










Original article

Morphological and productive Properties of Efe, Hamzadere, Çakmak and Tunca Rice Varieties in the Rice producing Conditions of North Macedonia

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Abstract

The number of days to flowering and growth stages, plant and stem height, panicle length, number of panicles/ m², 1000 grains weight of paddy and biomass yield at harvest (straw + paddy rice) were examined in the newly introduced Turkish rice varieties Efe, Hamzadere, Çakmak and Tunca. The new varieties were grown under typical rice producing conditions in the Kocani rice producing region of North Macedonia during 2013 and 2014, in field trials set up in randomized complete block design, compared to standard variety San Andrea. The results were analyzed by ANOVA and LSD test. The studied varieties in both seasons showed shorter average period from seeding to flowering (89 to 93 days across varieties) compared to San Andrea (99.5 days), as well as faster development thru the rice growth phases. The Turkish varieties had a significantly shorter plant (90.75 cm to 94.54 cm) and stem (77.00 cm to 86.53 cm) compared to San Andrea (114.50 cm and 99.63 cm). The number of panicles per m² varied between the two years, with average values from 526.17 in Efe to 647.17 in Tunca. The 1000 grains weight of paddy ranged from 29.03 g in Çakmak to 33.47 in Hamzadere. San Andrea had significantly higher 1000 grains weight, with average value of 37.88 g. The biomass (straw+ paddy) in all varieties was higher in the first year compared to the second. The average values ranged from 28608.34 kg/ha in Efe to 33850.00 kg/ha in Çakmak. The studied Turkish rice cultivars generally showed better results for the examined characteristics than the standard San Andrea (shorter vegetative stage, faster development and maturation, lower plant height, more stable biological yield) and as such are potentially suitable for cultivation in the rice producing conditions of North Macedonia.

Keywords: Rice, Plant height, Panicle length, Number of panicles, 1000 grains weight, Biomass.

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INTRODUCTION

In the Republic of North Macedonia, a centuries old tradition of rice cultivation persists. The rice production meets the domestic market demand, and considerable amount of the product remains for export (Andreevska et al., 2009). In the past decades, an attempt in improving the rice production was undertaken by introducing new cultivars from diverse origin on multiple occasions. In 2013 and 2014, as an attempt to improve the quality of rice, several number of Turkish rice varieties were introduced for the first time in the rice production of North Macedonia.

In previous research papers (Andov et al. 2017; Dimitrovski et al., 2017a, 2017b) the results for Kiziltan, Gala, Halilbey, Gönen and Paşali varieties are given. In this paper are presented the results for the varieties Efe, Hamzadere, Çakmak and Tunca.

Materials and Methods

Plant material

In this study, plant material from 4 newly introduced Turkish rice varieties (Efe, Hamzadere, Çakmak and Tunca) was used. These varieties are developed at the Trakya Agricultural Research Institute, Edirne in Turkey. The most common variety in cultivation- San Andrea, an Italian variety registered in 2000, was used as a standard. Some characteristics of the examined varieties are shown in Table 1 (Ente Nazionale Risi, 2003, 2010; Trakya Agricultural Research Institute, n.d.).

Table 1. Some characteristics of the examined rice varieties in the trial

Variety	Origin	Vegetation length (days)	Plant height (cm)	Head rice yield (%)	1,000 grains weight of paddy (g)	Potential paddy yield (kg/ha)
Efe*	Baldo x Demir	125 - 130	100- 105	64	37	8,000 – 9,000
Hamzadere*	Demir x 83013-TR631-4-1-2	130	95	62	37 - 38	8,000 – 9,000
Çakmak*	Trakya x N1-41T-1T-0T	130	90 - 100	60	33	8,000- 10,000
Tunca *	Rocca x Tthainato	136 – 140	90 - 95	65	32- 33	8,000 - 9,000
San Andrea **	Rizzoto (line)	150 – 160	107 –116	61 – 66.5	35 – 37	6,480 – 8,710

*Trakya Agricultural Research Institute (n.d.).** Ente Nazionale Risi (2003, 2010).

Experimental design

The field trials (complete randomized block design in three replications) were set up during 2013 and 2014, in the Rice experimental station of the Institute of Agriculture Skopje, in Sredorek area of Kochani, under the typical rice producing conditions of North Macedonia. The site is located within the main rice producing region and represents the typical rice growing conditions in the country. The standard rice production technology was applied.

