EFFECT OF DIFFERENT IRRIGATION REGIMENS ON WATER-YIELD RELATIONSHIPS OF POTATO

Borivoj PEJIĆ[1*], Ksenija MAČKIĆ[1], Žarko ILIN[1], Branka KRESOVIĆ[2], Boško GAJIĆ[3]

[1]Faculty of Agriculture, University of Novi Sad, Novi Sad, Serbia
[2]Maize Research Institute, Zemun Polje, Belgrade, Serbia
[3]Faculty of Agriculture, University of Belgrade, Belgrade, Serbia

The water balance (average data for R. Šančevi Met. Station, 1964-2013)

Elements	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Yearly values
t ^oC	- 0.7	1.0	6.2	11.2	16.6	19.6	21.3	20.7	16.8	11.5	5.6	1.6	11.2-17.3
i	0.00	0.16	1.39	3.39	6.15	7.91	8.97	8.59	6.26	3.53	1.19	0.18	47.72
(ETo)	0	3.7	22.2	46.9	77.0	94.9	105	101.6	78.1	48.5	19.16	4.0	601.9
ETo (mm)	0	3	23	53	99	122	138	123	81	46	15	3	706
P (mm)	37	32	38	47	59	85	70	59	41	43	50	48	609-350
Δ	+20	0	0	-6	-40	-37	-17	0	0	0	+35	+45	
r (mm)	100	100	100	94	54	17	0	0	0	0	35	80	
ETa (mm)	0	3	23	53	99	122	87	59	41	43	15	3	548
m (mm)	0	0	0	0	0	0	51	64	40	3	0	0	158
v (mm)	17	29	15	0	0	0	0	0	0	0	0	0	61

Δ ± difference in rainfalls (P) and ETP represent deficiency (m) or surplus (v) after consuming or filling the reserve of available water (r). In this method r = 100 mm
ETo = the evapotranspiration after correcting for geographical latitude, mm

One of the main questions in irrigation practice is the determination of the irrigation schedule for different plants as well as the determination of optimal and rational irrigation regime in relation to the soil, climate conditions, soil management practices and biological properties of cultivated crops

In irrigation practice there are several methods for the determination of irrigation schedule. The basic requirement of each method is practical and simple treatment as well as quick determination, i. e. to obtain the data of soil and plants water regime in a quick and simple way in the field conditions

The application of any method, including the simplest one requiring no measurement or computing, is more useful than to base the irrigation schedule without any criteria

Methods for determining the irrigation schedule

Soil
- According to the state of soil moisture
Pre - irrigation soil moisture = PWM + (FWC – PWM)/2 or 3
PWM = permanent wilting moisture
FWC = field water capacity
irrigation should be performed when about 1/2 or 2/3 of available
water in the soil layer of 0.4 - 0.6 m is spent
1/2 ≈ 80% of FWC, 2/3 ≈ 60% of FWC

Production of potato in the world
- planted area 19.3 million ha
- production potential 368 million t
- average yield of 19.1 t ha^{-1} (FAO, 2012)

Production of potato in Vojvodina
- planted area 18.000 ha
- with an average yield of 15.3 t ha^{-1} (Statistical Yearbook of the Republic of Serbia, 2012)

- Low yields
- the consequence of inadequate management practices
- insufficient amount and unfavorable arrangement of precipitation in the growing season
- inappropriate irrigation scheduling applied

MATERIAL AND METHODS

- Location: Rimski Šančevi experiment field of the Institute of Field and Vegetable Crops in Novi Sad, Serbia (19° 51' E, 45° 20' N, 84 m above sea level)
- Type of soil: the calcareous chernozem soil of the loss terrace
- Experiment variants: irrigation: pre-irrigation soil moisture of 60% FWC (16 mas.%), 70% FWC (18 mas.%), 80% FWC (20 mas.%) and rainfed – control
- Duration: 2002/2003
- Experiment arrangement: block design adapted to conditions of sprinkling irrigation
- Irrigation scheduling: soil moisture determination – gravimetric method - dryer at 105 – 110 °C – 60 cm

ET (ET_m - ET_a) determination: the amount of water taken up from the soil layer of 2 m, rainfall, irrigation water applied

$$ET_m = P + I \pm \Delta W - D$$
$$ET_a = P \pm \Delta W - D$$

ET_m - evapotranspiration determined in irrigation treatments
ET_a - evapotranspiration determined in conditions without irrigation
P - precipitation (mm)
I - irrigation water applied (mm)
$\pm \Delta$ - water storage change in the root zone (mm)
D - drainage water (percolation)

