Original scientific paper
Оригинален научни рад
UDC: 633.18-152.6:575.832
DOI: 10.7251/AGREN1701017A

University of Banjaluka, Faculty of Agriculture
Agro-knowledge Journal

Characteristics of Five Turkish Rice Cultivars (*Oryza sativa* L.) Grown under the Environmental Conditions of the Republic of Macedonia

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Abstract

The Turkish rice cultivars 'Kiziltan', 'Gala', 'Halilbey', 'Gönen' and 'Paşali' were evaluated under typical environmental conditions and production technology of the Kochani rice producing region in the Republic of Macedonia and compared to the standard cultivar 'San Andrea'. The field trial was set up during 2013 and 2014 in randomized complete block design in 3 replications. The Turkish rice cultivars showed shorter period from seeding to flowering compared to the standard. Significantly lower plant height and panicle length in the Turkish cultivars was determined, based on 30 plants per cultivar. 'Paşali' cultivar produced the highest average number of productive tillers (586.67 m^{-2}), while 'Gönen' the lowest (448.50 m^{-2}), based on 3 samples. The Turkish rice cultivars achieved higher average paddy rice yield (based on 3 samples per cultivar), with significant difference between means only for 'Paşali', where the highest value was obtained (9591.78 kg ha^{-1}). The Turkish rice cultivars generally showed better results than the standard and as such are potentially suitable for cultivation in the Republic of Macedonia.

Key words: days to flowering, plant height, panicle length, paddy yield

Introduction

In the Republic of Macedonia the rice production is spread to a surface area of 4,500 to 5,140 ha, with average paddy rice yields of 5,612 kg ha^{-1} of paddy rice or 2,806 kg ha^{-1} of white rice, calculated at 50% head rice yield for the period 2011-2014 (Statistical Yearbooks of the Republic of Macedonia 2011-2014). Rice is mainly grown along the valley of the Bregalnica river, in the eastern region of the country (Andreevska and Andov, 2015).

Important factors in rice production are soil and climatic conditions together with applied production technology, but for boosting yields and improving quality of rice, the use of high quality rice cultivars is of particular importance.

The introduction of rice cultivars of different origin have been evaluated on multiple occasions in the Republic of Macedonia, in an attempt to improve the production and enrich the gene pool of rice. Some cultivars have been included directly in the rice production, while others in the breeding process of new cultivars (Andov and Andreevska, 2010). In the last few years, the prevalent rice cultivar in cultivation is the Italian cultivar 'San Andrea', followed by Italian cultivars 'Monticelli' and 'R-76/6' and domestic cultivar 'Prima Riska' (based on the quantity of produced seed material, provided by Andov and Andrevska, 2015).

The aim of this study was to evaluate 5 Turkish rice cultivars under typical rice producing conditions of the Republic of Macedonia.

Material and Methods

Plant material from 5 rice cultivars ('Kiziltan', 'Gala', 'Halilbey', 'Gönen' and 'Paşali') developed at the Trakya Agricultural Research Institute from Edirne, Turkey was used. The most common rice cultivar in cultivation- 'San Andrea', an Italian cultivar, was used as a standard.

The field trials were set up in the Rice experimental station of the Institute of Agriculture Skopje, in Sredorek area of Kochani, during 2013 and 2014, in randomized complete block design in 3 replications, under the standard rice production technology. The site is located within the main rice producing region and represents the typical rice growing conditions in the country. During vegetation, the growth stages were monitored in each cultivar. Sowing dates: 08 May 2013 and 15 May 2014; harvest dates: 08 Oct. 2013 and 16 Oct. 2017. Days to flowering were determined as a number of days from seeding to full flowering in 50% of the panicles.

At mature grain stage, plant height, panicle length (total 30 plants- 10 plants per replication), number of productive tillers m^{-2} (3 samples) and paddy rice yield (3 samples) were examined. The results were analyzed by ANOVA and LSD test at 0.05 and 0.01 levels of probability.

Climate and soil

The site where the field trial was conducted belongs to the temperate continental-sub-Mediterranean region of the Republic of Macedonia (Filipovski et al., 1996). The first year of trial - 2013 was characterized with higher mean temperatures and lower precipitation during vegetation (April to October) compared to the second year 2014 (Tab. 1).

