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ECONOMIC EFFECT OF FERTILIZING WITH LUMBREX AND LUMBRICAL BIOPRODUCTS ON BIRD'S FOOT TREFOIL GRASSLAND

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Abstract

During the period 2014 - 2016 in the Research Institute of Mountain Stockbreeding and Agriculture in Troyan was conducted a research experiment to determine the economic effect of imported bioproducts in the following fertilizing variants: 1.Control /untreated/; 2. Lumbrex – 1.5 L/ha; 3. Lumbrex – 2.0 L/ha; 4. Lumbrical - 150 ml/m^2; 5.Lumbrical - 200 ml/m^2. Based on the presented economic indicators, biofertilizer and fertilizing dose were chosen, combining high economic and ecological effect. It was found that for the conditions of light gray pseudo-podzolic soils, fertilizing with Lumbrex at a dose of 1.5 L/ha showed high productivity (11.3 t/ha), the lowest production costs (924.40 BGN/ha), the highest gross profit (2825.60 BGN/ha) and profitability (305.67%). The introduction of this bioproduct in the production of meadow grasses is an alternative for the realization of high yield and economically important technological solution for obtaining ecologically clean fodder production.

Key words**:** *bird's foot trefoil (Lotus corniculatus L.), biofertilizers, economic effect*

INTRODUCTION

In recent years, there has been an increased interest in organically produced plant and animal products in the world, and in the European Union in particular. In the future, there are all prerequisites for mountain areas to become a major source of organic production. Recently, a research has been carried out to optimize the nutritional regime of forage crops [16, 8]. Emphasis is placed on improving fertilizing models based on more efficient use of nutrients and allowing a reduction in the amount imported into the soil [10]. Alternatives, environmentally friendly solutions for improving the regime are sought, which lead to biological control of soil fertility and realize the economic effect of the applied fertilizing [11, 12, 13, 3]. Fodder production can be economically profitable provided that all agrotechnical events are applied in accordance with the requirements of the crop, in optimal terms, doses and norms, and the yield is high enough to ensure profitability of production [9].

The risk of contamination of the products with hazardous substances is associated with the use of significant amounts of fertilizers. The demand for a high economic effect of the applied fertilizers contradicts the requirement for environmental friendliness of agricultural activity [1]. One of the ways to combine economic efficiency with environmental friendliness is the introduction of alternative fertilizing systems of organic origin [4].

With the launch of the Rural Development Program (RDP) for the period 2014–2020 [14], the expectations for the development of biological farming were increasing, as the EU funding for the cultivation of bioproducts increased 5 times. Such bioproducts are Lumbrical and Lumbrex, which stimulate the development of soil microflora, facilitate the absorption of nutrients in the soil and organogenic elements [2] and improve the quality parameters of plants [17]. Ecologically clean products, with high taste and nutritional qualities, are obtained from grasslands that have been fertilized with biohumus. Applied to bird's foot trefoil, they increase dry matter yield [5], bird's foot trefoil share in the grassland [6] and improve feed quality [7].

In the previous studies on grass fodder crops there is no data concerning the economic and ecological efficiency as a result of applied biofertilizers. The calculation of parameters such as net income, production cost price and production costs would determine the

economic effect of the applied fertilizing applied on bird's foot trefoil.

Establishing the parameters, such as production costs, production cost price and gross revenues (gross income) would determine the economic effect of the applied fertilizing on bird's foot trefoil.

The objective of the present study is to determine the economic effect of fertilizing with biofertilizers on bird's-foot-trefoil grassland, with a view to their effective application in practice.

MATERIALS AND METHODS

The study was conducted at the Research Institute of Mountain Stockbreeding and Agriculture in Troyan, in the period 2014-2016 on light gray pseudo-podzolic soil. It is based on data from Bozhanska (2020) [6] for the dry matter yield of bird's foot trefoil by years and average for the research period.

