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ECONOMIC EVALUATION OF NEW HERBICIDES FOR WEED CONTROL IN MAIZE GRAIN

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Abstract

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One of the economically significant problems related to the production of maize is the successful fight against weeds that annually spread and substantially damage the yield and the quality of the produce.

The aim of this survey is to implement a summarized assessment of the economic results from the application of new herbicidal preparations on fodder maize. The conducted field experiment at the experimental base of the Agricultural University, Plovdiv within the period 2011–2013 comprises 10 variants, including 8 variants treated with herbicides. We analyzed the production indices, the thresholds of economic efficiency and the factors determining them.

It has been established that the application of herbicidal preparations provides high economic results from the production of grain maize and also profits from unit of area as the profitability ranges from 38% to 43%.

Key words: fodder maize, herbicides, production costs, net profits, profitability

Introduction

In order to obtain high and sustainable yield of maize (*Zea mays* L.), it is necessary to grow it applying irrigation and at the same time fight the weeds by using the most appropriate herbicides (Stoimenova et al., 2004; Mahmood. and Swenton, 2005; Tonev et al., 2010). The production capacity of maize is manifested under circumstances comprising a combination of various factors which include the hybrid, the agro-ecological and weather conditions and also the used agrotechnics (Kirchev, 2001; Stamboliev and Petrov, 2003; Valkova, 2007; Zhelyazkov, 2007; Mohamed et al., 2008; Stoykova et al., 2010).

The choice of the most suitable hybrids for each region complying with the conditions and the technology of growing leads to obtaining stable yields, which results in high economic indicators (Angelov et al., 1995; Gramatikov et al., 1997; Epinal et al., 2001). One of the most important problems in the production of fodder crops, including maize, is the low yields and labour efficiency under the conditions of rising costs of technological nature. On the one hand, they affect the influence of factors such as irrigation, fight against the weeds, fertilization, mechanization and others and on the other hand, the economics and the management of the production processes.

New maize hybrids are constantly being introduced by testing their productivity in the various agro-ecological regions around the country (Ilchovska, 2008; Delibaltova and Ivanova, 2009). The strong negative influence of weeds on the growth and the yield of maize grain (Dimitrova et al., 2013) as well as the need to apply new, more efficient and ecologically safer herbicides on that crop set the objective of this study, on the grounds of which we will make a summarized assessment of the economic results from the chemical control of weeds.

The implementation of this objective comprises the following tasks: 1. Registering the amount of the production costs in elements and technological units; 2. Dividing the costs on the grounds of selected assessment criteria; 3. Determining the critical level of the average yield and the economic efficiency of the production of grain maize.

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Materials and Methods

Conducting the experiment

Within the period 2011–2013 in the experimental field of the Agricultural University, Plovdiv, we made field experiments using new herbicides applied into the soil after sowing and before the germination of the crop and also applied to the leaves during the vegetation period of the maize – a hybrid of Pioner company: Kolomba (450 FAO). The sowing during the three years of the experiment was performed on April 21-25. The experiments were made using the block method over an area of 21 m^2 in four repetitions (Table 1).

The agrotechnical activities were conducted in accordance with the commonly used technology for growing maize (processing of the soil, fertilization, sowing, rolling).

Methodological tools for development and assessment of the technological and economic estimates

The amount of the production costs for growing grain maize has been calculated on the grounds of a technological chart containing information about the physical volume and value of all necessary material and labour costs for growing and gathering the crop. The expenses for raw materials and other materials (seeds, fertilizers, preparations, water for irrigation, fuel and lubricants, electricity and others) have been calculated on the grounds of their volume and unit price, on average for the period 2011–2013. The expenses for labour, mechanized activities (ploughing, cultivating, harrowing, transporting, fertilizing, spraying, gathering and others), additional costs, machine and tractor and transport expenses have been calculated on the grounds of the estimates valid for the Agricultural University – Plovdiv.

The value of the finished produce – the maize grain, has been calculated based on the average price for the period of the experiment 2011–2013.

Methodological tools for determining the critical levels of the yield and the economic thresholds of efficiency in variants of the experiment

The determination of the critical levels of the yield and the thresholds of efficiency in the production of maize has been made using various indices shown in Table 3 and Table 4 (Koprivlenski, 2011).

The thresholds of efficiency, expressed through the critical level of the average yield for the separate variants, have been calculated using the formula:

$$Q_{BEP} = \frac{FC}{p - VC_1},$$

where: Q_{BEP} – the critical level of the average yield;
FC – total value of the stable costs;
p – average costs of the implementation;
VC_1 – variable costs for unit of production.