Tab. 1. Average monthly temperatures and monthly sums of rainfall during rice vegetation in Kochani region
Просјечне мјесечне температуре и мјесечне суме падавина током вегетационог периода пиринча у региону Кочани

Year *Година*	Months *Мјесеци*							Average (°C) *Просјек* (°C)	
	IV	V	VI	VII	VIII	IX	X	Yearly avg *Годишњи просјек*	During vegetation *У току вегетације*
	Mean monthly temperatures (°C) *Просјечне мјесечне температуре (°C)*								
2013	15.3	20.1	21.8	23.9	26.1	19.8	15.7	14.7	20.4
2014	12.4	16.8	20.8	23.2	23.8	18.3	13.8	13.8	18.4
Avg 1998/2012 *Просјек 1998/2012*	13.8	18.6	22.9	25.6	25.1	20.0	14.7	14.1	20.1
Monthly precipitation (mm) *Мјесечне суме падавина (mm)*								Precipitation sum *Укупне падавине*	
2013	39.0	45.0	130.5	32.0	11.0	29.0	30.0	559.5	316.5
2014	121.0	92.0	116.0	65.0	31.0	89.0	37.0	794.0	551.0
Avg 1998/2012 *Просјек 1998/2012*	39.7	49.4	54.5	27.6	34.5	42.7	60.4	489.5	308.9

The soil in Sredorek area is alluvial, with following major soil characteristics: the sample at 0-20cm depth had a pH reaction of 5.6 (in H_2O) i.e. 4.7 (in KCl), 23.61mg $100g^{-1}$ soil available P_2O_5 and 13.3mg $100g^{-1}$ soil available K_2O. The soil sample at 20-40cm depth had a pH reaction of 6.0 (in H_2O) i.e. 5.3 (in KCl), 7.48mg $100g^{-1}$ soil available P_2O_5 and 12.95mg $100g^{-1}$ soil available K_2O.

Results and Discussion

The most prevalent rice cultivars in Macedonian rice production (*'San Andrea', 'Prima riska' etc.)* are mainly characterized with plant height over 100 cm, and are susceptible to lodging, thus unsuitable for intensive production technology and for high doses of mineral (especially nitrogen) nutrients. In the past few years with unpleasant environmental conditions during harvesting, a serious failure in rice yield and deterioration in paddy quality were recorded (Andreevska et al., 2007, Andreevska et al., 2009).

In 2013, for the first time Turkish rice cultivars were introduced. These cultivars are generally characterized with shorter stem and shorter vegetation period. The use of new short-stem rice cultivars (semi-dwarf or intermediate) would improve the entire rice production, but also it would provide enrichment of the germplasm in rice breeding programs for creating new rice cultivars.

Number of days to flowering and growth stages

During the two-year trial all Turkish rice cultivars showed a lower number of days to flowering (dtf) compared to the standard cultivar 'San Andrea' (Tab. 2).

Tab. 2. Number of days to flowering and growth stages during 2013 and 2014
Број дана до цвјетања и фазе раста током 2013. и 2014. године

Cultivar *Сорта*	Days to flowering (average) *Дани до цвјетања (просјек)*	2013 – seeding date 8.5.2013 *2013 – датум сјетве 08.05.2013*			2014 – seeding date 15.5.2014 *2014 – датум сјетве 15.05.2014*		
		7.8.2013	26.8.2013	dtf	1.8.2014	4.9.2014	dtf
'Kiziltan'	96	Booting	Milk to dough stage	97	End of tillering, start of booting	Start of milk stage	95
'Gala'	92.5	Start of heading	Dough stage	94	Booting stage	End of milk to start of dough stage	91
'Halilbey'	90	Full flowering	End of dough stage	91	Full booting to end of booting	End of dough to mature grain stage	89
'Gönen'	90	Heading	Milk to dough stage	91	Start to full booting	End of milk to start of dough stage	89
'Paşali'	89.5	Full flowering	End of dough stage	91	Booting stage	End of milk to start of dough stage	88
'San Andrea'	99.5	Start of booting	Milk stage	100	End of tillering stage	End of grain formation to start of milk stage	99

The lowest average number of days to flowering was determined in 'Paşali' (89.5 days), while the highest in 'San Andrea' (99.5 days). All Turkish rice cultivars developed the growth stages and reached grain maturity earlier compared to the standard. According to the classification of University of California, Agriculture and Natural Resources (2013), 'Halilbey', 'Gönen' and 'Paşali' are early to medium vegetation length cultivars, 'Gala' is medium vegetation length cultivar while 'San Andrea' is a late cultivar.

Plant height and panicle length

During the two-year trial, the Turkish rice cultivars developed a significantly lower plant compared to the standard 'San Andrea', where the highest average plant height was 114.50 (Tab. 3).

