African Journal of Agricultural Research Vol. 4(15), pp. 1965-1972, 4 August, 2010
Available online at http://www.academicjournals.org/AJAR
ISSN 1991-637X ©2010 Academic Journals

Full Length Research Paper

Determination of some agronomical characteristics and Ochratoxin-A level of Karacadag rice (*Oryza sativa* L.) in Diyarbakir ecological conditions, Turkey

A. L. P. Aydin[1]*, Simten Yesilmen[2] Aydin Vural[3] and H. Sahan Guran[3]

[1]Department of Field Crops, Faculty of Agriculture, University of Dicle 21280 Diyarbakir, Turkey.
[2]Department of Microbiology, Faculty of Veterinary Medicine, University of Dicle, 21280, Diyarbakır, Turkey.
[3]Department of Food Hygiene and Technology, Faculty of Veterinary Medicine, University of Dicle, 21280, Diyarbakır, Turkey.

Accepted 22 June, 2010

This study was conducted to determine yield, quality and Ochratoxin-A level of Karacadag rice local varieties grown widely in Karacadag ecological conditions of Southeast Anatolian Region and to compare with some commercial rice varieties during 2006 and 2007. In the study, total 12 rice genotypes consisting of 10 local varieties and 2 cultivars from foreign origin were used as material. Statistically the differences among the genotypes for all the characters were highly significant. The longest plants of 99.50 cm were recorded in Karacadag landrace No. 1 location with 10.47 tillers per plant, 7.82 panicles per plant and biological yields of 285.10 g plant^{-1}. Whereas, cv. Ribe showed 99.52 grains per panicle, cv. Baldo had 2.686 g grain yield per panicle and 5662.2 kg ha^{-1} grain yield per unit area. Unbroken rice output rate of all rice landraces was higher compared to breeding cultivars. No 3 and 8 of Karacadag rice samples; which showed superior values in terms of plant height, number of tillers per plant and grain yield. It was concluded that these Karacadag rice landraces can contribute in obtaining of high yielded cultivars. That air temperature of Southeast Anatolian Region reached about 40^{0}C at booting stage lead to high spikelet sterility, but yield differences among landraces and breeding cultivars could be eliminated with great number of panicles per plant. All rice and white milled rice samples in this study were analysed in respect of Ochratoxin-A with ELISA test. It was found that ochratoxin-A level in samples from Odabası-Cermik and Mehmediyan-Kocakoy locations were higher compared to samples taken from other locations. In general, the samples were found suitable to Turkish Food Codex and European Union (EU) regulations

Key words: Karacadag rice landrace, yield, quality, toxicological quality, Ochratoxin-A.

INTRODUCTION

Rice (Oryza sativa L.) is the second most important food crop after wheat as a source of nutrition in human feeding in the world. In spite of milled rice obtained after processing of rice, it includes limited quantity of protein in its composition as an essential foodstuff due to high amino acids. More than 70% of world rice is produced in China, Pakistan, India, Indonesia, Bangladesh and Thailand (FAO, 2007). Although cultivated area of rice has fluctuated in Turkey from year to year, it covered an area 93.9 thousand hectares with an annual production of 648 thousand tons during 2007 with average yield of 6910 kg ha^{-1} (TUIK, 2007). Both rapid population increase and growing indispensability in specific areas restrict rice production which results in unavoidable imports.

The determining causes of low cultivation and production of rice in Turkey and its Southeast Anatolia Region accurately would show the way to adopt measures for increasing its production. Main reasons include regional scantiness of water sources, lack of technical knowledge for high rice production and undetermination of suitable rice cultivars for agricultural

*Corresponding author. E-mail: aydinalp21@hotmail.com.

Table 1. Location no and location names of rice and milled rice samples.

Location No.	Locations	Location No.	Locations
1	Odabası-Cermik	7	Kilickaya-Cinar
2	Mehmediyan- Kocakoy	8	Karahan-Merkez
3	Hazro	9	Subatan-Derik
4	Dumurlu- Karacadag	10	Yarimca -Mermer
5	Misirik-Cinar	Ribe	Devegecidi
6	Binik- Karacadag	Baldo	Dubullu-Karacadag

ecological regions. Southeast Anatolia Region has suitable conditions for rice cultivation. The ecological conditions in the region are suitable to two crops in a year. Scarcity of irrigation water is the most problematic in rice cultivation, which has been eliminated on a large scale with Southeast Anatolia Irrigation Project. The regional soils are not polluted with used intense fertilizer and chemicals. The soils are productive. Occurrence of spikelet sterility because of high temperature in the region leads to yield losses. Determining of suitable sowing time and breeding of suitable rice cultivars to the regional ecological conditions contribute to the regional rice production and national economy. Karacadag rice landrace is indispensable because of their resistance to extreme environmental conditions and excellent quality traits responding to consumer demands. Indigenous gene sources will protect their importance continuously in development of new rice cultivars regardless of breeding method and technology. Karacadag rice landrace is preferred primarily for its grain colour, aroma and taste by the regional public. The quality of Karacadag rice is related to cultivar characteristics, climatic and soil properties of Karacadag basin.

