RESEARCH ON THE ECONOMIC EFFICIENCY OF THE AGRICULTURAL ECOSYSTEM UNDER AGRO-TECHNICAL MEASURES TO CROPS OF CORN

CERCETĂRI PRIVIND EFICIENȚA ENERGETICĂ A ECOSISTEMULUI AGRICOL SUB INFLUENȚA MĂSURILOR AGROTEHNICE LA CULTURA DE PORUMB

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Abstract*. Against the background of global warming, increasing pollution levels and requirements for limiting the use of fossil fuels, demand for biomass has increased. For testing the energy efficiency of the agro ecosystem in the Experimental Farm of the Moara Domneasca, Găneasa, Ilfov County, a bi factorial experience has been achieved in which Factor A = Nitrogen Fertilization Level (N) and Factor B = Irrigation Level. Increasing the level of nitrogen fertilization (N) on the same phosphorus soil conditions has led to statistical gains of both the main production of grain production, thus maintaining land use for agricultural production, as well as secondary production that has potential for use as bio fuel. The increase in the level of irrigation (a_2, a_3) led to a very significant increase of the grain yields (kg / ha) and of the biomass production. Analyzing the economic efficiency of the ecosystem under the influence of the technological measures, it is noted the significant increase of all economic indicators compared to unfertilized (b1) or non-irrigated (a1) control, increases are proportional to the applied nitrogen dose and watering standard.*
Key words: biomass, bio fuel, increase yields, irrigation, fertilization.

Rezumat. *În ultima perioadă, pe fondul încălzirii globale şi a creşterii nivelului de poluare şi a cerinţelor privind limitarea utilizării combustibililor fosili, s-a intensificat cererea de biomasă. Cercetările s-au desfăşurat în condiţiile preluvosolului din Câmpia Română, în Ferma Experimentală Moara Domneasca, Găneasa, jud.Ilfov. Pentru testarea eficienţei energetice a ecosistemului, s-a realizat o experienţă bifactorială, în care Factor A Nivelul de fertilizare cu azot cu 3 graduări şi Factor B nivelul de irigare cu 3 graduări. În urma cercetarilor s-a constatat că creşterea nivelului de fertilizare cu azot pe acelaşi agrofond de fosfor a adeterminat creşteri asigurate statistic atât ale producţiei principale, productia de boabe (kg / ha), menţinându-se astfel destinaţia terenului pentru producţia agricolă, dar şi producţia secundară care are potenţial de utilizare ca biocombustibil. Creşterea nivelului de irigare (a_2, a_3) a determinat creşterea foarte semnificativă a producţiilor de boabe dar şi a producţiei de biomsă. Din punct de vedere al eficienţei energetice a ecosistemului, sub influenţa măsurilor tehnologice, se constată o creştere semnificativă a cantităţii de energie produsă comparativ cu martorul nefertilizat (b_1) sau neirigat (a_1).Cantitatea de energie produsă este proporţională cu doza de azot aplicată şi cu norma de udare aplicată.*
Cuvinte cheie: biomasă, biocombustibil, creşterea producţiei, irigaţii, ferilizare.

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INTRODUCTION

With a cultivated area of about 200 million hectares, maize occupies the second position in the world in terms of cultivated areas after wheat culture (FAOSTAT).

Worldwide, the corn crop productions are on the rise as a result of increased technological performance. In Romania, the areas cultivated with maize recorded a descending trend from 3.11 million hectares in 1995 to 2.41 million hectares in 2017. The level of average harvested production shows an upward trend from 2.76 t/ha in 1990, reaching a production of 5.96 t/ha in 2017, with very high production fluctuations, ie 1.71 t/ha in 2000 or 3.47 t/ha in 2015.

As the cultivated areas remain relatively constant, and at the level of the agricultural holdings there is a certain balance, with no significant variations in the structure of the crops, these modifications can be explained as a result of the climatic conditions and especially of the level precipitation.

Applying of the irrigation management allows to reduce the amount of water used and to obtain high yields under drought conditions (Kranz *et al.*, 2018).

The moment of application of the watering doses and their size have a direct impact on the productivity indicators of corn grain number, grain filling (Nilahyane *et al*., 2018).

