INFLUENCE OF DIFFERENT WATER QUALITY FOR IRRIGATION ON VEGETABLE PRODUCTION

UTICAJ NAVODNJAVANJA VODOM RAZLIČITOG KVALITETA NA PROIZVODNJU POVRĆA

J. SUBIĆ, Nataša CECIĆ, D. CVIJANOVIĆ

Institute of Agricultural Economics,Belgrade, Serbia
Corresponding author: Jonel SUBIĆ, e-mail: jonel_s@mail.iep.bg.ac.yu

***Abstract**: This paperwork relate to Community of Pančevo area which were insert on black list of ecological points in Republic of Serbia due to spacious endanger of natural resources. Objects of this research are water and soil as unregeneration natural resources on which exist all planet life, including state and nation and all economy of any area. With regard of living in technological prosperity period and industrialization and in that way water as natural resources recipients a huge quantity of waste water, and also exposed to another origin of pollution, problems with evaluation of water quality for irrigation get bigger in last decades. In the nature are less water of good quality with aggravation trend. Negative impact of mineral water on soil and plants lead to need for determination and evaluation of water irrigation quality. Criteria for evaluation of water quality are often local character, and distinction is understandable, because conditions between individual region are different. This paperwork include three Experimental fields on three region Community of Pančevo. Experimental fields are under greenhouses and in period form October 2006 to April 2007 will be produced vegetables lettuce, spinach, onion and radish. First experimental field will be in Glogonj village, second in Banatski Brestovac village and third experimental field belongs secondary agricultural school „Josif Pančić" in Pančevo. In greenhouses will be introduced modern technology of production with micro sprinkling irrigation systems. Research activity during realization of this project impact of different water quality with three different areas and three different soil type on quantity and quality of produced vegetables and yield.*

***Abstract**: Rad se odnosi na područje opštine Pančevo koja je uvrštena na listu crnih ekoloških tačaka u Republici Srbiji zbog velike ugroženosti njenih prirodnih resursa. Predmet proučavanja su voda i zemljište kao neobnovljivi prirodni resursi na kojima počiva sve živo na zemljinoj kugli, uključujući i državu, i naciju, i celokupnu privredu bilo kog područja. Obzirom da živimo u eri tehnološkog prosperiteta i industrijalizacije i da su vode kao prirodni resursi recipijenti ogromnih količina otpadnih voda, a takođe su izloženi brojnim drugim izvorima zagađenja, problemi ocene kvaliteta vode za navodnjavanje dolaze do punog izražaja poslednjih decenija. U prirodi je sve manje vode dobrog kvaliteta sa trendom njenog daljeg pogoršanja. Prvenstveno negativan uticaj mineralizovanih voda na zemljište i biljke uslovio je potrebu za određivanjem i ocenom kvaliteta vode za navodnjavanje. Kriterijumi za ocenu kvaliteta vode su često lokalnog karaktera, pa su razlike razumljive, jer se uslovi između pojedinih lokaliteta bitno razlikuju. Istraživanja u radu obuhvataju tri Eksperimentalna polja, na tri lokaliteta opštine Pančevo. Ogledna polja su pod plastenicima u kojima će se, u periodu oktobar 2006. – april 2007. godine, od povrtarskih kultura gajiti zelena salata, spanać, crni luk i rotkvica. Jedno ogledno polje se nalazi u selu Glogonj, drugo u selu Banatski Brestovac i treće ogledno polje pripada srednjoj poljoprivrednoj školi „Josif Pančić" u Pančevu. U plastenike će se uvesti savremena i moderna tehnologija proizvodnje sa sistemom za navodnjavanje orošavanjem. Istraživačka aktivnost tokom realizacije projekta prati uticaj vode različitog kvaliteta, sa tri različita lokaliteta i na tri različita tipa zemljišta, na visinu i kvalitet prinosa gajenog povrća.*

***Key words:** irrigation, water quality, soil, vegetable production*
***Ključne reči**: navodnjavanje, kvalitet vode, zemljište, proizvodnja povrća*

INTRODUCTION

The project encircles three experimental fields, on three spots of Pančevo Municipality. The experimental fields are under green houses in which, during period October 2006-March 2007, will be breed various vegetable cultures, as lettuce, onion, spinach and radish.