The experiment was performed by the block method in four replications, with 5 m^2 plot size. Biofertilizers, such as Lumbrex and Lumbrical were included for testing in a field experiment of a pure crop grassland covered by bird's foot trefoil cultivar "Leo" in the following variants: The experimental variants were: 1. Control /untreated/; 2. Lumbrex – 1.5 L/ha; 3. Lumbrex – 2.0 L/ha; 4. Lumbrical - 150 ml/m^2; 5. Lumbrical - 200 ml/m^2. Bioproducts were produced in Plovdiv region.

The traditional for the region technology for growing artificial grasslands has been applied [8].

The economic assessment was established on the basis of detailed technological maps developed for each fertilizing variant. The valuation of the seeds, fertilizers, materials, live and material labor used in the technology for calculation of the total production costs was performed at the market prices for 2016. The production was organized using own land and own mechanized equipment. The value of production was calculated on the basis of average prices for the analyzed period.

The main indicators determining the economic evaluation of the results of the experiment are gross revenues (BGN/ha) and profitability (%) [4]. They give an idea of the economic efficiency of the applied types of bioproducts and their doses. The economic assessment is developed on the basis of dry matter yield (t/ha) [6].

Research indicators were: production costs (BGN/ha), production cost price (BGN/t) and gross profit (BGN/ha) [1].

Statistical processing of dry matter yield data was performed by variance analysis (ANOVA) to establish the reliability of LSD differences.

RESULTS AND DISCUSSIONS

Dry matter yield

Table 1 presents data on the yield of dry matter from fertilizing with organic fertilizers, such as Lumbrex and Lumbrical on pure crop with bird's foot trefoil for each year and on average for the period.

Table 1. Dry matter yield of bird's foot trefoil fertilized with Lumbrical and Lumbrex over the years and average for the period 2014-2016, (t/ha)

Variants	2014		2015		2016		Average for the period	
	t/ha	% to C	t/ha	% to C	t/ha	% to C	t/ha	% to C
Control	5.6	100.0	11.6	100.0	13.0	100.0	10.1	100.0
Lumbrex 1.5 L/ha	5.6	100.6	13.4	114.8	14.8	114.0	11.3	111.8
Lumbrex 2.0 L/ha	5.6	101.3	13.0	111.1	14.0	108.3	10.9	108.1
Lumbrical 150 ml/m^2	5.7	102.2	13.3	114.0	14.9	114.9	11.3	112.2
Lumbrical 200 ml/m^2	5.7	101.9	13.5	116.3	13.4	103.0	10.9	107.9
LSD 0.05	0.6	11.0	1.3	11.1	2.9	16.9	0.9	8.5
LSD 0.01	0.9	15.4	1.8	15.6	3.1	23.7	1.2	11.9
LSD 0.001	1.2	21.8	2.6	22.0	4.3	33.5	1.7	16.9

*LSD- Limited Significant Differences.

Source: Based on data publication from Bozhanska (2020) [6].

The dry matter yield ranged from 5.6 t/ha for the control to 5.7 t/ha when fertilized with Lumbrical at a dose of 150 ml/m^2 and 200 ml/m^2. Low productivity was due to the biological characteristics of bird's foot trefoil, associated with its slow growth rate during the initial stages of development. No difference in yield was found, both in terms of the type of bioproduct used and its dose. This, in turn, had an impact on the presented economic indicators in the first experimental year for perennial forage crops, such as bird's foot trefoil.

In the second experimental year (Table 1), the total yield obtained as a result of the applied bioproducts significantly exceeded that of the previous year. These results are explained by the stimulating impact of the microbiological processes in the soil, which is confirmed by the use of similar bioproducts by Atanasov et al. (2016) in greenhouse tomatoes. The data show the proven positive effect of Lumbrical 200 ml/m^2 (13.5 t/ha), Lumbrex 1.5 L/ha (13.4 t/ha) and Lumbrical 150 ml/m^2 (13.3 t/ha) compared to the control variant with 11.6 t/ha. Regarding the doses administered, the difference in the administration of Lumbrex is more significant than that of Lumbrical. The lower dose for Lumbrex (var. 2) showed a higher effect on dry matter yield than the higher dose, while for Lumbrical the trend was the opposite. The higher dose (var. 5) had a higher effect than the lower one (var. 4).