During vegetation, the growth stages were monitored in each cultivar. Sowing dates were 08 May 2013 and 15 May 2014, while harvest dates were 08 Oct. 2013 and 16 Oct. 2014. Days to flowering were determined as a number of days from seeding to full flowering in 50% of the panicles. The plant height, stem height and panicle length were examined in field conditions at mature grain stage, on 10 plants per replication (total of 30 plants in each cultivar). The number of productive tillers per m² and the biological yield at harvest were accessed by taking plant samples bundles of whole plants – above ground biomass from 1 m² prior to harvesting from each replication. The 1,000 grains weight was measured in laboratory conditions. Results were analyzed by ANOVA and LSD test at 0.05 and 0.01 levels of probability.

Climate and soil conditions

The field trial site is located within the main rice producing region that belongs to the temperate continental- sub-Mediterranean region of Republic of Macedonia (Filipovski et al., 1996). The temperatures and precipitation sums during the trial, along with long-term average data for the 1998-2012 period are presented in Table 2.

From previous surveys (Petkovski et al., 1997) the soil in Sredorek area where the field trial was set up is classified as alluvial. The carbonate content of soil was measured with Scheibler calcimeter (Mitrikeski & Mitkova, 2001). The soil pH in distilled water and 1M KCl solution was determined electrometrically using a glass electrode (Mitrikeski & Mitkova, 2001). The soil available P₂O₅ and K₂O were determined using the AL (ammonium lactate) method (Džamić et al., 1996). The following major soil characteristics were determined: the sample at 0 – 20 cm depth had a pH reaction of 5.6 (in H₂O) i.e. 4.7 (in KCl), 23.61 mg/100 g soil available P₂O₅ and 13.30 mg/100 g soil available K₂O. The soil sample at 20- 40 cm depth had a pH reaction of 6.0 (in H₂O) i.e. 5.3 (in KCl), 7.48 mg/100 g soil available P₂O₅ and 12.95 mg/100 g soil available K₂O. Carbonates were not detected.

Table 2. Temperatures and precipitation sums for 2013 and 2014, along with 1998 - 2012 averages

Year	Months							Average	
	IV	V	VI	VII	VIII	IX	X	Yearly average	During vegetation
	Mean monthly temperatures (°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	13.8	18.6	22.9	25.6	25.1	20.0	14.7	14.1	20.1
	Mean monthly maximum temperature (°C)								
2013	21.7	26.5	28.2	30.8	33.3	27.2	23.1	20.6	27.3
2014	18.0	23.0	28.1	30.9	31.8	25.0	20.7	20.1	25.4
AVG 1998-2012	19.2	23.9	28.7	31.6	31.5	26.2	20.2	19.4	25.9
	Mean monthly minimum temperature (°C)								
2013	7.9	13.0	15.4	16.2	17.5	11.2	7.3	8.4	12.6
2014	7.4	10.8	14.0	16.5	16.6	13.4	8.7	8.5	12.5
AVG 1998-2012	5.7	10.1	13.3	15.1	15.0	10.8	6.8	6.3	11.1
	Monthly precipitation (mm)							Precipitation sum	
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	39.7	49.4	54.5	27.6	34.5	42.7	60.4	489.5	308.9

Data obtained from the meteorological station at the Institute of Agriculture Skopje - Rice research station in Kochani.

Results and Discussion

Number of days to flowering and growth stages

The results for the number of days to flowering are shown on Figure 1. The examined Turkish varieties showed shorted period from seeding to flowering compared to the standard cultivar in both years. The shortest average period (number of days to flowering) was determined in Efe and Tunca (89), while the longest average in the standard San Andrea (99.5 days).