The convert to production of high rice cultivation potential in Southeast Anatolia Region depend on widespreading of new cultivars and cultivation technics. By this time cultivar scarcity in rice breeding can be related to fewness of number of suitable genitor as variation sources. Therefore, determination of new genitors having desirable characters and adapting with one another in hybridization and development of new variation sources are aimed primarily in this region. Rice is grown over approximately 4380 ha (4.66% of Turkey) and with rice production of 17269 tons (2.66% of Turkey) in Southeast Anatolia Region (TUIK, 2007). Because of high productive breeding cultivars entering the region, the cultivation of Karacadag rice landraces has decreased. Karacadag rice grains mixed with grains of new cultivars and its excellent quality traits have been lost. Conservation of natural taste is important. Both rice processing factories and consumers prefer pure Karacadag white milled rice even at high prices. Toxigenic fungi may contaminate food products at different phases of production and processing, mainly in favourable humidity and temperature conditions. Invasion of cereal grain by fungi is frequently associated with a substantial risk of contamination by mycotoxins. Some mycotoxins known to exert toxic effect on human and animal health are constantly on the increase and legislative provision is needed to control their presence in food and feed. This study aimed to determine agricultural and qualitative traits of Karacadag rice landraces grown in local areas of the Southeast Anatolia Region and found mixed populations to determine usability in rice breeding programs and the total ochratoxin A levels in rice and milled rice, in respect of maximum tolerable limits in Turkish Food Codex and to demonstrate the importance of contamination regarding the public health.

MATERIALS AND METHODS

Materials

In the study, 10 rice landrace samples collected from Karacadag Basin and two cultivars were used as material. In this research, agricultural, quality and microbiological characters of 10 different Karacadag rice landrace samples and two breeding cultivars grown widely by rice producers in Southeast Anatolia Region were determined and compared. Field of farmers from where the rice samples was collected are given in Table 1.

Karacadag rice landraces; Karacadag rice landraces are characterized as middle-sized grains, tall straw and late maturity (150 days). This rice landrace resiss cold and drought, awned with poor resistance to lodging. Unbroken rice output is 50 - 70%. Karacadag rice is preferred by the regional public primarily due to its distinct taste and aroma (Kiran, 1992).

Ribe

Ribe is an Italian cultivar maturing in 135 -140 days (middle earlier) and is popularly planted in Turkey. It has middle panicle length, short plant height and longer grain length. It is resistance to lodging but sensitive to rice blight illness. Its 1000 grain weight is 33 - 34 g with rice milling output of 55 - 60% (Anonymous, 1980).

Baldo

It is an Italian cultivar with plant height of 105 - 110 cm. It is awnless and middle earlier with maturity duration of 125 -130 days. Its grain colour is yellow and has longer grains. 1000 grains weight is 38 - 39 g. Whole rice milling output rate is 60 - 65% (Anonymous, 1980). Table 1.

Table 2. Meteorological data of Diyarbakir province during 2006 and 2007 years (Meteorology Station of Diyarbakir, Turkey).

Meteorological factors	April		May		June		July		August		September		October	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Av.relative humudity (%)	69.0	79.3	53	75.5	23	51.9	25	27.3	16	23.5	36	31.0	71	71.0
Av.monthly Temp. (℃)	14.5	10.3	19.4	20.6	28.5	27.2	31.4	28.1	32.6	40.9	25.0	33.1	17.6	24.5
Av.highest Temp (℃)	20.6	16.4	27.5	27.6	37.0	35.2	38.1	39.0	40.9	38.8	33.1	34.6	25.1	26.9
Av.lowest Temp (℃)	8.6	4.4	10.1	13.1	16.9	17.6	21.8	22.0	22.5	21.5	16.5	15.5	11.6	11.2
Highest Temp of month (℃)	25.4	22.2	36.5	33.8	40.3	39.5	41.7	41.9	44.2	42.9	38.2	40.2	32.0	32.4
Lowest temp.of month(℃)	1.3	-1.9	5.2	4.9	10.8	12.1	16.0	19.4	17.0	17.1	11.0	11.0	7.0	5.2
Total precipitation (mm)	77.9	88.2	38.4	45.5	0.0	19.5	6.1	0.0	0.0	0.2	3.5	0.0	104.5	4.7

Experimental site

Research area soil at 50 - 70 cm depth and 1% sloping has first class irrigable field features. The soil is clay rich in humus. It is light alkaline (pH 7.79) and red-brown in colour. Soil analysis at Soil laboratory of Southeast Anatolia Agricultural Research Institute, Diyarbakır, showed total salt concentration of 0.044%, lime content of 25.9 %, organic matter of 2.3%, saturation rate of 87% and 1.32% phosphorus at 0 to 40 cm soil depth of the experimental site.

