.32	0.27	2.99	0.20
2	1.72	1.25	0.47	1.66	0.19
3	1.62	1.08	0.54	2.27	0.08
4	1.42	1.15	0.27	2.40	0.23
K	1.42	1.02	0.4	2.4	0.08

Carbon in the pyrophosphate extract is low (~ 1%). On the contrary, the non-extracted carbon retained in the residue is in a higher percentage (~ 2%). Fertilization favorably affects the content of humic acids. Humic acids are more stable organic acids in composition to organic matter. They sequester of larger amounts of carbon in its composition. In this sense the effect of fertilisation is in relation with sequestration of carbon in the system.The lowest is the percentage of humic acids in the unfertilized variant (control). On the contrary, the percentage of the more unstable and more easily mobile fulvic acids in the soil is high in the control (0.4%). Aggressive fulvic acids, however, are not high in this non-fertilized variant, probably due to the low level of carbon extraction in the pyrophosphate extract.

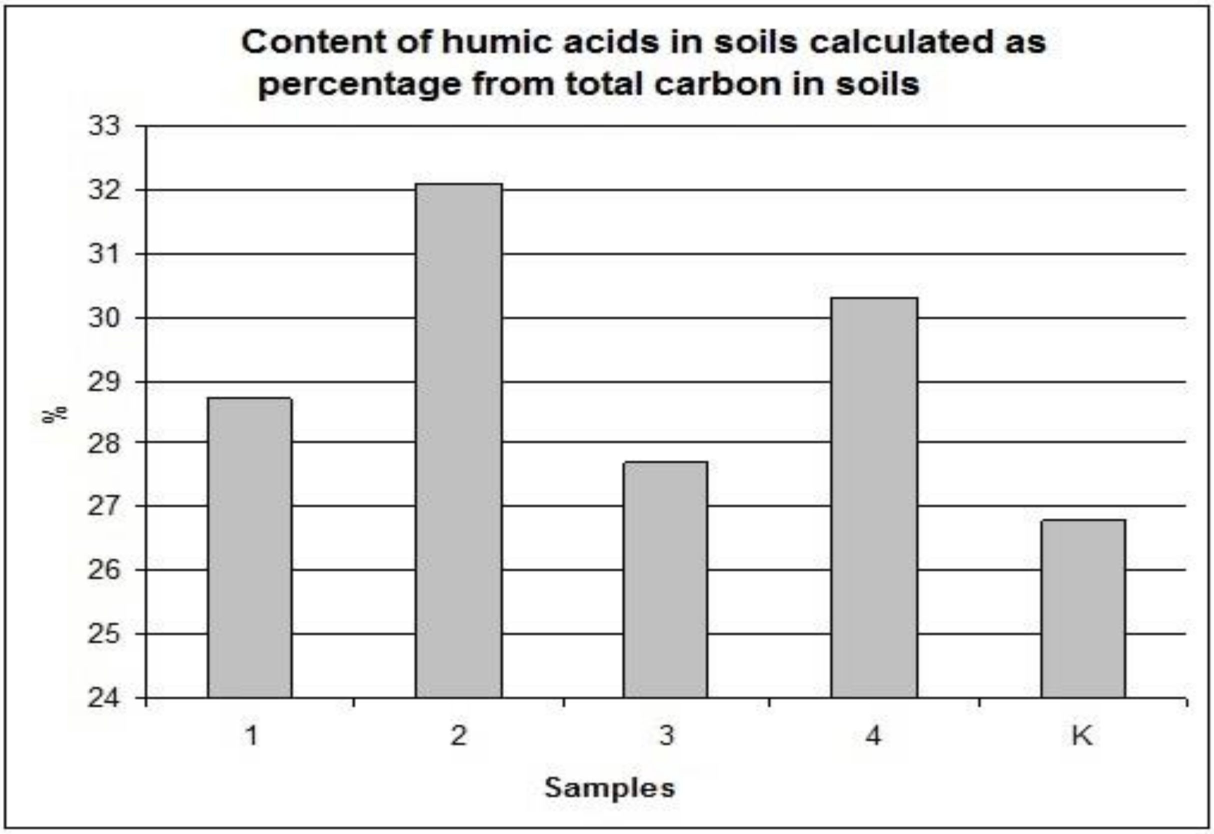

Figure 4. *Content of humic acids in soils calculated as percentage from total carbon in soils*

If, however, we calculate the amount of humic acids not in relation to the quantity of the sample but as a percentage of the total carbon content in the soil (Table 1), a clear picture is obtained - Fig. 4.

Clearly is hilighted the result, that the amount of humic acids is the lowest in the non-fertilized variant - the control. Hence, we can conclude that fertilization stabilizes organic matter in the soil, improving the amount of more stable forms of carbon - the humic acids. Sequestration of carbon is increased.

Conclusion

The use of organic fertilizer "Siapton" alone and in combination with "Kristalon" mineral fertilizer has a beneficial effect on the accumulation of biomass in the ryegrass, as well as on the properties of the soil. Fertilization results in:

- the accumulation of more dry matter in the leaves;
- higher carbon and nitrogen content in the foliage;
- improving soil acidity;
- better store of organic matter;
- a more favorable humus composition in the soil with a higher content of the humic acid fraction.

No repercussions of fertilization on the accumulation of biomass in the roots of ryegrass are detected. No statistical proofs were found.

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