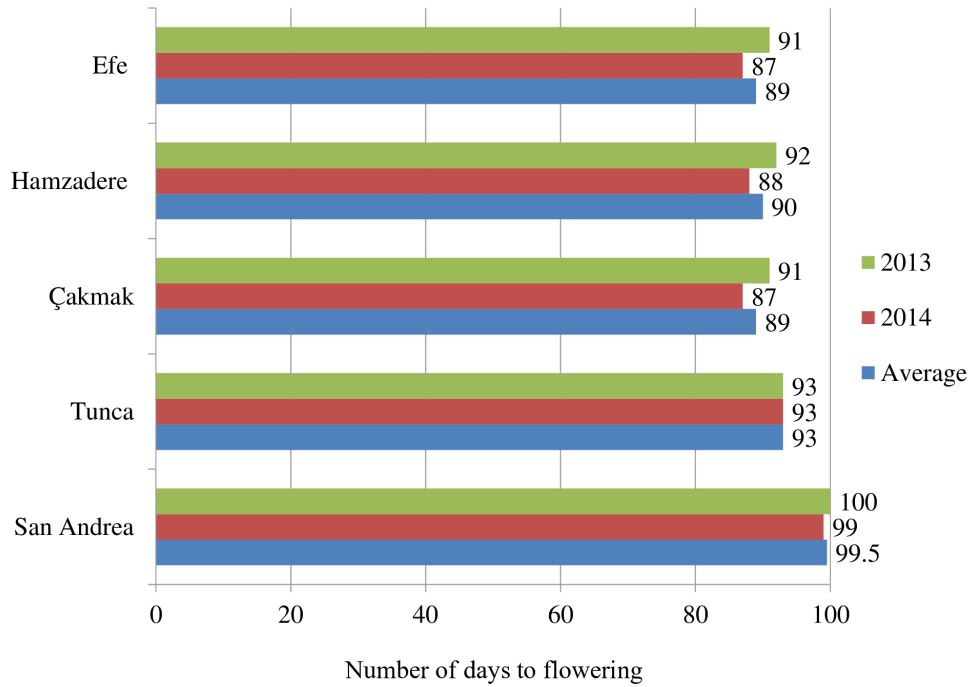


Figure 1. Number of days to flowering in the examined rice varieties

In consistence with the results for the number of days to flowering, the monitoring of growth stages in field conditions showed that the Turkish rice varieties had a faster development thru the growth stages and reached grain maturity earlier compared to the standard (Figure 2 and Figure 3).