The research area is located at latitude of 37° 30' and 38° 43'N and longitude of 40° 37' and 41° 20' E. The elevation is 660 m above sea level. Most precipitation in Diyarbakir occurs during October to May. The precipitation is not hard and relative humidity is lower during summer. Average long term annual precipitation of region, relative humidity and average temperature are 488.1 mm, 53% and 15.8℃ respectively. Monthly climatic data during 2006 and 2007 vegetation seasons are given in Table 2. This study, used 200 rice plants collected from 10 different Karacadag locations from rice farmers by removing them from soil with roots at maturity. The rice samples (250 g) processed in rice factory were analysed for toxicological analysis. The rice plants and milled rice samples for agricultural, quality and toxicological analysis were brought immediately to laboratory in cold chain (4 ℃). Panicles were threshed to separate seed from the straw after required measurements on plant and prepared for analyses and sowing.

Preparation of the specimens for Ochratoxin A analysis and the test procedure

The assessments of ochratoxin A was conducted using the RIDASCREEN® Ochratoxin A (Art.No. R 1301) ELISA test kits, respectively. The analyses of Ochratoxin A were performed in the laboratory of the Department of Food Hygiene and Technology, Faculty of Veterinary Medicine, Dicle University, Diyarbakır. Two granulated specimen were weighed two times and placed in a screwlidded glass container, followed by addition of 3 mL of PBS-buffer or 4 ml distilled water and 0.2 mL of amilase solution after gentle mixing at room temperature for 20 min. This was mixed with 1 mL of 5 N HCl for 5 min, followed by mixing of 10 mL dichloromethane for 15 min. This step was followed by centrifuging for 15 min at 3500 rpm at 15℃. The overlying layer was removed and the remainder was filtered. Then, 0.13 M of sodium hydrogen carbonate at a volume equal to that of the filtrate was added and mixed for 15 min and re-centrifuged for 15 min at 3500 rpm at 15℃, followed by removal of 100 µL of supernatant of the diluted filtrate, over which 400 µL of 0.13 M sodium hydrogen carbonate was added for additional dilution. Finally, 50 µL of this final diluted material was taken for testing.

Microtiter strips sufficient in amount for the standard and specimens were placed on the plate and 50 µL each of all standards or prepared specimens was placed in the wells. Then, 50 µL of diluted enzyme conjugate was added on each, followed by incubation at room temperature for 2 h. At the end of the incubation, the liquids within the wells were evacuated and the wells were washed with washing solution in an automated washer 3 times. Then, 50 µL of substrate and 50 µL of chromogen were placed in each well, followed by incubation for 0.5 h in dark at room temperature. At the end of the incubation, 100 µL of stopping solution was added and absorbance at 450 nm was assessed. The results were read over a calibration curve and multiplied with the dilution factor, which were 25.

Field experiments

Field experiments were carried out at the experimental areas of the Faculty of Agriculture, Dicle University, Diyarbakir, Turkey. Cultivar, soil tillage, growing and irrigation techniques of rice producers were reported in the autumn, 2005. Research soils were plowed at 30 cm depth once in the autumn. After plowing the field two times, harrowed with disc harrow at 15 cm depth and leveled with float in the early spring, 2006. Main irrigation canal above field and main drainage canal below field were opened.

Rice samples were sown directly in the field on 29 April 2006 and 24 April 2007 by hand broadcast application using seed rate of 180 kg ha^{-1} in plots of 5 $\times$ 2.4 m. Seeds had been soaked in water for 24 h before sowing. Experiment was sown in a randomized complete block design with four replications. Fertilizers were applied at the rate of 150 and 80 kg ha^{-1} of N and P_2O_5 respectively in the form of urea and di-ammonium phosphate. All phosphorus and 1/3 part of N was applied at pre planting, 1/3 at tillering and remaining at panicle initiation during both years. Weeds were controlled by hand as and when required. The field was flooded two days before sowing and water was maintained at about 10 cm height until 15 days before harvest. At maturity, ten plants from the center of each replication were randomly selected for agricultural measurements such as plant height (cm), number of fertile tillers per plant, number of panicle per plant, number of grain per panicle, grain weight per panicle (g), 1000 grain weight (g). Harvesting area was 2.0 x 4.0 = 8.0 m^2. Each plot was hand-harvested for plant biological yield (g-plant-^{1}) and grain yield per unit area (kg-ha-^{1}). Harvested and dried (up to 14% moisture) rice kernel samples were processed, whitened, polished and optically sorted in full automatic milling machine, and unbroken rice output percentage of kernels was founded. The analysis of variance was performed by TARIST

Table 3. ANOVA results of various plant charachteristics under investigation rice varieties (Sources of variation-SV, degrees of freedom-DF and coefficient of variation-CV).

SV	Year	Error 1	Cultivars	Year*Cultivar	Error	CV (%)
DF	1	4	11	11	44	
Plant height	20.909	263.722	179.491**	60.251	40.450	9.6836
The no. of tiller/plant	25.087	5.224	13.626**	5.787	3.600	33.7026
The no of panicle/plant	194.373*	23.259	7.681**	8.537**	2.546	51.8306
The no of grain/panicle	5358.368*	453.696	1899.252**	344.781	198.983	37.0287
Grain weight/panicle	0.360	0.383	1.056**	0.239	0.149	30.9461
Thousand grain weight	300.329	183.145	35.133**	15.806*	6.151	17.2154
Plant biological yield	54384.020	8490.856	8913.969*	8511.401*	3269.028	38.7802
Grain yield	3511.220	3209.815	83610.470**	12645.583**	4380.602	41.2906
Unbroken rice output rate	0.681	4.556	153.468**	3.105	11.268	8.7382

* , **: Significant at 0.05 and 0.01 levels of probability, respectively.

istatistic program. Treatment mean differences were separated by the least significant difference (LSD) test at the 0.01 and 0.05 probability levels.