In the pedoclimatic conditions in Transylvania Plain, it has been demonstrated that the application of watering doses must be correlated with the amount of precipitation and in a year with rainfall excess watering doses can be reduced to more than half (Pandrea, 2012).

The purpose of the research was to evaluate the impact of irrigation and fertilization on the economic efficiency of maize crops in pedoclimatic conditions at the Moara Domneasca, Ganeasa, Ilfov County.

MATERIAL AND METHOD

In order to achieve the established objective, in the agricultural year 2016-2017 a bifactorial experience was realized where:

Factor A = Watering doses with 3 graduations: a_1 = no irrigation, a_2 = 50% dose standard, a_3 = 100% watering dose.

Factor B = Nitrogen fertilization level where: b_1= unfertilized nitrogen, b_2= 75 kg N / ha, b_3= 150 kg N/ha.

Experience was realized by parcel method subdivided into 4 rehearsals.

Nitrogen doses were provided by the use of urea. The irrigation water used came from a drilled well.

For the calculation of the watering doses, the following formula was used:

$$\sum m = ETRO - Pv - Af - (Ri - Rf)\ (m^3/ha)$$

where:

-$\sum m$ - is the annual irrigation requirement (irrigation standard) or monthly irrigation water (m3 / ha);

-ETRO - optimal actual evapotranspiration or total water consumption in the growing season or in the month of calculation, or since the last watering (m3 / ha);

-Pv - the amount of useful rainfall during the vegetation period or the calculation month with the insurance of 80% (m3 / ha);

-Af - water intake from groundwater in the case of open circuit balance (m^3/ha);

-Ri - soil water reserve at crop sowing or at the beginning of the calculation month (m^3/ha);

-Rf - Soil water reserve at crop harvest or at the end of the calculation month (m^3/ha).

Density of the crop to land was 60,000 plants/ha.

Income = production (kg/ha) x sales price (lei/kg)

Profit = Income (lei/kg) - Expenses (lei/kg)

Profit rate = (profit/expense) x 100

RESULTS AND DISCUSSIONS

The obtained production results are centralized in table 1. Data analysis shows that the application of the watering and nitrogen fertilization norms had an impact on the harvested grain maize (kg/ha) production.

Influence of nitrogen fertilization on the obtained productions (B).

Analyzing the influence of the application of fertilization on the harvested grain maize production, it is observed that the increase of the nitrogen doses revealed the increase of the yields obtained from 3246 kg/ha in the unfertilized variant up to 6403 kg/ha in the fertilization with 150 kg N/ha, the production gains are very significant (tab. 1).

Table 1

Production of grain corn (kg / ha) obtained under the influence of nitrogen fertilization and irrigation

Specifications	a_1 (without irrigation)	a_2 (50% dose)	a_3 (100% dose)	average b
b_1 (unfertilized)	2300	3230	3980	3170.0
b_2 (75 kg/ha N)	3120	4480	5160	4253.3
b_3 (150 kg/ha N)	4910	6510	6960	6126.7
average a	3443.3	4740.0	5366.7	
	A	B	A x B	B x A
LSD 5%	194.39	295.89	314.54	375.52
LSD 1%	284.4	404.4	519.47	552.35
LSD 0,1%	411.7	625.34	697.12	720.79

Influence of application of watering doses on obtained yield (A).

As a result of the application of the watering norms, an increase in the production of grain maize (kg/ha) from 3443 kg/ha in the variant without irrigation (a_1) to 5366 kg / ha was observed in the case where each watering was applied 100% (a_3), with production increases being very significant (tab. 1).

Influence of applying watering doses for the same level of fertilization (AxB).

It is found that for all levels of fertilization (b_2, b_3) the application of the watering doses (a_2, a_3) determined the increase of the obtained productions and in all the variants studied the application of watering resulted in very significant production gains.

Influence of nitrogen fertilization (N) on the same watering standard (BxA).

From the analysis of the data centralized in table 1 we can see that the fertilization with nitrogen (N) has determined the increase of the obtained products for all studied fertilization variants (b_2, b_3), and the production gains obtained are very significant.

