Current Trends in Natural Sciences
Vol. 11, Issue 21, pp. 455-473, 2022
https://doi.org/10.47068/ctns.2022.v11i21.050

Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521

Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

ECONOMIC ANALYSIS OF PADDY PRODUCTION WITH DRIP IRRIGATION: CASE STUDY OF DARDANELLES-TURKEY

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Current Trends in
Natural Sciences

Abstract
In traditional paddy production, large water losses may occur due to drainage, evaporation and deep percolation (groundwater is highly polluted). In addition, while production costs increase, it also decreases in production areas. This study has been researched together with the usability of the drip irrigation method (DI) to reduce the global footprint of water in paddy production and its economic analysis. In the experiment, two irrigation intervals (2 and 4 days), four irrigation water levels (75, 100, 125 and 150% of cumulative Class A Pan values) and three different paddy genotypes (Baldo, Osmancik and Ronaldo) were investigated. In the research, irrigation water between 513-820 mm was applied to the treatments. Actual Evapotranspiration (ETa) values are 565-855 mm; The Crop Water Productivity (CWP) ranged from 0.84-1.35 kg ha^{-1} m^{-3} and the Irrigation Water Use Efficiency (IWUE) ranged between 0.95-1.49 kg ha^{-1} m^{-3}. Economical water productivity (EWP) was calculated between 0.79-1.24 \$ m^{-3} and the cost-benefit (B/C) ratio was calculated between 1.11-2.33. When the traditional cultivation method, the ponding method in the pan, is compared to the province, it has been determined that water savings are between 70-81%. Yield according to branches was measured as 4882-10305 kg ha^{-1}. According to the results of the research, up to 29% yield increase was achieved under the condition of applying 150% of the cumulative evaporation every 2 days.

Keywords: micro-irrigation, ETa, IWUE, EWP, Class A Pan

1. INTRODUCTION

Rice is the world's most abundant product after corn and wheat. The Asian continent accounts for 90% of the world's rice production. According to FAO (2020), 67% of total rice production comes from five countries (China, India, Indonesia and Bangladesh) (Anonymous, 2021b). According to the Sustainable Rice Platform (SRP) created by the United Nations Environment Programme (UNEP) and the International Rice Research Institute, rice is the main source of food for more than half of the world's population. About 40% of the world's clean water is used for rice production. Approximately 75% of the production is produced by the flooded method. Demand for rice is expected to increase by 25% by 2050. Experts agree that rice production should become more sustainable (Anonymous, 2021a; Arbat et al., 2020; Maraseni et al., 2018).

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Rice is produced in two ways, aerobic and anaerobic. Anaerobic production (also known as conventional production) is a production method that stores water at the border. This type of irrigation system is normally called flooded irrigation and the oldest and most widely used in the world is this method (Ramesh et al., 2019; Wassmann et al., 2000). Increasing pressures on water resources necessitate the production of rice aerobically. Developments in irrigation systems and pesticides (pesticides and herbicides) have made the aerobic production method much easier. In the literature, there are some researches about surface and subsurface drip irrigation methods (SDI) and the sprinkler irrigation method (pivot and linear systems), groundwater regulation/raising method and sub-irrigation method. In the case of using the DI method for paddy production; provides great savings in water, fertilizer, pesticide, labor costs, tillage, leveling, planting, maintenance, harvest, field rent and other expenses. It also makes great contributions to the reduction/prevention of root zone diseases. In addition to continuous wetting techniques with DI, it is possible to apply irrigation water sensitively to the plant root zone (Hanson and May, 2007). Furthermore, DI generally positively encourages plant growth by limiting evaporation and deep percolation in the soil. Moreover, because the fertilization is done in divided doses in the form of fertigation at the right times, rice yield increases (Adekoya et al., 2014). Otherwise, plant physiology, increased water and nutrient (Eid et al., 2013) resource use efficiency (Rajwade et al., 2018) are also significantly affected by drip irrigation (Tognetti et al., 2003; Parthasarathi et al., 2018).