RESULTS AND DISCUSSION

In the result of this research, differences among the genotypes for biological yield was significant at $p < 0.05$, other all parameters were significant at $p < 0.01$. Table 3. Plant height averages changed between 81.82 and 99.50 cm. The longest plants were measured from 1st location rice samples with least plant height in cv. Ribe. That plant height of 5th and 8th location samples were less, provided an advantage to breeder in breeding studyings for creation of variation. Issaka et al. (2009) reported that for both years plant height for intermediate maturing varieties were similar and taller than the early maturing variety and soil management did not influence plant height. Khan et al. (2006) obtained plant height between 114.73 and 177.33 cm in the study conducted with four varieties of rice under climatic conditions of Pakistan. Variation borders obtained in this research were parallel with the findings of Zeng et al. (2001) (52 - 210 cm) and Gulumser and Sezer (2007) (76 -165 cm). Russo (1994), noted that plant height was naturally influenced by fertilizer treatment, in particular the N dose was determinant. Generally N application increased the plant height slightly. The average height of the Panda variety (90.71 cm) was about 2 cm higher than for the Baldo variety (88.48 cm).

In this study, the number of tillers per plant of rice samples changed from 5.03 to 10.47. The maximum number of tillers per plant was found at samples collected from first location, the least number of tillers were recorded on cv. Ribe. Location 3 rice samples showed least tillering capacity in landraces. It was observed that all Karacadag rice samples had more tillering capacity compared to breeding cultivars. Tillering capacity of rice plants depended on genetic traits of genotypes and is largely affected by environmental conditions (Kun, 1997). When rice was densely planted a significant decrease in the number of tillers per plant was recorded. After maximum tillering stage the number of tillers began to decrease due to the dying of the underdeveloped tillers in agreement with Lin (1974). Khan et al. (2006) obtained 10 to 18 tiller per plant in the study conducted with four varieties of rice under climatic conditions of Pakistan. Savsatlı et al. (2006) determined that effect of sowing methods was important on number of tillers per plant, and average number of tillers per plant was 2.98 in broadcasting method and 1.70 in seedling method. Acikgoz et al. (1987) determined that number of tillers per plant in rice varieties in plants changed between 3.7 to 5.8. It was seen that number of tillers per plant according to varieties in findings of Saif-ur-Rasheed et al. (2002b) (16.00 - 28.67), Ogunbayo et al. (2005) (11 - 23) and Zaman et al. (2005) (5.1 - 11.1). These values given are compatible with values obtained in this study.

The number of panicles per plant obtained in this study changed from 3.82 to 7.82. The maximum number of panicles at rice samples of location 1. The least number of panicles per plant were determined at location 3 rice samples. That the number of panicle of rice landraces was higher compared to breeding cultivars was important because of creation of sufficient variation. Issaka et al. (2009) reported that sawah treatment gave the highest number of panicles/plant (11 - 14) for all the medium maturing varieties and farmer's practices gave the lowest number of panicles per plant (4 - 6) in the study conducted during 2006 and 2007 years with the main objective of comparing the effect of four soil and water management practices on the growth and yield of four rice varieties. Akram et al. (2007) concluded that the panicle ability of different rice varieties was affected significantly with transplanting dates. Khan et al. (2006) obtained 9.2 to 18 spikes per plant in the study conducted with four varieties of rice under climatic conditions of Pakistan. Amin et al. (2004) reported that length and

Table 4. The data for plant height, the number of tiller and the number of panicle of Karacadağ local rice samples and cultivars for 2006 and 2007 years and the averages.

Location No.	Plant height (cm)			The number of tiller/plant			The number of panicle/plant		
	2006	2007	Means	2006	2007	Means	2006	2007	Means
1	100.97 a	98.03 ab	99.50 a	8.90	12.03 a	10.47 a	4.67 abc	10.97 a	7.82 a
2	90.03 b-e	91.33 abc	90.68 bc	9.47	7.77 cd	8.62 abc	6.23 a	7.10 cd	6.67 abc
3	97.47 ab	95.47 ab	96.47 ab	5.63	5.83 cd	5.73 de	2.20 c	5.43 de	3.82 e
4	90.87 a-e	99.93 a	95.40 ab	6.60	11.33 ab	8.97 ab	3.33 bc	10.37 ab	6.85 ab
5	82.43 de	90.10 abc	86.27 cd	5.60	7.53 cd	6.57 cde	3.37 bc	6.70 cde	5.03 b-e
6	94.30 abc	92.23 ab	93.27 abc	5.80	8.03 cd	6.92 b-e	2.70 bc	7.17 cd	4.93 cde
7	92.93 abc	92.67 ab	92.80 abc	5.17	8.37 bc	6.77 b-e	3.40 bc	8.27 bc	5.83 bcd
8	85.40 cde	90.50 abc	87.95 cd	6.50	6.20 cd	6.35 de	4.17 abc	6.50 cde	5.33 b-e
9	87.20 b-e	99.47 a	93.33 abc	6.10	8.03 cd	7.07 b-e	3.17 bc	7.53 cd	5.35 b-e
10	92.90 a-d	87.67 bcd	90.28 bc	7.60	7.57 cd	7.58 bcd	3.60 bc	7.07 cd	5.33 b-e
Ribe	82.00 e	81.63 cd	81.82 d	5.07	5.00 d	5.03 e	4.33 abc	4.23 e	4.28 de
Baldo	87.00 b-e	77.40 d	82.20 d	6.87	5.77 cd	6.32 de	5.17 ab	4.43 e	4.80 de
LSD	10.748	14.638	7.407	-	4.762	2.210	0.691	4.841	1.858