The results of the expenditure on corn crops under the influence of nitrogen fertilization (N) and irrigation doses are centralized in table 2. Analyzing the data, it is found that the level of expenditures varied between 1480 lei/ha in the non-fertilized nitrogen control variant (b_1) and non-irrigated (a_1) and 2714 lei/ha in the variant where 150 kg N/ha (b_3) and a 100% watering standard (a_3) were applied. The expenditures that were recorded included two components: a constant component, represented by the sum of the expenditures with the soil works, the foundation and the maintenance of the crop and harvesting; the second component is the sum of variable costs with fertilization and the application of watering doses. According to the technological file, the fertilization costs of 75 kg N/ha were 261 lei/ha and the one with 150 kg N/ha of 521 lei/ha. The total irrigation costs were 380 lei/ha when applying 100% of the calculated norm, or 190 lei when 50% of the required amount was applied.

Table 2

Expenses (lei/ha) recorded for maize crop under the influence of nitrogen fertilization and irrigation

Specifications	a_1 (without irrigation)	a_2 (50% dose)	a_3 (100% dose)	average b
b_1 (unfertilized)	1480	1940	2350	1923.3
b_2 (75 kg/ha N)	1712	2122	2532	2122.0
b_3 (150 kg/ha N)	1894	2304	2714	2304.0
average a	1695.3	2122.0	2532.0	
	A	B	A x B	B x A
LSD 5%	97.05	108.62	144.95	127.57
LSD 1%	139.11	171.98	207.76	189.03
LSD 0,1%	196.12	245.48	305.7	244.84

The influence of Nitrogen Fertilization on Expenditures (B).

Analyzing the influence of the application of fertilization on the expenditures it is observed that the increase of the applied nitrogen doses caused

the increase of the expenditures from 1480 lei/ha to the unfertilized variants (b_1) to 2304 lei/ha in the fertilized variants with 150 kg N/ha (b_3) (tab. 2).

Influence of application of watering doses on produced products (A).Following the application of the watering norms, an increase in production costs was recorded from 1695 lei/ha in the case of the control variant (a_1) up to a value of 2532 lei/ha in the variant where 100% of the required watering standard was applied (a_3), these increases in expenditure being very significant.

Influence of applying watering doses for the same level of fertilization (AxB)

Applying the watering doses (a_2, a_3) for the same nitrogen fertilization dose has in all cases led to a significant increase in expenditure (tab. 2).

Influence of nitrogen fertilization on the same watering standard (BxA).

From the analysis of the data centralized in table 2, it is noticeable that nitrogen fertilization (B) led to an increase in expenditure for all studied irrigation levels (A), and expenditure increases are very significant (tab. 2).

The results of the incomes (lei/ha) obtained from the corn crop under the influence of nitrogen fertilization (B) and the irrigation doses are centralized in table 3. It can be seen that the incomes varied between 1403 lei/ha in the control variant (a_1, b_1) and a maximum value of 4245 lei/ha in the variant where 150 kg N/ha and 100% of the watering standard (a_3, b_3) were applied.

Influence of application of watering doses on income obtained (A). Following the application of the watering norms, there is an increase in the incomes obtained from 2100 lei/ha to 3273 lei/ha in the variants where a 100% watering norm was applied, the registered income increases being very significant (tab. 3).

Table 3

Income (lei/ha) recorded in maize crop under the influence of nitrogen fertilization and irrigation

Specifications	a_1 (without irrigation)	a_2 (50% dose)	a_3 (100% dose)	average b
b_1 (unfertilized)	1403	1970.3	2427.8	1933.70
b_2 (75 kg/ha N)	1903.2	2732.8	3147.6	2594.53
b_3 (150 kg/ha N)	2995.1	3971.1	4245.6	3737.27
average a	2100.43	2891.40	3273.67	
	A	B	A x B	B x A
LSD 5%	106.07	146.02	165.32	188.73
LSD 1%	169.72	233.63	264.51	301.97
LSD 0,1%	233.36	321.23	363.7	415.21

Influence of nitrogen fertilization (B) on the obtained production.

The increase in the level of nitrogen fertilization (B) caused an increase of the obtained incomes (lei/ha) from 1933 lei/ha to 3737 lei/ha in variants where 150 kg nitrogen/ha (b_3) was applied (tab. 3).

Influence of applying watering doses for the same level of fertilization (AxB)

It is found that for all tested levels of fertilization (b_2, b_3), the application of the watering doses (a_2, a_3) determined the increase of the obtained revenues, and the income increases are very significant in all cases.