Use between 675 and 4450 mm of irrigation water depending on soil texture/type, cultuvare of paddy production, variyete of paddy, climatic conditions, paddy production technology and irrigation method for production (Arbat et al., 2020; Maclean et al., 2013). In another study, seasonal irrigation water usage was reported in the range of 1650-3000 mm (Tuong and Bouman, 2003; Lampayan and Bouman, 2005). While evapotranspiration values for paddy in the Russian Federation vary between 600 and 800 mm, approximately 2000 mm of irrigation water has been used reported for flooded production (Kruzhilin et al., 2017). Researches conducted in Turkey (Ozer, 2018; Tuna 2012; Anonymous 2009; Çakır et al. 1998; Ayday et al. 1981; Özkara 1981) showed seasonal irrigation water requirements between 788-4355 mm.

He et al. (2013) obtained 5785 kg ha^{-1} yield against 11215 m^3 ha^{-1} irrigation water with surface drip irrigation method with NingGeng28 variety. The yield obtained was lower than the yield in conventional production (8300 kg ha^{-1}). In addition, WP in DI was obtained as 0.52 kg m^{-3}, twice the conventional production. Parthasarathi et al. (2015), WP_{Irr} value was calculated as 0.84 kg m^{-3}, including the contribution of precipitation falling in the irrigation season, in paddy production irrigated with DI irrigation (average yield of 4834 kg ha^{-1} was obtained in ADT (R) 45 variety) in India. Similarly, Arbat et al. (2018) obtained 5565 kg ha^{-1} yield and 0.60 kg m^{-3} WP_{Irr}.

Beser et al. (2015) cultivated rice with drip irrigation in their study. At the end of the two-year research, the mean evapotranspiration value was determined as 789 mm. Among the varieties used in the study, the highest yield was determined in Duragan (6517 kg ha^{-1}) variety, followed by Osmancik-97 (6238 kg ha^{-1}) and Halilbey (6231 kg ha^{-1}), and these varieties were suggested as varieties that can be used in production with drip irrigation. At the same time, it is reported that these varieties provide approximately 50% more water savings in drip irrigation conditions than in flooded irrigation.

Bouman et al (2002) state that new varieties suitable for aerobic rice cultivation should be developed. For this purpose, in their research in North China, a research was conducted in which the new varieties developed for aerobic production and the varieties suitable for conventional irrigation were compared. While the yield in aerobic production was 4.7-6.6 t ha^{-1}, it was 8.0-8.8 t ha^{-1} in conventional production. In aerobic conditions; irrigation water requirement is 50% less (470-650 mm) compared

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to conventional irrigation, labor requirements have decreased by 55% and WP has increased by 64-88%.

In this study, the conditions for producing rice with drip irrigation in Çanakkale-Turkey conditions were researched and the appropriate irrigation program (irrigation interval and irrigation water level) was researched for three different rice varieties. An economic analysis has also been made for Çanakkale, taking into account the production cost. In addition, with the studies on paddy production with drip irrigation, the total efficiency, the amount of irrigation water applied, the irrigation water savings rate, the water use efficiency (WUE), the irrigation water use efficiency (IWUE) and the benefit-cost ratio parameters of the traditional (with flooded) method of production have been determined.

2. MATERIALS AND METHODS

2.1 Study Area

The study area was built on the Ozbek Plain in Dardanelles region (Figure 1). The study area is located at coordinates 40°11'14.48"N and 26°29'24.95"E. It is 14 m above sea level. The soils of the research area are in clay loam texture and the soil depth is sufficient. There is no groundwater problem. An irrigation canal runs along the edge of the land. This water coming from the Atikhisar dam through the irrigation canal was used as irrigation water.