As bird's foot trefoil reached maximum productivity in the second and third year of its development, the high yield of dry matter (Table 1) in the third year is fully explained by the biology of the crop. The high stems and the large number of branches explain the obtained high yield, which for the treated variants ranged from 13.4 (var. 5) to 14.9 (var. 4) t/ha. The action of biofertilizers combined with the favourable climate conditions in 2016 determined the high productivity in all fertilizing variants.

On average for the study period, the productivity from the Lumbrical treatment alone at a dose of 150 ml/m^2 (Table 1) was the most effective, as a result of which the productivity exceeded the control by 12.2%. The yield value is extremely close when fertilizing with Lumbrex at a dose of 1.5 L/ha, respectively 11.8% above the yield of the control. The productivity of the other variants is lower, which is important for differentiated use of biological products and their careful application as a stage of bird's foot trefoil technology.

The yield had an impact on the presented economic indicators.

Economic effect of fertilizing of bird's foot trefoil with Lumbrex and Lumbrical

The analysis of the production costs (Table 2) on the level of efficiency shows that their volume increased from 1,668.2 to 1,824.1 BGN/ha for the applied bioproducts compared to that of the control variant. The higher costs in the first year compared to the other two years are impressive. The differences in the costs in the different variants are not significant, but their higher values are explained by the operations performed to create the crop, including different mechanical tillage. The events for maintaining the crop and its mowing are also included during the specified period. Higher costs were incurred for fertilizing with Lumbrical (1,771.7 and 1,824.1 BGN/ha) compared to Lumbrex (1,668.2 and 1,686.9 BGN/ha), which is due to the difference in the price of bioproducts. The low production costs in the control variant are determined by the lack of fertilizing costs. The highest production costs for treatment with Lumbrical at a dose of 200 ml/m^2 exceed those of the control by 289.9 BGN/ha. The highest cost price of dry matter was reported for the grassland fertilized with Lumbrical at a dose of 200 ml/m^2 or 3.200 BGN/t. Since the production cost price is mainly determined by production costs and yield, and they are the highest in the above-mentioned variant, this explains the resulting cost price in the different variants. The cost price values follow the course of the received production costs. The cost price data for the administration of Lumbrex in the two doses is similar (2.978 and 3.012 BGN/t). In the case of variant 4, the obtained cost price was lower, respectively 3.108 BGN/t at a cost price of 3.200 BGN/t in variant 5. The insignificant differences in the yield and in the

production costs by variants explain the results for the cost price of the fodder.

Gross income is affected by the productivity of the grassland. The grasslands that were fertilized with Lumbrical using both doses realized gross income, respectively 1,900 BGN/ha (var. 4) and 1,890 BGN/ha (var. 5). The highest dry matter yield determines the highest values of gross revenues.

The highest gross profit, which directly depends on the revenues and expenses, was registered in the untreated control, respectively 325.8 BGN/ha, as the invested expenses were also the least (1,534.2 BGN/ha). Of the treated crops, the highest gross profit (201.8 BGN/ha) was realized by fertilizing with Lumbrex at a dose of 1.5 L/ha. Almost similar values were reported for the higher fertilizer rate of the same bioproduct (193.1 BGN/ha). The gross profit from fertilizing with Lumbrical at the lower dose was twice as high (128.3 BGN/ha) than the treatment with the higher dose (65.9 BGN/ha). The effect of the fertilizing dose was significantly higher in the indicator of gross profit compared to other indicators.

Profitability is an economic indicator that is determined by the level of gross profit and production costs. Foliar treatment with Lumbrex at a dose of 1.5 L/ha provided the highest profitability, respectively 12.10%. These values are approached by the profitability of fertilizing with the other dose of Lumbrex, respectively 2.0 L/ha, which was 11.45%. For Lumbrical, the profitability values were significantly lower (7.24 and 3.61%).

