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THE IMPACT OF TREATMENT WITH KALAM AND FOCUS ULTRA HERBICIDES IN VARIOUS DOSES ON YIELD, GROSS REVENUE AND PROFIT IN BIRD'S-FOOT-TREFOIL GRASSLAND

Boryana CHURKOVA, Katerina CHURKOVA

Agricultural Academy, Research Institute of Mountain Stockbreeding and Agriculture – Troyan, 281 Vasil Levski Str., 5600, Bulgaria, E-mails: bchurkova@abv.bg, katerina.churkova@abv.bg

Corresponding author: bchurkova@abv.bg, katerina.churkova@abv.bg

Abstract

Weeds have a negative impact on the productive, quality and economic indicators in the production of bird's-foot-trefoil forage. The control against them is increasingly becoming a general ecological problem, which necessitates the need to look for new approaches to eliminate them. The implementation of systems and activities for sustainable agriculture is related to control over the use of plant protection preparations. This necessitates consideration of issues related to the application of appropriate agrotechnical practices to improve soil fertility and preserve useful cultivated species in grasslands from an economic point of view. Correlation dependences and derived regression equations were calculated on the sown grass from bird's-foot-trefoil treated with the herbicides Kalam in a dose of 20 and 40 g/da and Focus ultra in a dose of 100 and 200 ml/da. It was found that imported herbicides authorized for use showed a high positive correlation between yield with gross revenues (r=1.0000) and profit (r=0.9999). Graphical models have been developed to predict the main economic indicators based on the yield obtained after treating the grass with herbicides.

Key words**:** *grass forage, herbicide treatment, correlation dependences, regression equations, statistical analysis*

INTRODUCTION

Recently, weeds have covered large areas of arable land in plains and mountainous regions. The self-cultivation of crops using reduced tillage and intensive chemical protection, taking into account the herbicide resistance of weeds, is a cause of ecological and economic losses [8]. Ways to increase the profitability of agricultural crop production are being explored by reducing agronomic treatments [2] and intensifying chemical methods of weed control. Weeds cause severe economic losses to farmers and livestock producers. The increasing intensification of agriculture is leading to the emergence of herbicide-resistant weeds. This is limiting their adoption in sustainable agricultural practices [11; 20]. For many years, the strategies associated with herbicide application science experiments have been dependent on herbicide resistance [1; 14]. The increasing intensification of agriculture has led to a rapid increase in the incidence of herbicide-resistant weeds [19]. Chemical weed control is the most appropriate method to achieve high yields in forage crops [12]. Properly selected crop management technology [18], combined with the selection of the most suitable hybrids for a particular region, is a prerequisite for achieving sustainable yields and high economic results [3]. Elimination of weed competition by herbicide application increases productivity and income [9; 10; 16]. By analysing the economic results of herbicide treatments for weed control, it is possible to suggest the most appropriate one for use under specific soil and climatic conditions [21], according to its availability on the market. Properly selected herbicides for weed control are a cost-effective agronomic intervention that increases labour productivity and production efficiency and reduces production costs [23]. Weed control and fertilization [5, 6] are key elements of technology affecting yield, gross revenue and profit. A global strategy is needed to increase national capacity for herbicide resistance research. The aim of the study is to calculate correlations and derive regression equations for grass fodder produced from bird's-foot trefoil (Churkova, 2019) [4] after herbicide treatment based on yield and economic performance.

MATERIALS AND METHODS

In a research experiment in the experimental field of Research Institute of Mountain Stockbreeding and Agriculture-Troyan in the period 2020-2023 two herbicides were tested on bird's-foot trefoil grassland and their effect on weedy vegetation under the following variants: Kalam (dicamba 600 g/kg and tritosulfuron 125 g/kg) - 20 g/da; 2. Kalam (dicamba 600 g/kg and tritosulfuron 125 g/kg) - 40 g/da; 3. Focus ultra - 100 ml/da (active substance cycloxydim 100 g/l); 4. Focus ultra - 200 ml/da (active substance cycloxydim 100 g/l). The trial was laid out using the block method in 4 replications with a harvest plot size of 5 m².