First experimental field is located in village Glogonj, second experimental field belongs to Secondary agricultural school „Josif Pančić“ in Pančevo, and the third is in village Banatski Brestovac. Besides existed drip irrigation systems, in green houses are leading in, little by little, modern and actual production technology with irrigation system by sprinkling.

Experimental field I – Nurserymen association, Glogonj

Description of the green house:

- dimensions: 8,0 m x 35,0 m (or P=280,0 m^2);
- dimensions: 8,0 m x 25,0 m (or P=200,0 m^2);
- irrigation: by sprinkling.

Grown cultures are: spinach and radish.

Spinach is sowed on surface of 8,0 m x 35,0 m (green house I).

Radishes are sowed on surface of 8,0 m x 25,0 m (green house II).

Experimental field II – „Josif Pančić“ Secondary-school, Pančevo

Description of green house:

- dimension I: 4,0 m x 20,0 m (P=80,0 m^2);
- dimension II: 4,0 m x 20,0 m (P=80,0 m^2);
- dimension III: 4,0 m x 20,0 m (P=80,0 m^2) with 20,0 m^2 unused
- irrigation: system drip irrigation and sprinkling irrigation system.

Growing cultures are: spinach, radish, green salad and onion.

Spinach seed on area 3,0 m x 20,0 m (green house II).

Spinach seed on area 3,0 m x 20,0 m (green house II).

Radish seed on area 1,0 m x 20,0 m (green house II).

Lettuce has been replanted manually on area 1,5 m x 20,0 m (green house III).

Onion seed on area 1,5 m x 20,0 m (green house III).

Experimental field III – Association of truck farmers, Banatski Brestovac

Description of plastic house:

- dimensions I: 5,6 m x 17,0 m (P= 95,2 m^2);
- dimensions II: 5,2 m x 17,0 m (P=88,4 m^2);
- irrigation: system drip irrigation and sprinkling irrigation system.

Breeding cultures are: spinach, radish, onion and lettuce.

Spinach was sowed in the area of 1,4 m x 17,0 m (green house I) + 5,2 m x 17,0 m (green house II).

Radish was sowed in the area of 0,8 m x 17,0 m (green house I).

Lettuce was transplanted manually in the area of 2,8 m x 17,0 m (green house I).

Onion was sowed in the area of 0,6 m x 17,0 m (green house I).

MATERIAL AND METHOD - ECOLOGICAL ASPECTS

Material of researches: samples of soil and water, which used in the production treatment.

Tested qualities of soils: pH (H_2O), pH (KCL), $CaCO_3$ (%), Humus (%), P_2O_5 (mg/100 gr), K_2O (mg/100 gr).

Methods for soil researches: documentary method TAL-1.1-DM-1, 2, 3, 4, 5, 6, 7, 8, 9.

Methods for water researches: contributed in the tables, in company with results.

Modelling of the soil from experimental fields during researching were twice. The samples first time taken 15th December 2006 and results of agrochemical analysis are present on next table.

Table 1

Results of agrochemical characteristics researching of soils from experimental fields (first shaping)

Experimental fields	pH (H_2O)	pH (KCl)	$CaCO_3$ (%)	Humus (%)	P_2O_5 (mg/100 gr)	K_2O (mg/100 gr)
I Glogonj						
Green house 1.	7.80	7.17	2.07	3.37	239	67.0
Green house 2.	7.80	7.20	2.49	2.18	211	51.7
II Pančevo:						
Green house 1.	7.95	7.91	7.70	4.90	560	540.0
Green house 2.	7.53	7.42	6.85	5.69	267	72.0
Green house 3.	8.07	7.59	2.70	4.78	101	40.0
III Banatski Brestovac:						
Greenhouse 1. and 2. (average)	7.60	7.36	3.64	4.60	250	55.0

Resource: Reporting about researches (DP Institut „Tamiš“ – „TAMIŠ AGROLAB“ - Pančevo), January 2007.