In the second year, excluding the control variant, the highest economic effect was achieved by fertilizing with Lumbrex at a dose of 1.5 L/ha (Table 2).

This is due to the lowest production costs (572.0 BGN/ha), the lowest cost price (0.427 BGN/t) and the highest gross profit (3888.0 BGN/ha). The rate of profitability is a generalizing economic indicator and gives an idea of the economic evaluation of fertilizing.

The highest profitability was achieved when fertilizing with Lumbrex at a dose of 1.5 L/ha, whose numerical value was 679.72%. High profitability was also obtained with the second administered dose of 2.0 L/ha, which was respectively 630.88%. The profitability data show that when comparing both bioproducts from an economic point of view, the effect of the application of Lumbrex was much higher than Lumbrical.

The analysis of the impact of the production costs of the two types of fertilizers in both doses during the third experimental year on the efficiency shows that their volume increased from 533.0 to 685.2 BGN/ha compared to that of the control variant. The lowest costs were for the production of dry matter (533.0 BGN/ha) when fertilizing with Lumbrex at a dose of 1.5 L/ha. The highest production costs (685.2 BGN/ha) were registered in the variant with Lumbrical fertilizing at a dose of 200 ml/m^2. There is a tendency to increase the cost price of fodder obtained with increasing production costs.

Of all the fertilized variants, the grassland treated with Lumbrical at a dose of 200 ml/m^2 (var. 5) had the lowest yield (13.4 t/ha), the highest production costs (685.2 BGN/ha) and the highest production cost price (0.511 BGN/t). The values of gross revenues for fodder obtained after fertilizing with Lumbrical and Lumbrex at a dose of 150 ml/m^2 and 1.5 L/ha (4,960 BGN/ha and 4,920 BGN/ha) are similar. The untreated control showed the highest profitability (973.83%), and the maximum value was reported for the grassland fertilized with Lumbrex at a dose of 1.5 L/ha (823.08%). The high profitability is due to the highest gross profit (4,387.0 BGN/ha) and the high dry matter yield (14.8 t/ha).

On average for the period of the study, the variability of the values of the economic indicators follows the tendency of their variability by years. The analysis shows the maximum production costs of the fodder obtained when treated with Lumbrical at a dose of 200 ml/m^2 (1,079.23 BGN/ha) and minimum when fertilized with Lumbrex at a dose of 1.5 L/ha (924.40 BGN/ha).

Table 2. Economic effect of fertilizing of bird's foot trefoil with Lumbrex and Lumbrical over the years and average for the period

Fertilizing variants	Production costs	Cost price	Gross income	Gross profit	Profitability
	BGN/ha	BGN/t	BGN/ha	BGN/ha	%
2014					
Control	1,534.2	2.739	1,860.0	325.8	21.24
Lumbrex 1.5 L/ha	1,668.2	2.978	1,870.0	201.8	12.10
Lumbrex 2.0 L/ha	1,686.9	3.012	1880.0	193.1	11.45
Lumbrical 150 ml/m^2	1,771.7	3.108	1,900.0	128.3	7.24
Lumbrical 200 ml/m^2	1,824.1	3.200	1,890.0	65.9	3.61
2015					
Control	433.5	0.373	3,880.0	3,446.5	795.04
Lumbrex 1.5 L/ha	572.0	0.427	4,460.0	3,888.0	679.72
Lumbrex 2.0 L/ha	589.7	0.454	4,310.0	3,720.3	630.88
Lumbrical 150 ml/m^2	674.9	0.507	4,430.0	3,755.1	556.39
Lumbrical 200 ml/m^2	728.4	0.539	4,510.0	3,781.6	519.17
2016					
Control	402.3	0.309	4,320.0	3,917.7	973.83
Lumbrex 1.5 L/ha	533.0	0.360	4,920.0	4,387.0	823.08
Lumbrex 2.0 L/ha	549.9	0.393	4,680.0	4,130.1	751.06
Lumbrical 150 ml/m^2	636.5	0.427	4,960.0	4,323.5	679.26
Lumbrical 200 ml/m^2	685.2	0.511	4,450.0	3,764.8	549.45
Average for the period 2014-2016					
Control	790.00	0.782	3,350.0	2,560.0	324.05
Lumbrex 1.5 L/ha	924.40	0.818	3,750.0	2,825.6	305.67
Lumbrex 2.0 L/ha	942.17	0.864	3,620.0	2,677.8	284.22
Lumbrical 150 ml/m^2	1,027.7	0.909	3,760.0	2,732.3	265.87
Lumbrical 200 ml/m^2	1,079.23	0.990	3,620.0	2,540.7	235.42