weight of panicles, number of panicles per square meter and grains per panicle increased with increased rate of N and increased spacing (Table 4).

The number of grains per panicle of rice samples changed between 42.08 and 99.52 in this study. Ribe and Baldo breeding cultivars showed the highest grain number per plant but all rice landraces stayed behind of breeding cultivars with regard to grain yield per panicle. This current state can explain with high spikelet sterility in Karacadag rice landraces seen. The lowest grain number per panicle was found at location 5 and 7 samples, respectively. That air temperature of Southeast Anatolia Region reach about 40°C at booting stage of Karacadag rice that lead to high spikelet sterility, but yield differences with breeding cultivars can be eliminated with a great number of panicles per plant. Savsatlı et al. (2006) determined that effect of sowing methods was important statistically on grain number in panicle, and average value of grain was 98.8 in broadcasting method and 113.3 in seedling method. Savsatlı et al. (2008) determined that number of grains (51 - 178) had positive and important relation with grain weight per panicle, plant grain yield and grain size. The findings of Sezer and Koycu (1999) (81.7 - 109.3), Zeng et al. (2001) (30 - 340), Saif-ur-Rasheed et al. (2002a) (42.1 - 93.6) and Sharief et al. (2005) (120.0 -146.9) are compatible with values obtained in this study.

Panicle grain yields of rice samples changed between 1.217 and 2.686 g. The maximum grain weight was obtained in Baldo and Ribe cultivars, the least grain weight in location 5 rice landrace. Difference was not observed between grain yields of location 3 landrace and cultivars highly. Savsatlı et al. (2008) (1.12 - 5.68 g) stated that panicle grain weight had positive and important relations with spikelet fertility, number of grains per panicle, plant yield, grain size and 1000 grains weight; negative relations with panicle length. Savsatlı et al (2006) found grain weight between 2.74 and 3.80 g. Thousand-grain weight an important yield-determining component, is a genetic character least influenced by environment (Ashraf et al. 1999). 1000 grain weight of rice samples changed between 26.59 and 33.72 g. The maximum 1000 grain weight was found in Ribe and location 2 Karacadag rice landrace, the least 1000 grain weight was found at location 7 and 4 rice landraces. Khan et al. (2006) obtained 1000 grain weight between 16.15 and 21.50 g in the study conducted with four varieties of rice under climatic conditions of Pakistan. Savsatli and Gulumser (2006) determined that effect of sowing methods was important statistically on 1000 grain weight, and they obtained the highest value of 1000 grain weight of 39.70 g in Ipsala and the least 1000 grain weight value of 27.19 g in Veneria. Savsatli et al (2008) stated that 1000 grain weight (20.5 - 41.8 g) had positive and important relations with spikelet fertility, panicle grain yield and grain sizes, but 1000 grains weight had negative relations with panicle length. In different studies, limited values of 1000 grain weight were determined by Zeng et al. (2001) as 20 - 52 g, Baloch et al (2006) noted that the highest number of productive tillers m-2 was 506.6 but lower grain weight. Higher number of tillers reduced the number, size and weight of grains (Lockhart and Wiseman, 1988). Similarly, Singh (1994) noted that the number of grains and grain weight panicle-1 were positively correlated with grain yield. Table 5.

Plant biological yields of rice samples changed between 146.60 and 285.10 g-plant^{-1}. The highest biological yield at first location and the lowest biological yield in cv. Baldo, Ribe and location 2 samples. All of Karacadag rice landraces showed higher values compared to control cultivars for plant biological yield. Issaka et al. (2009) concluded that under the various rice

Table 5. The data for the number of grain per panicle, grain yield per panicle and thousand-grain weight of Karacadağ local rice samples and cultivars for 2006 and 2007 years and the averages.