Herbicides were selected from the "List of plant protection products, registered fertilizers and enhancers authorised for marketing and use" during the study period. Soil preparation for sowing was carried out according to generally accepted technology for the establishment of artificial grassland. Sowing was carried out in March at a rate of 1.2 kg/da with a row spacing of 12.5 cm and the area was irrigated before and after sowing. Herbicides were applied annually with a backpack sprayer at the 2-4 leaf stage of bird's-foot trefoil at a working solution rate of 50 l/da.

A statistical analysis based on economic indicators is applied. From the average dry matter yield (kg/da) data submitted to the Agricultural Academy in the ZFTK 7 project [22] over a four-year period, the economic indicators: production costs (BGN/da), cost price (BGN/kg), gross revenue (BGN/da), gross profit (BGN/da) and profitability (%) of dry matter yield of bird's-foot trefoil fodder production after herbicide treatment were calculated.

Correlation and regression analyses are presented. A tabular method was used to present the correlation dependences and a graphical method was used to derive the regression equations [13].

Correlation analysis is a numerical expression of the yield and the main economic indicators (production costs, cost price, gross revenue, gross profit and profitability of production). Data analysis of correlations and regressions is usually performed simultaneously as in this case [15].

The regression coefficient is a measure of the change by (+/-) when the i-th factor changes by the same unit [24].

In order to achieve the objective, the following indices were reported: Dry matter yield was reported as the average over the period (kg/da). The mathematical treatment of the yield was carried out using the method of analysis of variance by calculating statistically proven differences [17].

RESULTS AND DISCUSSIONS

Dry matter yield (Table 1) averaged over the study period was highest when bird's-foot trefoil grassland was treated with the herbicide Focus Ultra at 100 ml/da (1,017.4 kg/da).

Productivity was also high after application of the herbicide Kalam at 40 g/da (956.6 kg/da). Of the two herbicides tested, Focus ultra had a greater positive effect on productivity.

The application rate showed a higher effect with Focus Ultra herbicide than with Kalam herbicide.

Table 1. Dry matter yield of grassland of bird's-foot trefoil treated with herbicides in kg/da average over the period 2020-2023

Variants	*Dry matter yield (kg/da)*
Kalam 20 g/da	861.4
Kalam 40 g/da	956.6
Focus ultra – 100 ml/da	1,017.4
Focus ultra – 200 ml/da	868.0
LSD 5%	123.9
LSD 1%	180.2
LSD 0.1%	270.3

Source: Data from ZFTK7 Project to the Agricultural Academy of Bulgaria [22] and publication of Churkova and Churkova, 2024 [7].

Herbicide treatment of bird's-foot trefoil grassland had a significant effect on both the variation in average yield values and the economic indicators of forage production.

The highest positive correlation (Table 2) was found between yield and the gross revenue indicator (r=1.0000) and a negative correlation with costs (r=-0.9976).

Table 2. Correlation dependencies between yield and main economic indicators of bird's-foot trefoil production treated with herbicides

	Yield	Costs	Cost price	Gross Revenue	Gross Profit	Profitability
Yield	1					
Costs	0.9881	1				
Cost price	-0.9976	-0.9753	1			
Gross Revenue	1.0000	0.9881	-0.9976	1		
Gross Profit	0.9999	0.9878	-0.9977	0.9999	1	
Profitability	0.99943	0.9824	-0.9993	0.9994	0.9994	1

Source: Own calculations.

The theoretical regression line and the regression equation between the dry matter yield and the gross revenue of forage obtained after herbicide application on the bird's-foot trefoil stand are shown in Figure 1, where y=0.19x+0.0018 with an extremely high coefficient of determination, R^2=1. The obtained profit showed a positive, also very high positive correlation with the realized yield (r=0.9999), which proves the very strong correlation between these two indicators. The very strong correlation of yield with gross profit and gross revenue also determined the strong correlation dependence of yield and profitability with the effect of herbicide treatment and forage production obtained.