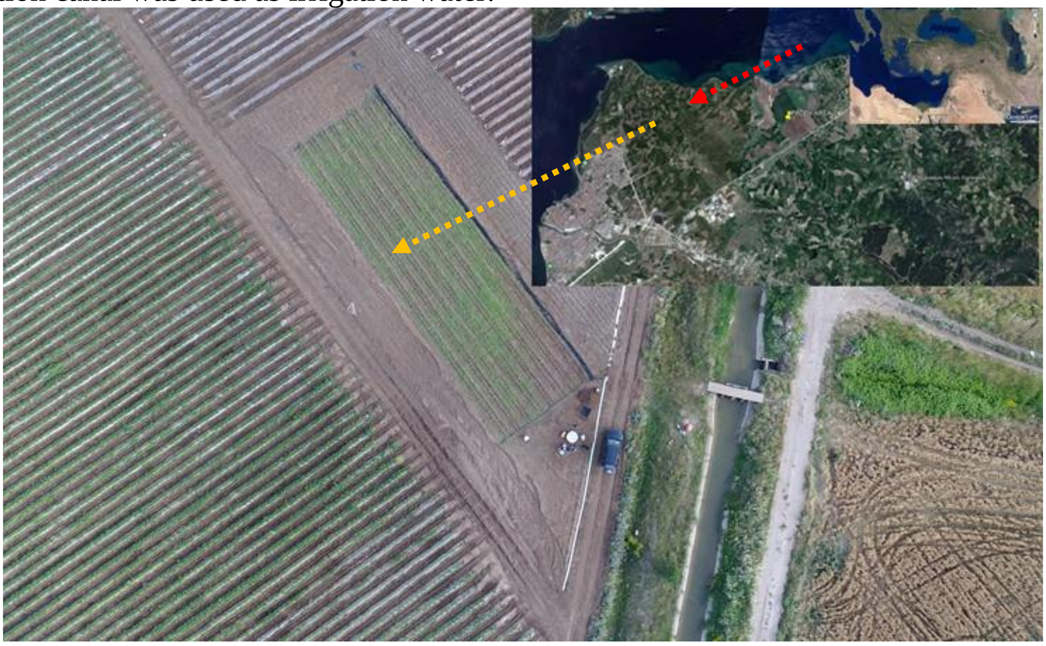

Figure 1. Study area

2.2 Climate Characteristics

Although the climate of Dardanelles shows a transitional nature due to its geographical location, it mostly shows the characteristics of the Mediterranean climate. The long-term (1929-2015) average of some climatic parameters of the study area and the values measured in the study year are given in Table 1. As can be seen from the table, the hottest months are July and August. While the average total precipitation for many years was 616.2 mm, the total precipitation was 570.9 mm in 2016. It was determined that the temperature values in the year of the experiment were high when compared to the long-term averages.

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Table 1. Climate data for the study area

Months	1929-2015							2016						
	Tort (°C)	Tmax (°C)	Tmin (°C)	Averge Sunshine duration (hours)	Average precipitation (mm)	Average wind speed (m/s)	Average relative humidity (%)	Tort (°C)	Tmax (°C)	Tmin (°C)	Averge Sunshine duration (hours)	Average precipitation (mm)	Average wind speed (m/s)	Average relative humidity (%)
1	7.2	10.9	3.2	3.6	110.2	4.5	80.0	7.2	10.9	3.2	3.6	110.2	4.8	73.6
2	10.9	14.7	7.7	4.2	88.4	4.7	78.5	10.9	14.7	7.7	4.2	88.4	5.0	72.2
3	11.2	14.8	7.5	5.3	53.6	4.3	77.0	11.2	14.8	7.5	5.3	53.6	4.6	70.8
4	15.8	20.8	11.2	8.4	15.0	3.8	75.0	15.8	20.8	11.2	8.4	15.0	4.1	69.0
5	18.3	22.5	14.0	8.5	26.8	3.4	73.2	18.3	22.5	14.0	8.5	26.8	3.6	67.3
6	24.5	29.9	19.6	11.2	39.9	3.3	67.6	24.5	29.9	19.6	11.2	39.9	3.5	62.2
7	27.0	32.5	22.0	12.2	0.0	3.8	62.9	27.0	32.5	22.0	12.2	0.0	4.1	57.9
8	27.0	32.5	22.5	10.8	0.0	4.0	63.3	27.0	32.5	22.5	10.8	0.0	4.3	58.2
9	22.5	27.6	17.7	8.5	1.8	3.7	68.0	22.5	27.6	17.7	8.5	1.8	4.0	62.6
10	17.1	21.3	12.7	5.8	8.6	3.7	74.3	17.1	21.3	12.7	5.8	8.6	4.0	68.4
11	12.5	16.1	8.2	3.1	210.3	3.9	78.7	12.5	16.1	8.2	3.1	210.3	4.2	72.4
12	4.9	8.9	1.2	0.22	16.3	4.4	80.3	4.9	8.9	1.2	0.22	16.3	4.7	73.9
Aver./ Year	15.0	19.6	10.7	7.3	616.2	4.0	73.2	16.6	21.0	12.3	6.8	570.9	4.2	67.4