- Water use efficiency

$$Iwue = (Yrr - Ydry)/I$$

$$ETwue = Yirr/ ET_m$$

Iwue = Irigation water use efficiency (kg m^{-3})
ETwue = Evapotranspiration water use efficiency (kg m^{-3})
Yrr – Ydry – yield in irrigated and rainfed conditions (t ha^{-1})

- Experimental units: 10 m^2 – yield t ha^{-1}

- Statistic anallysis: variance of two factorial trial – significance - Fisher's LSD test, regression analysis

Mean monthly air temperature (ºC) and monthly precipitation sum (mm)
## (GMS Rimski Šančevi)

Year	Month											Seasonal average	
	May		June		July		August		September				
	ºC	mm	ºC	mm	ºC	mm	ºC	mm	ºC	mm	ºC	mm
2002	19.1	19	21.1	28	23.6	35	21.5	50	16.3	45	20.3	177
2003	20.6	23	24.0	31	22.6	60	24.6	30	17.2	84	21.8	228
Long-term average (1964-2001)	16.8	60	19.9	86	21.4	68	21.0	57	17.1	35	19.2	306

Potato yield (kg ha⁻¹), irrigation and evapotranspiration water use efficiency IWUE, ETWUE (kg ha⁻¹ mm⁻¹) depending on pri-irrigation soil moisture

Potato yield (kg ha^{-1}), irrigation and evapotranspiration water use efficiency IWUE, ETWUE (kg ha^{-1} mm^{-1}) depending on pri-irrigation soil moisture

Year	Variant	Yield	P	I	ET_m/ET_a	IWUE	ETWUE
2002	80 % FWC	36808	212.7	240	484.2	83.5	76.0
	70 % FWC	40860	212.7	225	471.8	107.1	86.6
	60 % FWC	32468	212.7	180	469.7	87.3	69.1
	Ø	16759	212.7	0	381.2	-	-
2003	80 % FWC	37043	156.1	270	501.4	78.1	73.9
	70 % FWC	45456	156.1	250	467.3	118.0	97.3
	60 % FWC	29306	156.1	240	451.5	55.6	64.9
	Ø	15966	156.1	0	373.4	-	-
2002/03	80 % FWC	36926	184.4	255	492.8	80.8	75.0
	70 % FWC	43158	184.4	237.5	469.6	112.5	91.9
	60 % FWC	30887	184.4	210	460.6	71.4	67.0
	Ø	16362	184.4	0	377.3	-	-

	%	A	B	AB
LSD	0.01	3.149	2.226	4.453
	0.05	4.287	3.031	6.062

$$y = -0.051x^2 + 7.485x - 229$$
$$r = 0.973$$
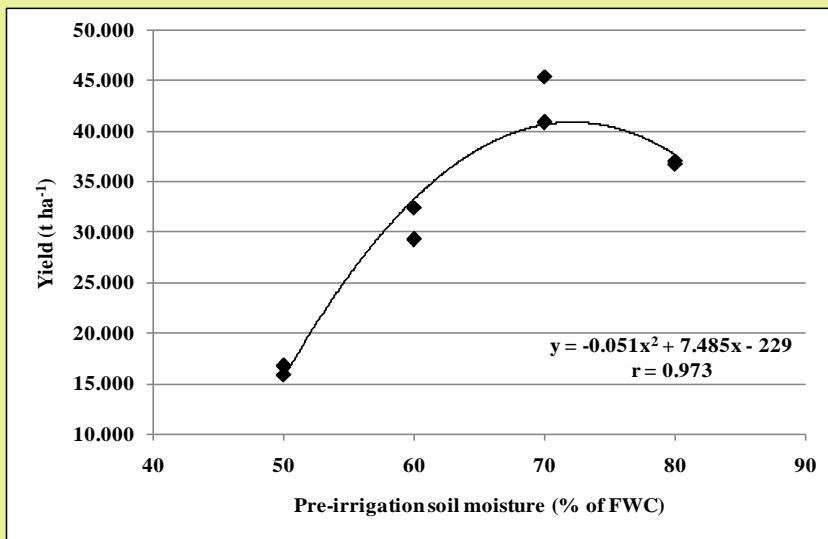
Potato yield depending on pre-irrigation soil moisture

CONCLUSIONS

Potato yield was significantly affected by irrigation

Having in mind that the highest values of yield, IWUE and ETWUE of potato were obtained in the variant of pre-irrigation soil moisture of 70% of FWC, it could be concluded that this level of soil moisture represent the lower limit of optimum soil moisture, it means on that level of soil moisture is needed to start with irrigation if potato is grown in a soil with medium soil texture in climate conditions of the region

The evapotranspiration rate of 470 mm (70% of FWC) could be considered as the water requirement of potatoes grown under the local soil and climatic conditions