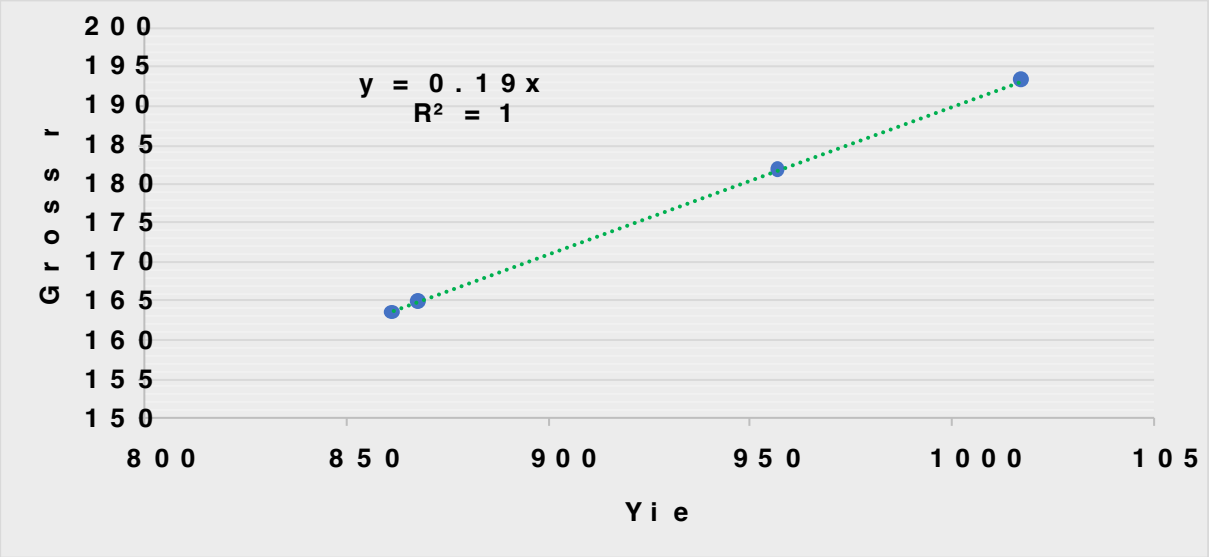

Fig. 1. Theoretical regression line and regression equation between dry matter yield and gross revenue
Source: Own calculations.

The efficiency of the herbicide treatment is a numerical expression of the resulting high value of the correlation coefficient between production costs and gross revenue, which is r=0.9881. The high values of production costs with profit (r=0.9878) and profitability (r=0.9824) were also found. Cost prices negatively correlated with gross revenue (r=-0.9976), gross profit (r=-0.9977) and profitability (r=-0.9993).

The very strong correlation between gross revenue and gross profit (r = 0.9999) determines the very high coefficient of determination shown in Figure 2 (R^2 = 0.9998) and the derived regression equation (y = 0.9767x - 11.256).

The high correlation between production costs and gross revenue (r=0.9881) determines the possibility of predicting gross revenue depending on the production costs of herbicide inputs and other production activities in the realization of forage production.