Location No.	The number of grain/panicle			Grain weight g/panicle			Thousand-grain weight (g)		
	2006	2007	Means	2006	2007	Means	2006	2007	Means
1	49.80 bc	83.04 b	66.42 bc	1.273 f	1.865 bc	1.569bed	33.19 abc	23.72 c	28.45 bc
2	50.53 bc	54.37 cd	52.45 cde	2.037 b-e	1.400 c	1.718 bc	36.75 a	29.18 b	32.96 a
3	53.60 bc	77.54 bc	65.57 bcd	2.137 bcd	1.882 abc	2.010 b	30.74 bcd	27.53 bc	29.13 bc
4	56.94 b	73.02 b	64.98bcd	1.653 def	1.655 c	1.654bed	27.70 d	25.85 bc	26.78 c
5	34.13 d	50.03 d	42.08 e	1.180 f	1.255 c	1.217 d	32.74 abc	26.84 bc	29.79 b
6	42.57 cd	60.50 bed	51.54 cde	1.417 ef	1.633 c	1.525 cd	34.02 ab	25.42 bc	29.72 b
7	50.80 bc	48.77 d	49.79 de	1.573 def	1.595 c	1.584bed	27.74 d	25.45 bc	26.59 c
8	48.50 bc	65.21 bed	56.86 cde	1.627 def	1.822 bc	1.724bc	29.37 cd	27.54 bc	28.46 bc
9	72.40 a	79.52 b	75.96 b	2.393 abc	1.589 c	1.991 b	30.20 bcd	26.92 bc	28.56 bc
10	57.47 b	52.17 d	54.82 cde	1.977 cde	1.479 c	1.728 bc	32.06 bc	26.83 bc	29.44 bc
Ribe	82.00 a	117.03 a	99.52 a	2.650 ab	2.399 ab	2.525 a	33.71 ab	33.73 a	33.72 a
Baldo	72.80 a	117.36 a	95.08 a	2.863 a	2.509 a	2.686 a	33.43 abc	33.63 a	33.53 a
LSD	12.312	12.438	16.426	0.729	0.388	0.450	3.706	4.401	2.888

Table 6. The data for plant biological yield, grain yield per unit area and unbroken rice output rate of Karacadağ local rice samples and cultivars for 2006 and 2007 years and the averages.

Location No.	Plant biological yield (g-plant^{-1})			Grain yield per unit area (kg.ha^{-1})			Unbroken rice output rate (%)		
	2006	2007	Means	2006	2007	Means	2006	2007	Means
1	163.97	406.23 a	285.10 a	2725.7 bc	3090.0 bcd	2907.8 bc	67.00 abc	67.00 a	67.00 abc
2	185.20	161.33 d	173.27 cd	2782.3 bc	2521.0 de	2651.7 bcd	70.67 a	68.00 a	69.33 a
3	181.47	200.77 cd	191.12 bcd	2266.7 bc	3818.7 bc	3042.7 bc	62.33 c	63.33 a	62.83 d
4	176.17	317.87 ab	247.02 ab	2206.0 c	3876.0 b	3041.0 bc	68.00 ab	68.33 a	68.17 ab
5	177.37	186.40 cd	181.88 bcd	2764.3 bc	1868.3 ef	2316.3 cd	66.67 abc	66.33 a	66.50 abcd
6	172.50	227.73 bcd	200.12 bcd	2749.3 bc	2934.3 b-e	2841.8 bc	64.67 bc	66.00 a	65.33 bcd
7	185.23	241.27 bcd	213.25 bc	3012.3 bc	2764.3 cde	2888.3 bc	68.00 ab	67.00 a	67.50 ab
8	178.53	182.60 cd	180.57 bc	3309.3 b	3233.7 bcd	3271.5 b	66.00 abc	63.33 a	64.67 bcd
9	173.40	265.73 bc	219.57 abc	2877.7 bc	2377.0 de	2627.3 bcd	63.00 bc	63.67 a	63.33 cd
10	166.00	227.70 bcd	196.85 bcd	2644.7 bc	1253.0 f	1948.8 d	67.00 abc	68.33 a	67.67 ab
Ribe	161.57	149.50 d	155.53 cd	5501.0 a	5823.3 a	5662.2 a	55.67 d	54.33 b	55.00 e
Baldo	139.67	153.53 d	146.60 d	5159.7 a	6115.3 a	5637.5 a	53.00 d	54.00 b	53.50 e
LSD	-	134.849	66.585	132.178	163.526	77.079	5.066	9.343	3.909

environments, sawah and bunded and leveled rice fields gave the highest harvest index (39 - 45%) while farmer's practices gave the lowest harvest index (25 - 38%). Amin et al. (2004) reported that harvest index were not significantly influenced by the plant spacing and fertilizer dozes while straw yield were affected significantly. Grain yield per unit area was found to change between 1948.8 and 5662.2 kg ha-^{1}. The highest grain yield was obtained in cv. Baldo and Ribeand the lowest grain yield in location 10 rice landrace. All of Karacadag rice landraces showed lower values compared to control cultivars for grain yield per unit area. Unbroken rice output rate of rice samples were reported to change between 53.50 and 69.33%. It was noted that the highest unbroken rice output in second location and the lowest unbroken rice output rate in cv. Baldo and Ribe. All Karacadag rice landraces showed higher values compared to control cultivars for unbroken rice output rate. Table 6.