The critical level of the average yield determines the amount of the yield for which the maize production results in no profits or losses, after which each kilogram of the finished produce above the critical yield shall secure profits.

Table 1

Variants	Active substans	Dose
1. Control (K1) - untreated and not trenced area		
2. Industrial control (K2) – untreated with 2–3 hoeing		
3. Laudis OD	44 g/l *tembotrion*	200 cm^3/da (folair application)
4. Lumux 538 SK	375 g/l *s-metolaxlor*	400 cm^3/da (soil application)
	125 g/l *terbutilazin*	
	37.5 g/l *mezotrion*	
5. Elumis	30 g/l *nikosulfuron*	200 $cm^3$3/da (folair application)
	75 g/l *mezotrion*	
6. Gardoprim	312.5 g/l *s-metolahlor*	450 cm^3/da (soil application)
	187,5 g/l *terbutilazin*	
7. Wing	212.5 g/l *dimetenamid-P*	400 cm^3/da (soil application)
	250 g/l *pendimetalin*	
8. Stelar	50 g/l *topramezon*	100 cm^3/da (folair application)
	160 g/l *dikamba*	
9. Kaspar 55 WG	50 g/kg *prosulfuron*	30 g/da (folair application)
	500 g/kg *dikamba*	
10. Merlin flex	240 g/l *izoxaflutol*	42 cm^3/da (soil application)

Table 2

Production costs for growing maize under the conditions of irrigation, BGN/da

Variant	Material costs /A/	Expenses for tractor and transport /B/	Expenses for manual labour /C/	Direct costs I /A+B+C/	Additional costs II	Total costs I + II
K_0	97.84	45.61		145.85	31.54	177.39
K_1	97.84	54.11	3.0	154.95	33.39	188.34
3	117.97	59.45	4.0	181.42	36.42	217.84
4	118.75	59.45	4.0	182.2	36.29	218.49
5	122.09	59.45	4.0	185.54	37.03	222.57
6	115.35	59.45	4.0	178.8	35.96	214.76
7	113.54	59.45	4.0	176.99	35.72	212.71
8	113.36	59.45	4.0	176.81	35.72	212.53
9	107.71	59.45	4.0	171.16	34.68	205.84
10	114.51	59.45	4.0	177.96	35.85	213.81

*The direct and indirect costs have been calculated based on the estimates for the Agricultural University

Results and Discussion

The main results from the economic assessment of the tested new herbicides for fighting weeds in the production of grain maize have been summarized in Tables 2, 3 and 4.

The amount and the structure of the production expenses for the elements vary within narrow limits for all the variants of the experiment treated with herbicides – from 3 to 10 (Table 2).

The only exceptions are the variants 1 (K_0) and 2 (K_1), which differ from the rest in terms of their total production costs and also the costs for the elements. The data in Table 2 shows that the price of the material expenses is the highest for the variants treated with herbicides, which exceed the control samples by 10% (variant 9) to 25% (variant 5) and determine the amount of the direct and production costs.

Table 3

Amount of the stable and variable costs in the production of grain maize

Variants	Average yield,	Total variable costs,	Total stable costs,	Total production costs,
	kg/da	BGN/da	BGN/da	BGN/da
1 – K_0	437.6	141.99	35.4	177.39
2 – K_1	628.42	148.7	39.64	188.34
3	831.7	174.07	43.77	217.84
4	838.9	177.55	40.94	218.49
5	832.6	181.99	40.58	222.57
6	836.3	173.76	41.0	214.76
7	816.8	170.0	42.71	212.71
8	821.5	171.89	40.64	212.53
9	791.6	164.47	41.37	205.84
10	820.1	172.47	41.34	213.81

The technological and economic estimates in Table 2 show that the production costs are the highest for the variants 5, 4 and 3 in which the herbicides Elumis, Lumax 538 SK and Laudis OD are used. The total amount of the material costs for these variants together with the additional costs is – 122.09 BGN/da; 118.75 BGN/da and 117.97 BGN/da, respectively and the amount for the entire production is 222.57 BGN/da; 218.49 BGN/da and 217.84 BGN/da. For the other treated variants, these values are higher compared to the zero control samples by 16% (variant 9) to 21% (variant 6). The difference in the total production costs between the variants ranges from 4% to 9%.