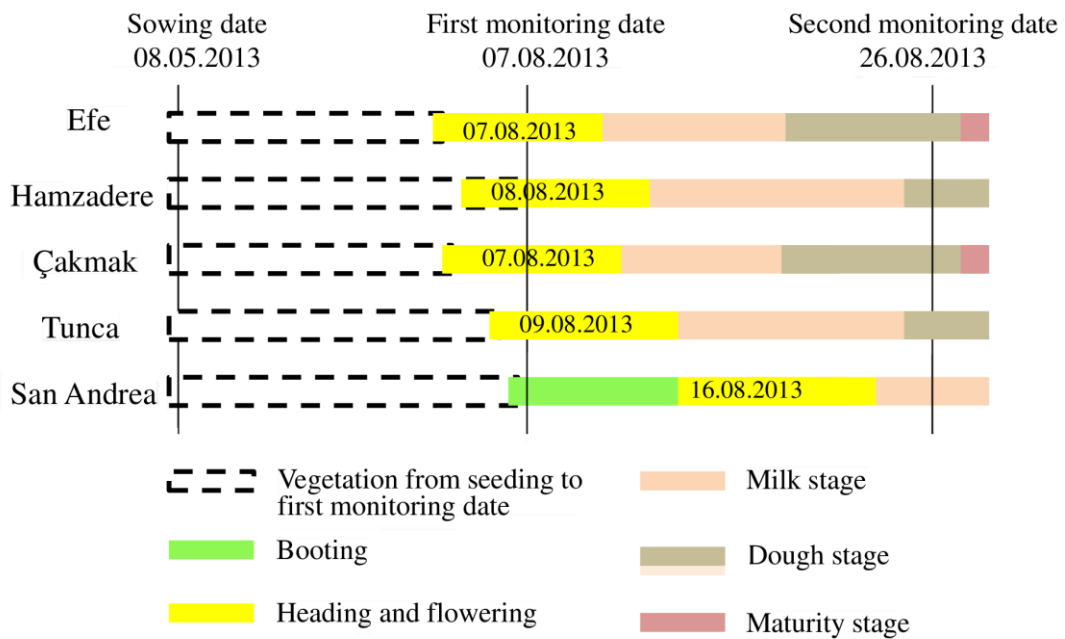


Figure 2. Monitoring of growth stages in field conditions during 2013

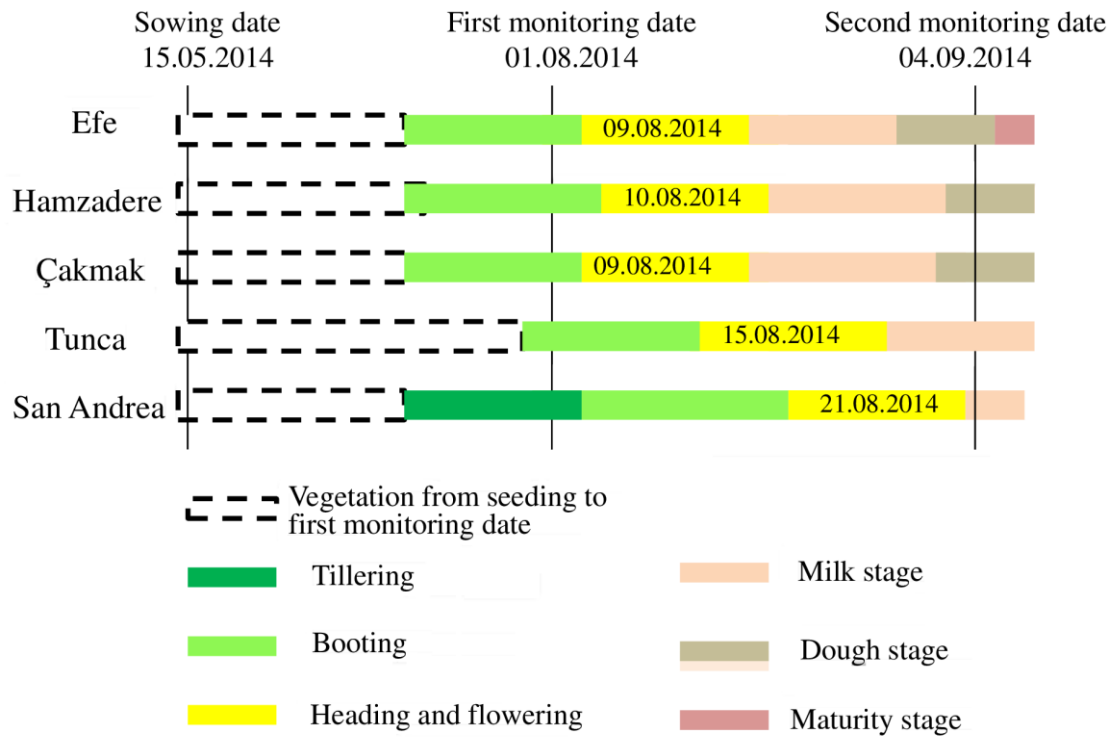


Figure 3. Monitoring of growth stages in field conditions during 2014

Plant height, stem height and panicle length

During the two-year trial, the Turkish rice cultivars developed significantly lower plant and stem compared to the standard San Andrea, where the highest average plant and stem height were measured (114.50 cm and 97.83 cm accordingly, Table 3). The lowest average plant height was measured in Çakmak (90.75 cm), while the lowest average stem height in Tunca (75.74 cm).

According to the plant height classification by IRRI (2013) the standard cultivar San Andrea is an intermediate cultivar, while the Turkish cultivars are semidwarf cultivars. In the rice producing conditions of Republic of Macedonia, Hamzadere, Çakmak and Tunca showed similar plant height as in the country of origin, while Efe had a lower plant height. The standard cultivar also showed plant height in the range reported from the country of origin, Italy (Ente Nazionale Risi, 2003, 2010).

Table 3. Plant and stem height (cm)

Year	Efe	Hamzadere	Çakmak	Tunca	San Andrea	LSD _{0.05}	LSD _{0.01}
Plant height							
2013	98.70 **	99.80 **	91.43 **	93.60 **	115.67	9.35	13.61
2014	90.37 **	89.10 **	90.07 **	90.33 **	113.33	4.68	6.81
Average	94.54	94.45	90.75	91.97	114.50		
Stem height							
2013	85.23 **	86.53 **	78.67 **	77.00 **	99.63	8.57	12.47
2014	78.77 **	76.50 **	77.07 **	74.47 **	96.03	5.22	7.59
Average	82.00	81.52	77.87	75.74	97.83		

* significant difference at $\alpha_{0.05}$ level of probability; ** significant difference at $\alpha_{0.01}$ level of probability - compared to standard.

Efe, Hamzadere and Çakmak developed significantly shorter panicle in comparison to the standard in both years, while the values for Tunca were statistically non significant (Table 4). The longest panicle was determined in the standard (16.67 cm average), while the shortest in Efe (12.54 cm average).

Table 4. Panicle length (cm)

Year	Efe	Hamzadere	Çakmak	Tunca	San Andrea	LSD _{0.05}	LSD _{0.01}
2013	13.47 **	13.27 **	12.77 **	16.60	16.03	1.35	1.96
2014	11.60 **	12.60 **	13.00 **	15.87	17.30	1.79	2.61
Average	12.54	12.94	12.89	16.24	16.67		

* significant difference at $\alpha_{0.05}$ level of probability; ** significant difference at $\alpha_{0.01}$ level of probability - compared to standard.