Tab. 3. Plant height for the examined cultivars (cm)
Висина биљака испитиваних сорти (cm)

Cultivar *Сорта*	Year *Година*	X [cm]	σ (S)	Sx	CV %	min [cm]	max [cm]
'Kiziltan'	2013	65.80 **	4.50	0.82	6.84	59	74
	2014	64.40 **	3.59	0.65	5.57	55	72
	Average / *просјек*	65.10	4.04	0.74	6.20	57	73
'Gala'	2013	85.57 **	8.72	1.59	10.20	74	105
	2014	79.33 **	7.32	1.34	9.23	67	91
	Average / *просјек*	82.45	8.02	1.46	9.72	70.5	98
'Halilbey'	2013	87.27 **	7.79	1.42	8.93	73	102
	2014	89.53 **	5.89	1.08	6.58	80	103
	Average / *просјек*	88.40	6.84	1.25	7.75	76,5	102.5
'Gönen'	2013	97.70 **	8.84	1.61	9.05	83	110
	2014	101.57 **	7.94	1.45	7.82	88	120
	Average / *просјек*	99.64	8.39	1.53	8.43	85.5	115
'Paşali'	2013	86.60 **	6.20	1.13	7.15	77	100
	2014	85.18 **	5.43	0.99	6.38	77	96
	Average / *просјек*	85.89	5.81	1.06	6.77	77	98
'San Andrea'	2013	115.67	5.99	1.09	5.18	104	129
	2014	113.33	5.85	1.07	5.16	104	125
	Average / *просјек*	114.50	5.92	1.08	5.17	104	127
	2013 2014	* significant at 0.05 level of probability, ** significant at 0.05 and 0.01 levels of probability (compared to standard cultivar 'San Andrea'),					
LSD 0.05	10.55 7.79						
LSD 0.01	15.00 11.08						

The lowest average plant height was measured in cultivar 'Kiziltan' (65.10cm). According to the plant height classification by IRRI (Standard Evaluation System for Rice, 2002), the standard cultivar 'San Andrea' is an intermediate cultivar, while the Turkish cultivars are semidwarf cultivars.

Compared to the results obtained in this research, the standard cultivar 'San Andrea' showed lower plant height in its country of origin, Italy (Ente Nazionale Risi, 2003; Ente Nazionale Risi, 2010). In opposite, the investigated Turkish cultivars had, on average, higher plants under the environmental condition of Turkey (Sürek, 2011 a).

All Turkish cultivars developed a significantly shorter panicle compared to the standard cultivar 'San Andrea', where the longest panicle measured was 16.67cm (Tab. 4). The shortest panicle was measured in 'Gala' (11.87cm two years average). In another research conducted in the same region, on average shorter panicles than those in 'San Andrea' were assessed in the Italian rice cultivars 'Arpa' and 'Onice', while longer panicles were found in 'Prima riska', Macedonian rice cultivar (Andov et al., 2016).

Tab. 4. Panicle length in the examined cultivars (cm)
Дужина метлицеиспитиваних сорти (cm)

Cultivar *Сорта*	Year *Година*	X [cm]	σ (S)	Sx	CV %	min [cm]	max [cm]
'Kiziltan'	2013	13.50 **	1.20	0.22	8.86	11	15
	2014	14.08 **	1.70	0.31	12.09	11	20
	Average / *просјек*	13.79	1.45	0.26	10.47	11	17.50
'Gala'	2013	11.93 **	1.40	0.26	11.71	9	15
	2014	11.80 **	1.00	0.18	8.45	10	14
	Average / *просјек*	11.87	1.20	0.22	10.08	9.50	14.50
'Halilbey'	2013	13.80 **	1.52	0.28	11.00	12	17
	2014	14.07 **	1.48	0.27	10.55	11	17
	Average / *просјек*	13.94	1.50	0.27	10.77	11.5	17
'Gönen'	2013	14.63 **	1.45	0.26	9.91	12	18
	2014	15.43 **	2.05	0.37	13.26	6	17
	Average / *просјек*	15.03	1.75	0.32	11.58	9	17.50
'Paşali'	2013	12.27 **	2.07	0.38	16.85	10	21
	2014	11.65 **	1.08	0.20	9.30	10	14
	Average / *просјек*	11.96	1.58	0.29	13.08	10	17.5
'San Andrea'	2013	16.03	1.13	0.21	7.04	14	18
	2014	17.30	3.88	0.71	22.42	10	26
	Average / *просјек*	16.67	2.50	0.46	14.73	12	22
	2013 2014	* significant at 0.05 level of probability, ** significant at 0.05 and 0.01 levels of probability (compared to standard cultivar 'San Andrea'),					
LSD 0.05	0.86 1.26						
LSD 0.01	1.23 1.79						

Number of productive tillers

The highest average number of productive tillers was produced by 'Paşali' with 586.67m^{-2}, while the lowest in 'Gönen' (448.50m^{-2}). The standard produced 527.17 productive tillers m^{-2} (Tab. 5).