Ochratoxin-A in rice and milled rice: Ochratoxin A (OTA) is a mycotoxin produced by several fungal species from Aspergillus and Penicillium genera. It is widespread in food and feed and its occurrence has been reported in cereals, cereal-derived products, dried fruits and spices. This mycotoxin was implicated in several human and animal pathologies such as the Balkan Endemic Nephropathy and the Tunisian Chronic Interstitial Nephropathy of unknown cause (Zaied et al., 2009). Maximum tolerable limit of Ochratoxin A level according to Turkish Food

Table 7. Ochratoxin-A level in Rice and milled rice of Karacadağ local rice samples and cultivars for 2006-2007 averages.

Location No.	Location names	Ochratoxin-A in rice (µg/kg)	Ochratoxin-A in milled rice (µg/kg)
1	Odabası-Cermik	1.57	1.33
2	Mehmediyan- Kocakoy	2.51	0.77
3	Hazro	0.38	0.45
4	Dumurlu- Karacadag	0.43	0.53
5	Misirik-Cinar	0.59	0.36
6	Mehmediyan- Kocakoy	0.85	0.26
7	Kilickaya-Cınar	0.22	0.18
8	Karahan-Merkez	0.47	0.42
9	Subatan -Derik	0.34	0.21
10	Yarimca-Mermer	0.68	0.69
Ribe	Devegecidi	0.35	0.29
Baldo	Dubullu-Karacadag	0.34	0.47

Codex and EU Regulation is clarified as 5 µg/kg in untreated cereals and as 3 µg/kg in treated cereal products or cereal presented to consumption directly (Turkish Food Codex, 2008; ECR, 2003). Ochratoxin A level was found between 0.22 and 2.51 µg/kg in rice samples, between 0.18 and 1.33 in white milled rice samples. Ochratoxin A level of all rice and milled samples analysed with ELISA test were found within values permissible according to Turkish Food Codex and EU Regulation. The ochratoxin levels in these genotypes was with in the safe limits. Ochratoxin A level of rice was determined by Abdelhamid (1990) as 4 ng/g; Scudamore et al. (1999) 1 -19 ng/g; Trung et al., (2001) 21.3 - 26.2 ng/g; Nguyen et al (2007) 0.75 ng/g and Juan et al. (2008) 0.08 - 47 ng/g. Average values obtained in this study were lower level than most of the above mentioned studies. Table 7.

Conclusıon

It was concluded that 3 and 8 numbered Karacadag rice samples showed superior values in terms of agricultural traits; which can contribute in obtaining high yield cultivars. All of Karacadag rice landraces showed higher values compared to breeding cultivars for unbroken rice output rate. It was observed that the adaptation of local rice varieties to environmental conditions of region was superior compared to breeding cultivars. It was found that ochratoxin-A level in samples providing from Odabaşı-Çermik and Mehmediyan-Kocaköy locations were higher compared to samples collected from other locations.. Samples were suitable to Turkish Food Codex and European Union (EU) regulations.

ACKNOWLEDGEMENTS

The authors are deeply grateful to Coordinator of Scientific Research Projects of Dicle University for financial support (Project No: DUBAP 06 ZF 98).

REFERENCES

Abdelhamid AM (1990). Occurrence of some mycotoxins (aflatoxins, ochratoxin A, citrinin, zearalenone and vomitoxin) in various Egyptian feeds. Arch. Anim. Nutr., 40: 647-664.

Açıkgöz N, Atannasiu N, Çolakoğlu H, Eryüce N, Westphal A (1987). Cultivar, seeding and fertilization problems of rice cultivation in Aegean Region. J. Fac. Agric., Aegean Univ. 24(3).

Akram HM, Abbas A, Mushtaq AN, Iqbal MS (2007). Yield and yield components of rice varieties as

Amin M, Khan MA, Khan EA, Ramzan M (2004). Effect of İncreased plant density and fertilizer dose on the yield of rice variety ir-6. J. Res. (Sci.), Bahauddin Zakariya University, Multan, Pakistan, 15(1): 09-16, June 2004.

Anonymous (1980). Trakya Agricultural Research Institute Reports.

Ashraf A, Khalid A, Ali K (1999). Effect of seedling age and density on growth and yield of rice in saline soil. Pak. J. Biol. Sci., 2(30): 860-862.

Baloch MS, Awan IU, Hassan G (2006). Growth and yield of rice as affected by transplanting dates and seedlings per hill under high temperature of Dera Ismail Khan, Pakistan. J. Zhejiang Univ. Sci. B, 7(7): 572-579.

ECR (2003). European Commission Regulation. Commission Regulation (EC) No 2174/2003 of 12 December 2003 amending Regulation (EC) No 466/2001 as regard aflatoxins. Official J. Eur. Union L326: 12.

FAO (2007). Food and Agriculture Organization. http://faostat.fao.org/site/567/default.aspx#ancor. (Available online: 01.10.2009)

Issaka RN, Buri MM, Wakatsuki T (2009). Effect of soil and water management practices on the growth and yield of rice in the forest agro-ecology of Ghana. J. Food, Agric. Environ., 7(1): 214-218.

Juan C, Zinedine A, Idrissi L, Maries J (2008). Ochratoxin A in rice on the Moroccan retail market. Int. J. Food Microbiol., 126: 83–85.