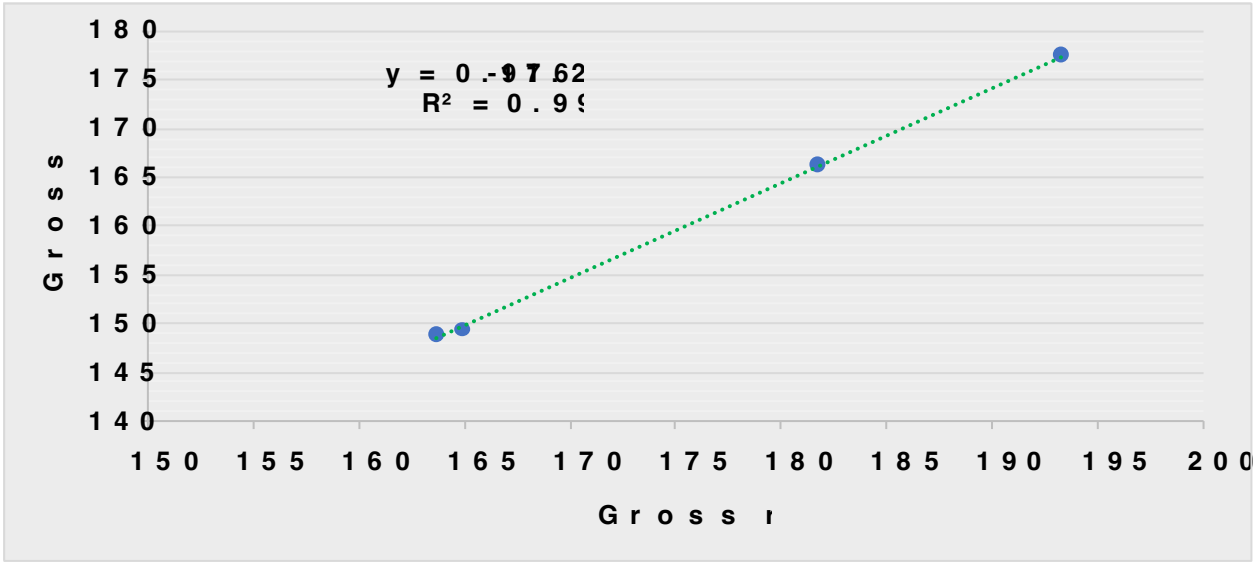

Fig. 2. Theoretical regression line and regression equation between gross revenue and gross profit
Source: Own calculations.

This also determined the derivation of the regression equation y=30.245x-288.57 with the coefficient of determination (R^2=0.7051) shown in Figure 3.

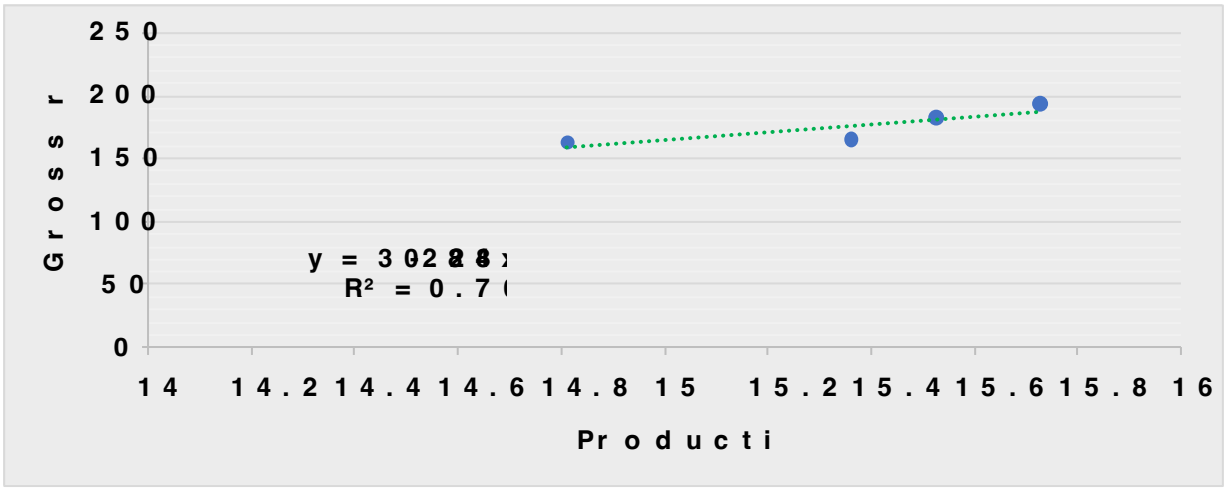

Fig. 3. Theoretical regression line and regression equation between production costs and gross revenues
Source: Own calculations.

The results of the analysis show a positive correlation (r=0.9994) between gross profit and profitability.