Compared to the standard, 'Kiziltan', 'Gala', 'Halilbey' and 'Gönen' produced significantly lower number of productive tillers in 2013, while 'Kiziltan' and 'Paşali' developed a significantly higher number of productive tillers in 2014. In some previous field examinations with newly introduced Italian cultivars in the rice production in Macedonia (Andov et al., 2012), a higher number of productive tillers m^{-2} than standard cultivars 'Prima riska' and 'R-76/6' was assessed in the Italian cultivars 'Brio' and 'Ellebi'.

Tab. 5. Number of productive tillers m^{-2} for the examined cultivars
Број продуктивних бокора по m^2 испитиваних сорти

Cultivar *Сорта*	'Kiziltan'	'Gala'	'Halilbey'	'Gönen'	'Paşalı'	'San Andrea'
2013	595.33 *	582.67 **	563.33 **	531.00 **	654.33	656.00
CV	1.59	3.39	8.66	7.71	4.97	1.32
2014	488.67 **	401.33	409.00	366.00	519.00 **	398.33
CV	15.21	4.77	4.77	4.34	2.17	6.32
Average / *просјек*	542.00	492.00	486.17	448.50	586.67	527.17
	LSD 0.05	LSD 0.01	* significant at 0.05 level of probability, ** significant at 0.05 and 0.01 levels of probability (compared to standard cultivar 'San Andrea')			
2013	51.51	73.27				
2014	56.88	80.91				

Paddy rice yield

Table 6 presents the results for the paddy rice yield at 14% grain moisture.

Tab. 6. Paddy rice yield in the examined cultivars (kg ha^{-1})
Принос сировог пиринча испитиваних сорти (kg/ha)

Cultivar *Sorta*	'Kiziltan'	'Gala'	'Halilbey'	'Gönen'	'Paşalı'	'San Andrea'
2013	9093.20	8966.11	9713.23	9027.33	10606.83**	9087.41
CV	6.79	3.68	4.65	3.43	3.20	5.03
Difference from standard	+ 0.06	- 1.33	+ 6.89	- 0.66	+ 16.72	100 %
2014	9974.29	8237.14	8916.95	7831.12	8576.72	7525.38
CV	14.08	11.67	6.94	11.19	17.28	13.62
Difference from standard	+ 32.54	+ 9.46	+ 18.49	+ 4.06	+ 13.97	100 %
Average	9533.75	8601.63	9315.09	8429.23	9591.78	8306.40
Difference from standard	+ 14.78	+ 3.55	+ 12.14	+ 1.48	+ 15.47	100 %
	LSD 0.05	LSD 0.01	* significant at 0.05 level of probability, ** significant at 0.05 and 0.01 levels of probability (compared to standard cultivar 'San Andrea')			
2013	729.68	1037.86				
2014	1489.63	2060.03				

All Turkish rice cultivars showed higher average paddy rice yield compared to the standard 'San Andrea', where the lowest average was achieved (8306.40kg ha^{-1}). Statistically significant differences compared to the standard were found only for 'Paşali', the cultivar with the highest average paddy rice yield (9591. 78kg ha^{-1}).

'San Andrea' produced paddy rice yield within the yield limits in the country of origin - from 6480 to 8710kg ha^{-1} (Ente Nazionale Risi 2003; 2010). Although 'Paşali' cultivar had the largest difference in paddy between 2013 and 2014 on varietal level, in both years the yield was higher compared to the yield potential in the country of origin of 7500 to 8500kg ha^{-1} (Trakya Agriculture Research Institute).

Conclusion

The studied Turkish rice cultivars generally showed better results of the examined characteristics than the standard cultivar 'San Andrea' and as such are potentially suitable for cultivation in the Republic of Macedonia. The shorter vegetative stage, faster development and maturation of these cultivars in the Kochani rice production region allow earlier crop harvest, avoiding unfavorable environmental conditions (precipitation, lower temperatures) that may occur at the end of the vegetation season. The lower plant height of Turkish cultivars allows more intensive production technology (first of all application of higher fertilizer doses) towards higher productivity.

Acknowledgements

This research was financed by the Turkish Cooperation and Coordination Agency - TIKA.

References

Andov, D. and Andreevska, D. (2010). *Selekcija na oriz*. Kočani: Opština Kočani.

Andov, D., Andreevska, D. and Simeonovska, E. (2012). Yield and some morphological properties of newly introduced Italian rice varieties grown in Macedonia. *Agroznanje*, *13*(1), 47-54.