Khan TN, Razzaq A, Shahbaz M, Ajmal S, Ghulam MA, Joyia MF (2006). Performance of Four Varieties of Fine Rice for Best Yield and Yield Components Under Climatic Conditions of Bahawalpur (Pakistan). J. Agric. Soc. Sci., 1813-2235 (2006) 02-3- 187-188. http://www.fspublishers.org.

Kiran AK (1992). Effect of sowing time on yield and yield components in rice cultivars at the Southeast Anatolia Region. PhD Thesis. Ankara University Graduate School of Natural and Applied Sciences

Department of Agronomy. Ankara, Turkey.
Kun E (1997). Cereals II. Warm Climate Cereals – Coursebook. University of Ankara, Faculty of Agriculture, Field Crops Department Press, No. 1452. Ankara, Turkey, 317 p. (in Turkish).
Lin MH (1974). Studies on the relation among leaf age index, the stages of panicle development under different conditions in rice. Bull. Taichung Dis. Agr. Imp. Sta., 10: 1-22.
Lockhart JAR, Wiseman AJL (1988). Introduction to Crop Husbandry. Wheaton and Co. Ltd., Pergamon Press, Oxford, UK, p.70-180.
Nguyen MT, Tozlovanu M, Tran TL, Pfohl-Leszkowicz A (2007). Occurrence of aflatoxin B1, citrinin and ochratoxin A in rice in five provinces of the central region of Vietnam. Food Chem., 105: 42-47.
Ogunbayo SA, Ojo DK, Guei RG, Oyelakin OO, Sanni KA, (2005). Phylogenetic Diversity and Relationships Among 40 Rice Accessions Using Morphological and RAPDs Techniques. Afri. J. Biotechnol., 4(11): 1234-1244, November.
Russo S (1994). Rice yield as affected by the split method of N application and nitrification inhibitor DCD. Cahiers Options Mediterraneennes, 15(1): 43-52.
Saif-ur-Rasheed M, Sadaqat HA, Babar M (2002b). Interrelationship Among Grain Quality Traits of Rice (Oryza sativa L.). Asian J. Plant Sci., 1(3): 245-247.
Saif-ur-Rasheed M, Sadaqat HA, Babar M, (2002a). Cause and Effect Relations of Panicle Traits in Rice (Oryza sativa L.). Asian J. Plant Sci., 1(2): 123-125.
Savsatli Y, Gulumser A (2006). The effects of transplanting and broadcast sowing methods in some paddy cultivars on yield and some quality characters. J. Fac. Agric., OMU, 21(2): 154-159.
Savsatli Y, Gulumser A, Sezer I (2008). Comparıson to rıce genotypes growıng ın samsun ecologıcal condıtıons regardıng the yıeld and yıeld components. J. Fac. Agric., OMU, 23(1): 7-16.
Savsatli Y, Koycu C, Gulumser A (2006). The effects of transplanting and broadcast sowing methods in some paddy cultivars on yield and yield components. J. Fac. Agric., OMU, 21(1): 6-13.
Scudamore KA, Patel S, Breeze V (1999). Surveillance of stored grain fromthe 1997 harvest in the United Kingdom for ochratoxin A. Food Additives Contaminants, 16: 281–290.
Sezer I, Köycü C (1999). A research on determination of some rice (Oryza sativa L.) varieties on the Kizilirmak Walley Turkey 3th Field Crops Congress. 15-18 November 1999, Adana., 1: 293-298.
Sharief AE, EL-Moursy SA, Salama AM, EL-Emery MI, Youssef FE (2005). Morphological and Molecular Biochemical Identification of Some Rice (Oryza sativa L.) Cultivars. Pakistan J. Biol. Sci., 2(9): 1275-1279.
Singh VP (1994). Correlation studies in rice. Agric. Sci. Digest, 14(3-4): 185-188.
Trung TS, Bailly JD, Querin A, Lebars P, Guerre P (2001). Fungal contamination of rice from South Vietnam, mycotoxigenesis of selected strains and residues in rice. Revue de Médecine Vétérinaire, 152: 555-560.
TUIK (2007). Turkish statistical Institute. http://www.tuik.gov.tr/bitkiselapp/bitkisel.zul.
Turkish Food Codex (2008). Official gazete, 17.05.2008- 26879; No: 2008/26, notification on determination of detection limits of certain contaminants in foods. Prime Ministery Press Ankara, Turkey.
Zaied C, Abid S, Zorgui L, Bouaziz C, Chouchane S, Jomaa M, Bacha H (2009). Natural occurrence of ochratoxin A in Tunisian cereals. Food Control, 20: 218–222.
Zaman MR, Paul DNR, Kabir MS, Mahbub MAA, Bhuiya MAA (2005). Assessment of Character Contribution to the Divergence for Rice Varieties. Asian J. Plant Sci., 4(4): 388-391.
Zeng Y, Li Z, Yang Z, Wang X, Shen S, Zhang H (2001). Ecological and Genetic Diversity of Rice Germplasm in Yunnan. Issue 125, China, pp. 24-28.