Influence of nitrogen fertilization on the same watering dose (BxA)

The application of nitrogen doses (B) led to an increase in the income obtained for all studied irrigation variants (A), and the recorded income increases are very significant (tab. 3).

Table 4 summarizes earnings data. It is noted that the profits varied depending on the applied rates between 83 lei/ha and 1983 lei/ha.

Influence of application of watering doses (A) on profits obtained.

It is noticed that the increase of the applied watering norms has led to the increase of the profits obtained from 506 lei / ha for the irrigation (a_1) variants up to 1299 lei/ha for the variants to which a full watering standard (a_3) are very significant (tab. 4).

Table 4

The profit (lei/ha) obtained in the corn crop under the influence of nitrogen fertilization and irrigation

Specifications	a_1 (without irrigation)	a_2 (50% dose)	a_3 (100% dose)	average b
b_1 (unfertilized)	83	460.3	727.8	423.70
b_2 (75 kg/ha N)	322.2	961.8	1186.6	823.53***
b_3 (150 kg/ha N)	1113.1	1899.1	1983.6	1665.27***
average a	506.10	1107.07***	1299.33***	
	A	B	A x B	B x A
LSD 5%	61.6	58.4	71.3	68.6
LSD 1%	99.8	88.6	109.5	108.4
LSD 0,1%	137	140.7	152.8	155.7

Influence of nitrogen fertilization (B) on profits obtained

The increase of the nitrogen fertilization level resulted in an increase of the profits obtained from 423 lei/ha to 1665 lei/ha in the variants where 150 kg nitrogen/ha (b_3) were applied.

Influence of applying watering doses for the same level of fertilization (AxB)

It is found that for all tested levels of fertilization (b_1, b_2), the application of the watering doses (a_2, a_3) has led to a very significant increase in the profits obtained.

Influence of nitrogen fertilization on the same watering standard (B xA)

The application of nitrogen doses (b_2, b_3) led to a very significant increase in the profits obtained for all studied irrigation variants (a_2, a_3) (tab. 4).

Table 5 summarizes earnings data.

Influence of application of the watering doses on the profits obtained (A).

It is noticeable that the increase in the applied watering doses has led to an increase in the profit rate from 28.6% for non-irrigated variants to 63.67% for variants where a 100% watering standard has been applied.

Table 5

Profit rate (%) obtained in corn crop under the influence of nitrogen fertilization and irrigation

Specifications	a_1 (without irrigation)	a_2 (50% dose)	a_3 (100% dose)	average b
b_1 (unfertilized)	6.3	30.5***	42.8***	26.53
b_2 (75 kg/ha N)	20.4***	54.3***	60.5***	45.07***
b_3 (150 kg/ha N)	59.1***	91.7***	87.7***	79.50***
average a	28.60	58.83***	63.67***	
	A	B	A x B	B x A
LSD 5%	2.5	3.1	3.5	3.3
LSD 1%	4.1	4.7	5.4	5.2
LSD 0,1%	5.7	7.5	7.5	7.4

Influence of Nitrogen Fertilization on Profit Rate (B).

The increase in nitrogen fertilization has led to a very significant increase in profits from 26.5% to 79.5% in variants where 150 kg nitrogen/ha (b_3) was applied.

Influence of applying watering doses to the profit rate for the same level of fertilization (AxB).

It is noted that the application of nitrogen doses resulted in very significant increases in the profits obtained for all tested fertilization levels (table 5).

Influence of nitrogen fertilization on the profit rate under the same watering standard (BxA).

Applying nitrogen doses led to a very significant increase in the profits obtained for all studied irrigation variants (a_2, a_3) (tab. 5).

CONCLUSIONS

1. Applying nitrogen doses has led to increased production and economic indicators.

2. Irrigation had a favorable impact on the yields of grain maize (kg/ha) as well as on other economic indicators.

3. Simultaneous application of nitrogen doses (b_2, b_3) and watering doses (a_2, a_3) had a synergistic effect, leading in all cases to increases in the yields obtained.

4. The profit rate recorded the highest values when applying a nitrogen norm of 150 kg/ha (b_3) supplemented with 50% of the water requirement (a_2).

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