2.3 Research Topics

In the study, paddy varieties (Baldo, Osmancik and Ronaldo) were placed in the main subjects irrigation interval (2 and 4 days) and sub-subject irrigation water level (75, 100, 125 and 150 % levels of cumulative evaporation [E] from Class A Pan [CAP] container) (Table 2).

Table 2. Research topics

Treatment	Explanation
2 D- I_{75} -B	2 D: 2 day irrigation interval; I_{75}: 75% of the cumulative E from the CAP; B: Baldo
2 D- I_{100} -B	2 D: 2 day irrigation interval; I_{100}: 100% of the cumulative E from the CAP; B: Baldo
2 D- I_{125} -B	2 D: 2 day irrigation interval; I_{125}: 125% of the cumulative E from the CAP; B: Baldo
2 D- I_{150} -B	2 D: 2 day irrigation interval; I_{150}: 150% of the cumulative E from the CAP; B: Baldo
2 D- I_{75} -O	2 D: 2 day irrigation interval; I_{75}: 75% of the cumulative E from the CAP; O: Osmancik
2 D- I_{100} -O	2 D: 2 day irrigation interval; I_{100}: 100% of the cumulative E from the CAP; O: Osmancik
2 D- I_{125} -O	2 D: 2 day irrigation interval; I_{125}: 125% of the cumulative E from the CAP; O: Osmancik
2 D- I_{150} -O	2 D: 2 day irrigation interval; I_{150}: 150% of the cumulative E from the CAP; O: Osmancik
2 D- I_{75} -R	2 D: 2 day irrigation interval; I75: 75% of the cumulative E from the CAP; R: Ronaldo
2 D- I_{100} -R	2 D: 2 day irrigation interval; I_{100}: 100% of the cumulative E from the CAP; R: Ronaldo
2 D- I_{125} -R	2 D: 2 day irrigation interval; I_{125}: 125% of the cumulative E from the CAP; R: Ronaldo
2 D- I_{150} -R	2 D: 2 day irrigation interval; I_{150}: 150% of the cumulative E from the CAP; R: Ronaldo
4 D- I_{75} -B	4 D: 4 day irrigation interval; I_{75}: 75% of the cumulative E from the CAP; B: Baldo
4 D- I_{100} -B	4 D: 4 day irrigation interval; I_{100}: 100% of the cumulative E from the CAP; B: Baldo
4 D- I_{125} -B	4 D: 4 day irrigation interval; I_{125}: 125% of the cumulative E from the CAP; B: Baldo
4 D- I_{150} -B	4 D: 4 day irrigation interval; I_{150}: 150% of the cumulative E from the CAP; B: Baldo
4 D- I_{75} -O	4 D: 4 day irrigation interval; I_{75}: 75% of the cumulative E from the CAP; O: Osmancik
4 D- I_{100} -O	4 D: 4 day irrigation interval; I_{100}: 100% of the cumulative E from the CAP; O: Osmancik
4 D- I_{125} -O	4 D: 4 day irrigation interval; I_{125}: 125% of the cumulative E from the CAP; O: Osmancik
4 D- I_{150} -O	4 D: 4 day irrigation interval; I_{150}: 150% of the cumulative E from the CAP; O: Osmancik
4 D- I_{75} -R	4 D: 4 day irrigation interval; I75: 75% of the cumulative E from the CAP; R: Ronaldo
4 D- I_{100} -R	4 D: 4 day irrigation interval; I_{100}: 100% of the cumulative E from the CAP; R: Ronaldo
4 D- I_{125} -R	4 D: 4 day irrigation interval; I_{125}: 125% of the cumulative E from the CAP; R: Ronaldo
4 D- I_{150} -R	4D: 4 day irrigation interval; I_{150}: 150% of the cumulative E from the CAP; R: Ronaldo