Andov, D. and Andreevska, D. (2015). Proizvodstvo na seme od oriz. In Dimitrovski, R., Andreevska, D., Andov, D., Atanasova, I., Ajtovska, LJ., Petrov – Fafa, V. and Ilieva, V. (Eds.), *Kočanskiot oriz* (pp. 75-78), Kočani: Opština Kočani.

Andreevska, Danica, Ilieva, Verica, Andov, D. and Zasheva, Tanja (2007). Effect of basic fertilization and split application with different nitrogen fertilizers upon yield and quality of *prima riska* - recently developed rice variety. *Journal of Agriculture and Plant Sciences, 7*(1), 87-96.

Andreevska, Danica, Andov, D., Zasheva, Tanja and Ilieva, Verica. (2009). Effect of fertilization upon yield and some morphological-biological and productive properties of *prima riska*recently developed rice variety. *Anniversary yearbook of the Institute of Agriculture – Skopje*, *XXVI/XXVII*, 141-152.

Andov, D., Andreevska, D., Simeonovska, E. and Dimitrovski, T. (2016). Yield and some morphological characteristics of the introduced rice varieties (*Oryza sativa* L.) in the Republic of Macedonia. In *Symposium proceedings of 2nd International Symposium for Agriculture and Food, 7-9 October 2015, II,* 1031-1037, Ohrid, Republic of Macedonia.

Andreevska, D. and Andov, D. (2015). Značenje na orizot vo zemjodelskoto proizvodstvo na R. Makedonija. In Dimitrovski, R.,Andreevska, D., Andov, D., Atanasova, I., Ajtovska, LJ., Petrov – Fafa, V. & Ilieva, V. (Eds.), *Kočanskiot oriz* (pp. 33- 36), Kočani: Opština Kočani.

Ente Nazionale Risi. (2003*). XXXV Relazione Annuale-2002*. Retreived from: http://www.enterisi.it/upload/enterisi/bilanci/Rel2002_15916_32.pdf

Ente Nazionale Risi Milano. (2010). *XLII Relazione Annuale 2009*. Retreived from http://www.enterisi.it/upload/enterisi/bilanci/Relazione%202009_15916_38.pdf

Filipovski, G., Rizovski, R. and Ristevski, P. (1996). *Karakteristiki na klimatsko-vegetacisko-počvenite zoni (regioni) vo R. Makedonija*. Skopje: MANU.

International Rice Research Institute (IRRI). (2002). *Standard evaluation system for rice*. Manila (Philippines): IRRI.

Sürek, H. (2011). Rice research activities in Turkey. Edirne (Turkey): Trakya Agricultural Research Intitute.

State Statistical Office, Republic of Macedonia. (2011-2014). *Statistical Yearbooks of the Republic of Macedonia (2011-2014)*. Skopje: State Statistical Office, Republic of Macedonia.

TARI - Trakya Agricultural Research Institute, Edirne, Turkey. (2014). *Cultivars. Rice. Paşalı.* Retrieved from: http://arastirma.tarim.gov.tr/ttae/Sayfalar/EN/Detay.aspx?SayfaId=115

University of California, Agriculture and Natural Resources. (2013). *Integrated pest management for rice, Third edition*. Oakland: University of California.

Карактеристике пет турских сорти пиринча (*Oryza sativa* L.) у условима гајења у Македонији

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Сажетак

Турске сорте пиринча 'Kiziltan', 'Gala', 'Halilbey', 'Gönen' i 'Paşali' испитиване су у агроеколошким условима Кочанског производног региона, типичним за производњу пиринча у Републици Македонији. Пољски огледи су спроведени током 2013. и 2014. године по случајном блок систему у 3 понављања, а као стандард је била употребљена сорта 'San Andrea'. Турске сорте су показале краћи период од сетве до цвјетања у односу на стандард. Код њих је утврђена и знатно мања висина биљке и дужина метлице (30 биљака по сорти). Сорта 'Paşali' је развила највећи просјечан број продуктивних бокора (586,67 по m^2), а сорта 'Gönen' најнижи (448,50 по m^2). Турске сорте су постигле већи просјечан принос сировог пиринча у поређењу са стандардом (3 примјерка по сорти), али су разлике између средњих вриједности биле значајне само између стандарда и сорте 'Paşali', гдје је добијена највећа вриједност приноса (9591,78 kg /ha). Турске сорте пиринча су углавном показале боље резултате испитиваних карактеристика од стандарда и као такве су потенцијално погодне за производњу у Македонији.

Кључне ријечи: број дана до цвјетања, висина биљке, дужина метлице, стерилност класића, принос арпе

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Received: February 24, 2017
Accepted: June 20, 2017