Agrochemical analysis of researching samples of soil present following:

- With reaction pH all soils belongs to category of low alkali soils (pH in KCl = 7.20–7.91). Then it is not need to take measure of repairing soil. Possibly intervention could be application with some acid mineral fertilizers, but it is not necessary at all.
- With contents of humus (3.26–5.69 %) soils are humused, except soils from one of three greenhouses in Secondary agricultural school "Josif Pancic" - Pancevo (P=0.6 ha). High percent of humus presents that those soils are with high production possibility. Humus has positive influence on soil structure, water characteristics and soil air, warm, physics, mechanics and chemical characteristics of soil etc.
- Content of organic phosphorus in soil, it could be in correlation with content of organic material, in other word humus. It means that if contents are good for accumulation of organic phosphorus in soil, the more gathers in it and organic phosphorus. But, the results of analysis presents a large amount of phosphorus, what is consequence of using large quantity of fertilisers on experimental fields. Situation with K_2O is the same, and the result is probably increasing of fertilization on experimental fields.
- With content of $CaCO_3$ soils belongs to group of carbonated and strong carbonated soils. This thing has a positive reaction on chemical and physical characteristics of examined soils, and across them and on soil fertility.

The samples of soil were second time taken on 22nd February 2007. The results are present on the table 2.

For difference than first modelling, the samples taken from depth of profile and from depth 0-30 cm and 30-60cm. With reaction of environment all samples belongs low-alkali soils (pH in KCl = 7,2 – 7,58). Content of humus is increased in soils of greenhouses in Pancevo because entering some amount of stable manure. It presents that by content of humus this soils are strong humused (5,25-5,69 %), and content of humus is smaller on depths from 30-60 cm (4,23-4,95 %) because of reduction of manure infiltration in deeper profile horizons. The soil in Banatski Brestovac is humused (3,76 %), and in Glogonj weak humused (2,94-3,13 %).

Table 2

Results of agrochemical characteristics researching of soils from experimental fields (second shaping)

Experimental fields		pH (H_2O)	pH (KCl)	$CaCO_3$ (%)	Humus (%)	P_2O_5 (mg/100 g)	K_2O (mg/100 g)
I Glogonj							
Greenhouse 1.	average	8.00	7.35	2.50	3.13	218	39,7
Greenhouse 2.	average	8.00	7.38	2.92	2.94	190	55
II Pančevo:							
Greenhouse 1.	(0-30 cm)	8.10	7.58	10.84	6.24	370	236
	(30-60 cm)	8.10	7.50	6.26	5.25	206	123
Greenhouse 2.	(0-30 cm)	7.90	7.28	6.26	5.69	220	52
	(30-60 cm)	8.00	7.40	7.09	4.23	209	50
Greenhouse 3.	(0-30 cm)	8.00	7.40	4.17	5.35	137	59
	(30-60 cm)	7.90	7.20	1.67	4.95	70	39,2
III Banatski Brestovac:							
Greenhouse 1. and 2. (average)		8,10	7.48	6.26	3.76	261	45

Resource: Reporting about researches (DP Institut „Tamiš“ – „TAMIŠ AGROLAB“ - Pančevo), March 2007.

With content $CaCO_3$ soils belongs to group carbonated and strong carbonated soils. Results of analysis presents a large amount of phosphorus, as and K_2O, and results probably increased fertilization on experimental fields. The samples subsurfaces water which used in systems for irrigation taken twice as and samples of soil. Results of analysis presents that in this water there are no harmful pesticides and hard metal, in that way and possible content of hard metal in fruit are not result of using irrigation water with bad quality (table 3.).

Table 3

Results of researching samples of subsurfaces water – Glogonj, Pančevo and B. Brestovac (first shaping)

Parameter	Method	Measuring unit	Sample l.b. 1100		
			Glogonj	Pančevo	B. Brestovac
Cd	EPA M 213.2:74	mg/l	<0.0002	<0.0002	
Pb	EPA M 239.2:78	mg/l	<0.002	<0.002	
Hg	EPA M 245.1	mg/l	<0.001	<0.001	
Ni	EPA M 249.2:78	mg/l	<0.003	<0.003	
Fe	EPA M 236.1:78	mg/l	<0.05	<0.05	
Lindan	EPA M 8081B:98	µg/l	<0.01	0.15	
Aldrin	EPA M 8081B:98	µg/l	<0.01	<0.01	
Dieldrin	EPA M 8081B:98	µg/l	<0.01	<0.01	
Endrin	EPA M 8081B:98	µg/l	<0.01	<0.01	
Heptahlor	EPA M 8081B:98	µg/l	<0.03	<0.03	
Metoxihlor	EPA M 8081B:98	µg/l	<0.01	<0.01	
DDT	EPA M 8081B:98	µg/l	<0.01	<0.01	

Resource: Reporting about researches („MOL“ a.d. – Belgrade), january 2007.

MATERIAL AND METHOD - ECONOMIC ASPECTS

This research analyses basic aim is to point out how economic efficacy in agriculture could be evaluate, with accentuation on vegetables production in green houses. There have been used statically (one period) methods, which by, as calculative elements, have been used production costs and value of final products at annually level. In analyses were used data, which had been collected on experimental fields in Pancevo, Glogonj and Banatski Brestovac.

RESULTS AND DISCUSSION

Consistent to proposed task and forms of calculative operations, statically methods for economic efficacy evaluation of vegetables production in green houses can be split in seven basic groups: production capacity, number of engaged workers, production costs, profit, profitability, work productivity and specific consumption. Concerning the fact that members of domestic economies have been only used as labour (experimental fields in Glogonj and Banatski Brestovac) and work of scholars within the practical teaching (experimental field in Pancevo), as well as that they have worked without money compensation (being paid), we have decided to omit criteria which use labour costs as calculative elements.

Production capacity. Index reflects production potential which can be realize in time period of one year. Valuable enunciation of production capacity is nothing else than criteria called **production value** (table 4.).

Table 4.

Effectuated production and average price

Experimental fields / grown culture	Production capacity (1)	Unity prime cost (din/kg) (2)	Production value(din) (3) = (1) x (2)
I Glogonj:			
1. spinach	536.7 kg (1.9 kg/m^2)	90.00 (maloprodaja)	48.303.00
2. radishes	780.0 kg (3.9 kg/m^2)	55.00 (veleprodaja)	42.900.00
II Pančevo:[1]			
1. spinach	369.36 kg (2.6 kg/m^2)	50.00 (veleprodaja)	18.468.00
2. radishes	100.8 kg (5.0 kg/m^2)	44.44 (veleprodaja)	4.479.55
3. lettuce	172 kg (5.7 kg/m^2)	40.00 (veleprodaja)	6.880.00
4. onion	75.5 kg (2.5 kg/m^2)	66.67 (veleprodaja)	5.033.58
III Banatski Brestovac:			
1. spinach	253.0 kg (2.2 kg/m^2)	50.00 (veleprodaja)	12.650.00
2.radishes	57.6 kg (4.2 kg/m^2)	44.44 (veleprodaja)	2.559.74
3. lettuce	230 kg (4.8 kg/m^2)	40.00 (veleprodaja)	9.200.00
4. onion	27.6 kg (2.7 kg/m^2)	66.67 (veleprodaja)	1.840.09

Remark: 1 EUR = 80.9261 RSD (official quotation of National Bank of Serbia, on 28.03.2007.)
Source: Data collected on terrain (experimental fields I, II i III,), October 2006. - March 2007.

Realised production indicates to a fact that the best results have been effectuated on experimental field in Pancevo, than follows experimental field in Banatski Brestovac and, at the end, experimental field in Glogonj. Otherwise, the experimental field in Glogonj has the most production value.

Production costs. Using this criteria, total production costs for period of 1 year are being determine. Data necessary for appliance of this index are given in table 5.

Using mentioned criteria, there have been results that indicate to experimental field in Glogonj as work-researching activity, which requires the highest production costs. Relatively high production costs, according to other two experimental fields, are directly connected to the surfaces under green houses.

Profit, represents crucial index in determination of net effect of any agricultural husbandry (or economic entity), or for any product individually. It expresses valuably the size of

[1] Realised production mostly covers the needs of school kitchen. However, for economic analyses needs are taken the wholesale prices (the example of experimental field in B. Brestovac).

realised result economic efficiency in time period of 1 year. Otherwise, profit calculates as discrepancy of realised production value and production total costs on annually level (table 6.).

Table 5.

Elements of production costs

Experimental fields /grown culture	Seed	Protection	Fertilizer*	Specific costs**	The rest ***	Total costs
	(1)	(2)	(3)	(4)	(5)	(6)=(1+2+3+4+5)
I Glogonj:						
1. spinach	2.018,65	1.682,20	1.682,20	5.046,64	2.018,65	12.448,34
2. radishes	2.103,53	1.262,21	2.103,53	6.310,74	2.519,12	14.299,13
II Pančevo:						
1. spinach	1.009,32	841,10	841,10	-	1.009,32	3.700,84
2. radishes	210,35	126,22	210,35	-	251,91	798,83
3. lettuce	234,93	293,66	587,31	-	352,39	1.468,29
4. onion	266,34	199,77	332,94	-	399,51	1.198,56
III Banatski Brestovac:						
1. spinach	808,90	674,08	674,08	2.022,26	808,90	4.988,22
2. radishes	143,04	85,83	143,04	429,13	171,30	972,34
3. lettuce	372,75	465,94	931,87	1.397,81	559,12	3.727,49
4. onion	88,78	66,59	110,98	332,94	133,17	732,46

* Basic and additional fertilizing. ** Fuel, package and market place tax. *** Water, electrical power and similar.
Source: : Data collected on terrain (experimental fields I, II i III,), October 2006. - March 2007.

Table 6.

Calculative elements for net effect determination

Experimental fields / grown culture	Production value	Production costs	Profit
	(1)	(2)	(3) = (1) - (2)
I Glogonj:			
1. spinach	48.303,00	12.448,34	35.854,66
2. radishes	42.900,00	14.299,13	28.600,87
II Pančevo:			
1. spinach	18.468,00	3.700,84	14.767,16
2. radishes	4.479,55	798,83	3.680,72
3. lettuce	6.880,00	1.468,29	5.411,71
4. onion	5.033,58	1.198,56	3.835,02
III Banatski Brestovac:			
1. spinach	12.650,00	4.988,22	7.661,78
2. radishes	2.559,74	972,34	1.587,40
3. lettuce	9.200,00	3.727,49	5.472,51
4. onion	1.840,09	732,46	1.107,63

Source: Data collected on terrain (experimental field I,II,III), October 2006-March 2007.

According to attained results, it could be concluded that highest profit has been got in radishes grow in experimental field in Glogonj; this culture has been effectuated the best net effect (143,00 din/m^2). Good result has been also effectuated with spinach grow.

Results got on experimental field in Banatski Brestovac are also very satisfying (except lower profit in spinach production: 68,29 din/m^2).

Profit effectuated in experimental field in Pancevo is not representative for this thematic analyses, because the production is not intend for market sale. Accordingly, there is no specific costs which undoubtedly affect on increment of total costs and decrement of net effect.

Profitability. In economic theory and practice, profitability represents the most representing index for economic efficiency evaluation. Otherwise, this criterion could be found in literature also as profitability rate. Profitability is shown as a relation of realized profit and realized production costs, and the fraction multiplies with 100. For adequate calculative operation appliance, necessary calculative elements have been given in table 7.