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2.4 Cultural Operations

In the research, the seeds of the three varieties (Baldo, Osmancık and Ronaldo) with the highest production in the region were obtained from the farmers and planted. The sowing process was carried out in the third week of May by arranging 550 seeds m^{-2} between the grain seeder and 20 cm rows. As base fertilizer, 200 kg ha^{-1} DAP fertilizer was applied with planting. Top fertilization was applied by drip irrigation system from 33% Ammonium Nitrate fertilizer to 300 kg ha^{-1}. Commercially available drugs were used when needed for weed control. Harvesting and threshing processes were done manually and the paddy yield was determined after the necessary measurements were taken morphological measurements.

2.5 Planning and Application of Irrigation

The drip irrigation method was used in the research. In the first irrigation, enough irrigation water was applied to bring the current moisture in the soil to the field capacity, and then equal amounts of irrigation water were applied to all subjects for four weeks until the seedling root system developed. After the plants achieved sufficient development, irrigation treatments were started. The amount of irrigation water was determined by using the Class A Pan which was placed in the research area. The measured cumulative evaporation values by the Class A Pan were applied at intervals of 2 and 4 days, respectively. 150% (I_{150}), 125% (I_{125}), 100% (I_{100}) and 75% (I_{75}) of the cumulative evaporation value were applied as irrigation water level. The amount of irrigation water to be applied was calculated by using the following equation (Sezen et al., 2005);

$$I = A \; x \; Epan \; x \; Kcp$$

where;
I = Amount of irrigation water to be applied (L),
A = Plot area (m^2);
E pan = Cumulative evaporation from the pan during the irrigation interval (mm),
Kcp = Plant-pan coefficient.

It makes it easy to increase and decrease losses and gains because various soil water balance parameters are usually expressed in water depth. The capillary rise of precipitation, irrigation and groundwater to the root zone brings water to the root zone. Soil evaporation, plant transpiration, and seepage losses can remove water from the root zone. ET value was estimated using the measured SWC by a water balance method described by Allen et al. (1998). The equation can be written as:

$$\mathrm{ET} = \mathrm{I} + \mathrm{P} \pm \Delta\mathrm{S} - \mathrm{Dp} - \mathrm{Rf}$$

where ET is evapotranspiration (mm); I is the amount of irrigation water (mm); P is the precipitation (mm); ΔS is the change in the soil water content in the 60 cm soil profiles (mm); Dp is the deep percolation (mm); and Rf is the amount of runoff (mm). Run off and deep percolation was neglected in the study.

2.6 Irrigation Water Use Efficiency

Using the irrigation water and yield data, the Water Use Efficiency (WUE) and Irrigation Water Use Efficiency (IWUE) values were calculated using the following equations (Maximov, 1929; Viets, 1962; Howell et al., 1990).

$$IWUE = \frac{Y}{I}$$

where;
IWUE: Irrigation water use efficiency (kg ha mm^{-1}),

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Y = Yield (kg ha^{-1}),
I = Amount of irrigation water applied (mm),

2.7 Crop Water Productivity

Different researchers define Crop water productivity (CWP) differently (French and Schultz, 1984; Bessembinder et al., 2005; Passioura, 2006). CWP can be defined as the amount produced or the value per unit of water consumed or transferred. It is calculated from the ratio of actual production to actual evapotranspiration:

$$CWP = \frac{Y}{ETa}$$

CWP = