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Economic assessment of different irrigation regimes in sudan grass as a second crop

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Abstract

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The experiment was conducted during the period 2014-2016 with sudan grass as second culture in the experimental field of the Agricultural Institute, Stara Zagora. In the field experience, the following options were studied: Variant 1 – no irrigation (control); Variant 2 – optimal irrigation, 70-75% of FC (100% irrigation rate); Variant 3 – irrigation as Variant 2 but with removal of first watering; Variant 4 – irrigation as Variant 2 but with removal of second watering; Variant 5 – irrigation as Variant 2 but with removal of third watering in order to establish the most effective irrigation regime for sudan grass. It has been found that the efficiency of irrigation water use in the different irrigation regimes is best expressed in optimal irrigation with three irrigations where each cubic meter of water provides 0.00402 t/ha of extra green biomass yield with near water efficiency for irrigation is the irrigation regime with a second watering system, where each cubic meter of water provides an additional extra of 0.00392 t/ha of green biomass.

Keywords: sudan grass, irrigation regime, economic assessment

Introduction

In Bulgaria, the sudan grass is mainly grown in Northeastern Bulgaria under non-irrigated conditions (Kikindonov & Slavev, 2011). In their studies Slanev (2013), Slanev & Enchev (2014) have established for this region that the sudan grass retains comparatively sustainable yields in years with different agro-climatic characteristics. Although it is not a traditional irrigated crop, the factor that largely determines its yield in our soil climatic conditions is moisture. Therefore, the attention to its cultivation should be directed to maintaining optimum soil moisture, which is achieved by timely and proper irrigation. There are few and insufficient surveys in which the effect of crop irrigation is expressed by the economic magnitudes (Davidov & Stoyanova, 2010; Moteva & Stoyanova, 2010). According to some authors (Varbanov, 1968; Kotov, 1970), the essence and content of economic efficiency is expressed in the ratio of the economic performance of production to the cost of this production.

The effect of irrigation on maize is determined by some of the authors based on the extra yield obtained from irrigation and productivity of irrigation water (Vurlev et al., 1994; Zhivkov, 1995a, 1995b; Eneva, 1996; Matev, 2001; Davidov, 2003). The restudies in our country on agro-technical requirements, included irrigation and the cost of growing the sudan grass as a second crop are scarce and insufficient. The aim of the present study is to establish the economic efficiency of different irrigation regimes in sudan grass grown as a second crop.

Material and Methods

The experiment is conducted during the period 2014 – 2016 in the experimental field of Stara Zagora on soil type meadow-tin cinnamon with sudan grass variety Endge as second crop. The soil type is characterized by the following water-physical properties: maximum field moisture – 26.57%, soil fading coefficient – 18.19%, porosity – 47% and bulk density – 1.45. The experience was based on the blocking method with four repetitions, with a plot size of 25 m^2. The sudan grass was harvested in a phase of milk-waxy maturity. Irrigation was carried out gravitationally with a seasonal fixed installation. In the field experience, the following options were studied: Variant 1 – no irrigation (control); Variant 2 – optimal irrigation, 70-75% of FC (100% irrigation rate); Variant 3 – irrigation as Variant 2 but with removal of first watering; Variant 4 – irrigation as Variant 2 but with removal of second watering; Variant 5 – irrigation as Variant 2 but with removal of third watering.

The irrigation was dispensed at the same time in all the variants. The water was distributed in the irrigation grooves by means of perforated pipes with hoses mounted on them in order to direct the irrigation jets in the respective furrows.

The economic analysis is based on actual yield for each variant. Production costs are calculated at current prices in 2016. The following economic indicators have been identified: total income, net income, production costs, cost of 1 ton biomass, profitability, coefficient of efficiency of the irrigation water.

The efficiency of irrigation regimes in sudan grass was examined as a ratio of the increase in the yields of the irrigation variants to the non-irrigated variants towards the magnitude of the different irrigation norm, i.e. the additional yield from the irrigation.

Results and Discussions

Three waterings a year were required over the three experimental years 2014, 2015 and 2016. The data for the most important economic indicators characterizing the effect of different irrigation regimes in sudan grass as a second crop after wheat margrave and gravity irrigation are presented in Table 1. The increase in total income in all variants compared to that of the control varies from 19.7% in the option without first watering up to 36.9% in the variant irrigated with three waterings. The application of the irrigation regime with the removal of second irrigation with the proven necessity of its implementation has led to an increase of the total income by 28.5% compared to the control. A similar effect is the variant with removing the third irrigation, where the total income increases by 26.0% relative to the control.

Production costs for irrigated variants significantly increased, compared to irrigation options. The highest costs were in the variant with three waterings – 72.5% higher than the control (without irrigation). In the other three options with the cancellation of consecutive irrigation, the production costs are almost the same and to 48.3% higher than the control. The increased direct production costs of the irrigation option are mainly due to the additional costs of preparing and carrying out the irrigation process, which is an equally expensive and labor-intensive event, as well as the high cost of water for irrigation.