The high correlation allows the derivation of a regression equation (Figure 4), which is y=4.8697x+262.65, with a coefficient of determination R^2=0.9574.

The high correlation between the indices presented above determined the relationship between yield and the economic indicators in forage production. In the graphical regression models developed on this basis, the coefficients of determination are statistically proven and allow them to be used for indicative prediction of the economic effect of the agrotechnical interventions applied, as in this case the application of herbicides to obtain weed-free crops in the production of bird's-foot trefoil fodder.

Herbicide treatments on a self-seeded bird's-foot trefoil crop had the greatest influence on the change in yield values and thus on the economic indicators and the relationship between them. The established correlations show a good possibility of approximating the yield as a function of the production costs, and

the graphical models in Figure 3 determine, using the mentioned equation, the possibility of forecasting the gross revenue of the obtained fodder as a function of the magnitude of the production costs.

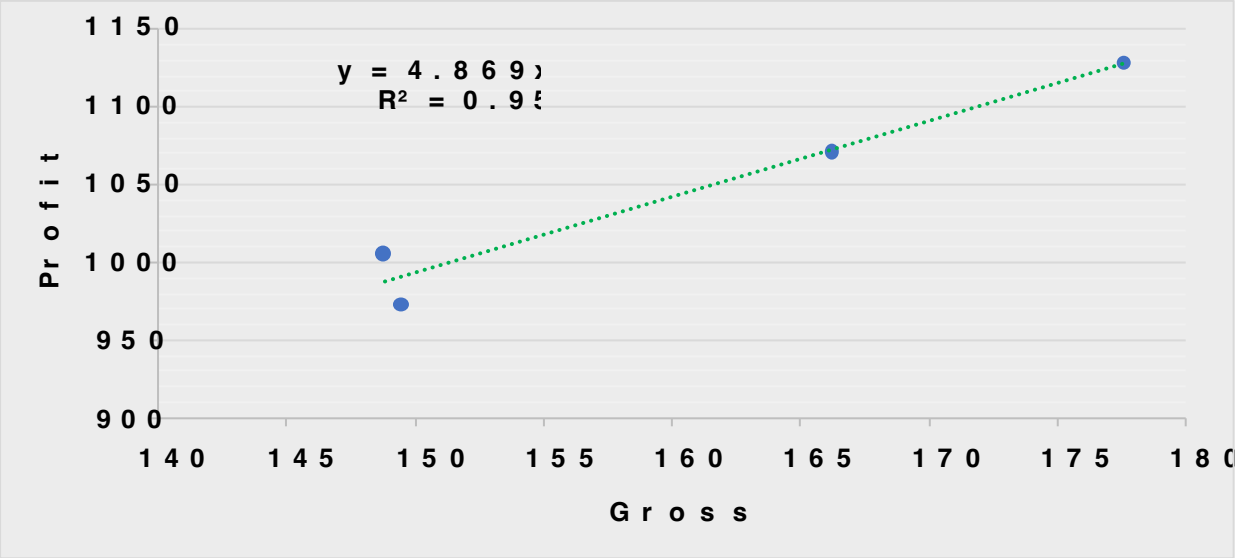

Fig. 4. Theoretical regression line and regression equation between gross profit and profitability
Source: Own calculations.

CONCLUSIONS

The treatment of a self-seeded grassland of bird's-foot trefoil with Kalam and Focus Ultra herbicides determined the high positive correlation between yield and gross revenue (r=1.0000) and gross profit (r=0.9999).

The very strong correlation relationship between gross revenue and gross profit (r=0.9999) determined the very high coefficient of determination (R^2= 0.9998) and is a prerequisite for the derivation of the regression equation (y=0.9767x - 11.256). The developed graphical regression models of the indicators showed high correlation relationships, can be used to determine and predict economic parameters related to the implementation of important agrotechnical measures for grass forage production.

The data analysis made it possible to predict the gross income in relation to the production costs of herbicide inputs and other production activities for fodder production realization.

The statistical treatment of the presented data proved the profitability of reducing agronomic treatments and intensifying chemical methods of weed control.

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