The production costs for growing grain maize have been classified in two other bigger groups – stable and variable costs (Table 3). The purpose is to use them to calculate the main economic indices and the thresholds of efficiency for the experimental variants. The data analysis shows that within the structure of the total production costs, the variable costs are dominant. They vary from 141.99 BGN/da for the zero control samples to 181.99 BGN/da when applying the herbicide Elumis (variant 5). The amount of the stable costs varies from 35.4 BGN/da (variant 1) to 43.77 BGN/da (variant 3). This structure of the costs is typical of the crops with a high level of mechanization of the production processes, such as the maize. Considering the costs incurred, the highest average yield has been obtained from variants treated with herbicides: Lumax 538 SK – 838.90 kg/da; Gardoprim plus Gold 500 SK – 836.30 kg/da and Elumis – 832.60 kg/da. The lowest average yield has been obtained from the zero control samples – 437.60 kg/da and also from variant 2, with some hoeing being performed – 628.42 kg/da. The production capacity of the maize is largely determined by

Table 4

Economic efficiency and critical levels of the average yield in the production of grain maize

Variant	Average yield,	Critical level of the average yield,	Value of the total produce,	Net profit from 1 da,	Prime cost of the produce	Profitability rate,
	kg/da	kg/da	BGN/da	BGN/da	BGN/kg	%
K_1	628.42	252.75	232.52	43.38	0.30	23.18
3	831.7	280.56	307.73	88.77	0.26	40.54
4	838.9	262.88	310.39	90.78	0.26	41.34
5	832.6	278	308.06	84.37	0.27	37.72
6	836.3	263.25	309.43	93.55	0.26	43.33
7	816.8	273.94	302.22	88.39	0.26	41.34
8	821.5	261	303.96	90.31	0.26	42.27
9	791.6	265.56	292.89	85.93	0.26	41.52
10	820.1	262.19	303.44	89.02	0.26	41.52

*The value of the total produce has been calculated on the grounds of the average selling price for the year 2013 г. – 0.37 BGN/kg

the weather conditions during the respective year, mostly by the quantity and the distribution of the rainfall within the vegetation period. Similar data regarding the productivity of the hybrid Colomba has been obtained by Delibatova (2009) from a field experiment conducted within the period 2006-2008 in Northeastern Bulgaria.

The data in Table 3 shows that the largest increase of the total production costs has been registered in variant 5, which compared with K_0 is 25.5%. But in this variant we also observe a significant increase of the average yield – 90.3%. Similar results have been received in the other variants treated with herbicides 3, 4 and 6. This means that the rate of increase of the additional produce from unit of area is 3.7 to 3.9 times faster than the rate of the expenses incurred. This positive trend can also be observed in the other variants where herbicides are used to fight the weeds.

The amount of the production costs and the level of the average yield are the main factors influencing the economic efficiency in the production of maize (Table 4).

The data shows that in accordance with the amount of the production costs and the level of the average yield, the economic efficiency of the zero control samples is the lowest. The low level of the yield from that sample and the relatively high production costs are the reason for the unsatisfactory value of the total production 161.91 BGN/da and it cannot provide net profits – with this variant the production shows a loss and the profitability rate is negative. The critical level of the average yield is 721.40 kg/da, which is very close to the limit of the biological capacity of this crop and the potential capacity of the applied technology of production. The prime cost of the production in the control variant is 0.04 BGN/kg higher than the purchase price, which causes a loss amounting to 16.15 BGN/da.

Even with relatively high production costs, the control sample without herbicides and with some hoeing being performed (variant 2) provides a level of the average yield of 628.42 kg/da. The prime cost of the obtained produce is 0.30 BGN/kg and it provides a profit of 43.38 BGN/da and the profitability rate is 23.18%, which is sufficient for implementing extended reproduction.

The highest economic efficiency has been registered for the variants 6 and 8, whose profitability rate is 43.33 % and 42.27%, respectively and the net profit is as follows: 93.55 BGN/da and 90.31 BGN/da. For the other variants treated with herbicides the net profit varies from 85.93 to 90.78 BGN/da and the profitability rate ranges from 37.72 % to 41.52%. It is sufficient for the implementation of extended reproduction.

Conclusions

The analysis of the results from the conducted survey allows us to draw the following conclusions:

The use of herbicides in the fight against weeds is economically appropriate because when eliminating the competition of the weeds they lead to a growing rate of increase of the additional costs, as a result of which the total revenue is higher or at least equal to the variable costs.

All variants, in which the fight against the weeds is conducted using the tested herbicides, provide high economic results in the production of grain maize, sufficient amount of the profit from unit of area and profitability within 38% to 43%. The critical level of the yield is hardly 36-37% of the obtained produce from unit of area.

The indicated thresholds of efficiency for all treated variants provide higher competitiveness of the grain maize, which allows reinvestment in the production.

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