The net income (profit) has increased for all irrigated variants compared to the irrigation option. The smallest increase of 14, 2% was observed in the variant with the removal of first watering. The highest net income was observed in the variant with optimum irrigation (with three waterings). With optimal irrigation, net income increased by 29.4% compared to non-irrigation variant. In the other two variants, the increase in net income was of relatively the same degree, i.e. by 26.3% and by 22.8%, respectively for Variant 3 (without second watering) and Variant 4 (without third watering) relative to the control.

With an increase in production costs, an increase in the cost of 1 t of green biomass is observed. The cost of production, expressed by the correlation between production costs and the yield obtained, ranges between 100% and 126.6%. The lowest cost is the cost of production under the control,

Table 1. Economic results from the application of different irrigation regimes in sudan grass on average for the period 2014-2016

Variants	Total income		Production costs		Net income (profit)		Cost of 1 ton of green mass		Profitability norm	
	lv/ha	%	lv/ha	%	lv/ha	%	lv/ha	%	lv/ha	%
Variant 1 – no irrigation	2600	100.0	1220	100.0	1380	100.0	680	100.0	1130	100.0
Variant 2 – optimal irrigation		136.9		172.5		129.4		126.6		74.4
Variant 3 – without a first watering		119.7		148.3		114.2		123.8		76.2
Variant 4 – without a second watering		128.5		148.3		126.3		115.4		84.7
Variant 5 – without a third watering		126.0		148.2		122.8		117.6		82.5

Table 2. Effect of irrigation water in sudan grass on average for the period 2014-2016

Variants	Irrigation rate, m^3/ha	Additional yield from irrigation, t/ha	Coefficient of efficiency of the irrigation rate (K)
Variant 1 – no irrigation	0	0	0
Variant 2 – optimal irrigation	2400	9.66	4.02
Variant 3 – without a first watering	1600	3.46	2.16
Variant 4 – without a second watering	1600	6.28	3.92
Variant 5 – without a third watering	1600	5.94	3.71

where production costs are the lowest. The highest cost is in the variant with optimum irrigation (three waterings), which was 26.6% higher than that of the control. With the variants with removing of waterings, the lowest cost is found in the variant without a second watering – 115.4% compared to the control. Despite the fact that the production costs for the three variants with the removing of waterings are the same, the lowest yield of the variant with removing the first watering resulted in an increase in the cost of production.

Another indicator that characterizes the efficiency of a given production is the relationship of net income to production costs, i.e. the profitability norm. The lowest rate of profitability was characterized by the variant with three number of watering – 74,4% over the non-irrigated control. In the variant with the removing of first watering, the rate of profitability is almost the same as that of the variant with three waterings, the difference being only 1.8 points. For the other two options, respectively, with removing of second and third irrigation, the rate of profitability has decreased by 15.3% over the control.

The effect of the application of different irrigation regimes carried out by gravity mode in sudan grass can be quite accurately expressed by the coefficient of efficiency of the irrigation rate (K), representing the ratio of the resulting additional yield from the irrigation, in other words the yield above that obtained from the non irrigation control to the size of the irrigation rate (Table 2). In the optimum variant with three watering, K is 4.02, which means that each cubic meter of water has provided an extra green biomass yield of 0.00402 t/ha.

In the variant with removal of first watering, K is 2.16, which means by 1.18 lower compared to the optimal variant. In the variants with removing a second irrigation and a third irrigation the coefficient acquires values corresponding to 3.92 and 3.71, with a reduction of 0.18 and 0.31 compared to the optimally irrigated variant.

Conclusions

Growing the sudan grass as a second crop and irrigated with three waterings a year ensures receipt the highest income (2600 lv/ha) and profit (1380 lv/ha) compared to the other three variants irrigated without the first, the second and the third irrigation. Growing the sudan grass without irrigation provides the lowest overall income and profit.

The cost of production of the irrigated variants shows a marked upward trend with the increase in production costs. A decisive influence on its manifestation is the growth of yields.

Applying an economical (disrupted) irrigation regime by canceling the first, second or third irrigation is distinguished by higher economic efficiency and rate of profitability. When irrigating the sudan grass with the removal of second watering, the profitability increased by 10.3 points compared to the variant with the application of three waterings.

The efficiency of using irrigation water in different irrigation regimes is best expressed in optimal irrigation with three irrigations where each cubic meter of water provides an additional yield of 0.00402 t/ha green biomass. The irrigation regime close to the optimal was the variant with cancellation of the second irrigation, where each cubic meter of water provides an additional yield of 0.00392 t/ha green biomass.

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