Number of productive tillers per m²

In the first year of trial, the Turkish varieties developed statistically similar number of productive tillers (panicles) per m² as compared to the standard. In the second year, Hamzadere, Çakmak and Tunca developed significantly higher number of productive tillers per m². As shown on Table 5, the lowest average was determined in Efe (526.17 productive tillers per m²), while the highest in Tunca (647.17 productive tillers per m²). The standard, with an average of 527.17 productive tillers per m² had the largest difference in produced panicles between 2013 and 2014 among the examined cultivars.

Table 5. Number of productive tillers per m²

Year	Efe	Hamzadere	Çakmak	Tunca	San Andrea	LSD _{0.05}	LSD _{0.01}
2013	581.67	648.67	600.33	708.00	656.00	92.66	134.81
2014	470.67	606.00 **	519.67 *	586.33 **	398.33	100.70	146.51
Average	526.17	627.34	560.00	647.17	527.17		

* significant difference at $\alpha_{0.05}$ level of probability; ** significant difference at $\alpha_{0.01}$ level of probability - compared to standard.

1000 grains weight of paddy

The new varieties had a significantly lower 1000 grain weight of paddy in comparison to the standard. As presented in Table 6, the lowest average during the two years trial was measured in Çakmak

(29.03 g), while the highest in the standard (37.88 g). In this trial, the new variety Tunca and the standard San Andrea reached 1,000 grains weight similar to the value reported in the country of origin, while in Efe, Hamzadere and Çakmak a lower value was determined (Ente Nazionale Risi, 2003, 2010; Trakya Agricultural Research Institute, n.d.). The thousand grains weight is a varietal characteristic determined by the grain dimensions (Golam Sarwar et al., 1998; Yoshida, 1981) which depend on the rice hulls size (Fujita et al., 1984; Yoshida, 1981). Some environmental factors, specifically the solar radiation two weeks prior to heading may affect the hull size also affecting the thousand grains weight (Yoshida, 1981). The applied production technology, such as the sowing date (Bashir et al., 2010) and the plant density (Baloch et al., 2002) may also significantly affect the thousand grains weight.

Table 6. 1000 grains weight of paddy (g)

Year	Efe	Hamzadere	Çakmak	Tunca	San Andrea	LSD _{0.05}	LSD _{0.01}
2013	32.21 **	33.81 **	28.93 **	32.98 **	37.90	1.95	2.83
2014	32.98 **	33.12 **	29.12 **	32.69 **	37.86	0.84	1.22
Average	32.60	33.47	29.03	32.84	37.88		

* significant difference at $\alpha_{0.05}$ level of probability; ** significant difference at $\alpha_{0.01}$ level of probability - compared to standard.

Biological yield

In 2013, the lowest biological yield (straw + paddy) was determined in Efe (31750.00 kg/ha), and was significantly lower compared to the standard San Andrea which had the highest higher value (37716.67 kg/ha, Table 7). In 2014 Hamzadere, Çakmak and Tunca had significantly higher biological yield compared to the standard (26933.33 kg/ha). The highest value was determined in variety Çakmak (31466.67 kg/ha). Efe had the lowest average in the two year trial (28608.34 kg/ha), while Çakmak the highest (33850.00 kg/ha). All Turkish rice varieties showed more stable biological yield than the standard, where the highest difference between the two years was obtained.

Table 7. Biological (straw + paddy) yield (kg/ha)

Year	Efe	Hamzadere	Çakmak	Tunca	San Andrea	LSD _{0.05}	LSD _{0.01}
2013	31750.00 *	36916.67	36233.33	33183.33	37716.67	5881.76	8557.37
2014	25466.67	30566.67 *	31466.67 **	31416.67 **	26933.33	2881.68	4192.56
Average	28608.34	33741.67	33850.00	32300.00	32325.00		

* significant difference at $\alpha_{0.05}$ level of probability; ** significant difference at $\alpha_{0.01}$ level of probability - compared to standard.

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 North 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, and negatively affect the rice production in the region. The lower plant height of Turkish cultivars allows

more intensive production technology aiming towards higher productivity, such as application of higher fertilizer doses. Similar results in the rice production conditions of North Macedonia were found for the Turkish cultivars Kiziltan, Gala, Halilbey, Gönen and Paşali (Andov et al., 2017).

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