Source: Own calculation.

Regarding the dose of imported bioproducts, a more significant difference in production costs was observed at Lumbrical, respectively 51.53 points. The production cost price is determined by the level of average yields and the amount of production costs. With an increase in production costs, an increase in the cost of the obtained dry matter yield is established. The grassland fertilized with Lumbrex at a dose of 1.5 L/ha showed the lowest production costs (924.40 BGN/ha) and the lowest production cost price (0.818 BGN/t). The highest values of these indicators were registered in the fertilizing with Lumbrical at a dose of 200 ml/m^2, respectively 1,079.23 and 0.990 BGN/t. Gross revenues (3620 BGN/ha) in fertilizing with Lumbrex and Lumbrical at a dose of 2.0 L/ha and 200 ml/m^2 (var. 3 and 5) were the same due to the similar values of dry matter yield (10.9 and 10.9 t/ha). Obtaining a higher gross profit is based on the use of opportunities to reduce the production cost price in different fertilizing variants. Fertilizing with Lumbrex at a dose of 1.5 L/ha realized the highest gross profit (2,825.60 BGN/ha) and the lowest cost price of the obtained fodder (0.818 BGN/t). The highest gross profit from fodder was obtained after fertilizing with Lumbrex at a dose of 1.5 L/ha (2,825.60 BGN/ha), while the lowest was gathered by fertilizing with Lumbrical at a dose of 200 ml/m^2 (2,540.77

BGN/ha) the lowest. The values of the gross profit also determine the profitability of the imported bioproducts. Maximum profitability was shown by fertilizing with Lumbrex at a dose of 1.5 L/ha (305.67%) and the minimum in fertilizing with Lumbrical at a dose of 200 ml/m^2 (235.42%). The lowest profitability rate compared to control in grassland treated with Lumbrical 200 ml/m^2 makes it economically inefficient. The high productivity (11.3 t/ha), the lowest production costs (924.40 BGN/ha), the highest gross profit (2,825.60 BGN/ha) and profitability (305.67%) when fertilizing with Lumbrex at a dose of 1.5 L/ha determine its high economic effect. This gives grounds for the use of this bioproduct as the most economically feasible technological solution in the production of pure crop grassland with bird's foot trefoil. The present results show that the transition from conventional to biological farming has a practical orientation due to the ability to plan and manage revenues and expenditures. The data from the experiment correspond to those obtained by Stoykova et al. [15] related to the selection of appropriate technological solutions, one of which is the application of organic foliar treatment to grasses and legumes mixtures.

Fertilizing bird's foot trefoil with bioproducts has not only economic but also environmental effect. Recently, more and more farms are introducing an environmentally friendly way of feeding animals. Finding the right management solution is related to combining economic and environmental effects in one.

CONCLUSIONS

Bioproducts, such as Lumbrex and Lumbrical, increased the dry matter yields, which affects the economic effect of the obtained fodder.

The most cost-effective was fertilizing with Lumbrex at a dose of 1.5 L/ha, due to high productivity, the lowest production costs, the highest gross profit and profitability. The introduction of this bioproduct in the production of meadow grasses is an alternative for the realization of high yield and economically important technological solution for obtaining ecologically clean fodder production.

The cultivation of bird's foot trefoil as a pure crop in mountaine areas using Lumbrex and Lumbrical for foliar and soil nutrition is an important element of the technology for the production of meadow grasses of grass and legume species, which can be recommended for practical application.

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