Concerning the fact that production from experimental field in Pancevo is not intend for commercialization, we can conclude that the highest profitability has been realised in experimental field in Glogonj (spinach production).

Table 7.

Calculating elements for assessment of production profitability

Experimental fields / grown culture	Profit (1)	Value of expenses (2)	Profitability (3) = (1 : 2)
I Glogonj:			
1. spinach	35.854,66	12.448,34	2,88
2. radish	28.600,87	14.299,13	2,00
II Pančevo:			
1. spinach	14.767,16	3.700,84	3,99
2. radish	3.680,72	798,83	4,61
3. lettuce	5.411,71	1.468,29	3,69
4. onion	3.835,02	1.198,56	3,20
III Banatski Brestovac:			
1. spinach	7.661,78	4.988,22	1,54
2. radish	1.587,40	972,34	1,63
3. lettuce	5.472,51	3.727,49	1,47
4. onion	1.107,63	732,46	1,51

Source: Data gathered from terrain (experimental fields I, II and III), October 2006-March 2007.

Specific consumption. Another criterion for assessment of economic efficiency which is in relate to expenses such as: fuel, wrapping material and market tax. Using this method one can also express other expenses in accordance to the production value. Thus, specific consumption is presented as quotient of specific expenses and achieved production value on annual level (table 8.).

Table 8.

Calculating elements for assessment of specific consumption

Experimental fields / grown culture	Specific expenses (1)	Value of expensis (2)	Specific consumption (3) = (1 : 2) x100
I Glogonj:			
1. spinach	5.046.64	12.448.34	0.41
2. radish	6.310.74	14.299.13	0.44
II Pančevo:	-	3.700.84	-
1. spanać	-	798.83	-
2. radish	-	1.468.29	-
3. lettuce	-	1.198.56	-
4. onion	-	3.700.84	-
III Banatski Brestovac:			
1. spinach	2.022.26	4.988.22	0.41
2. radish	429.13	972.34	0.44
3. lettuce	1.397.81	3.727.49	0.36
4. onion	332.94	732.46	0.45

Source: Data gathered from terrain (experimental fields I, II and III), October 2006-March 2007.

Above mentioned data lead to the conclusion that expenses such as fuel, wrapping material and market tax, have the least participation in total production expenses when lettuce is being grown (experimental field in Banatski Brestovac). Specific consumption of other vegetables (spinach, radish and onion) is almost identical, regardless to the experimental field and place of realization. Of course, evenness of specific production is confirmed with the fact that Glogonj and Banatski Brestovac are almost identically distant from the marketing place: Green market in Pancevo (about 20 km) and Wholesale market in Belgrade (about 50 km). Also, wrapping material and market tax are both identical for chosen vegetable culture (for example: spinach and radish).

CONCLUSIONS

In reflection of previous expose, which has ecological and economical analysis of production vegetable on experimental plots in Glogonj, Pančevo and Banatski Brestovac, it could be possible to make conclusions:

- with reaction pH all soils belongs to category of low alkali soils;
- with contents of humus, soils are humused, except soils from one of three greenhouses in Secondary agricultural school "Josif Pancic"-Pancevo;
- results of analysis presents a large amount of phosphorus, as and K_2O;
- with content of $CaCO_3$ soils belongs to group of carbonated and strong carbonated soils;
- results of analysis presents that in water there are no harmful pesticides and hard metal;
- the experimental field in Glogonj has the most production value;
- relatively high production costs in Glogonj, according to other two experimental fields, are directly connected to the surfaces under green houses;
- highest profit has been got in radishes grow in experimental field in Glogonj;
- the highest profitability has been realised in experimental field in Glogonj (spinach production);
- expenses such as fuel, wrapping material and market tax, have the least participation in total production expenses when lettuce is being grown (experimental field in Banatski Brestovac).

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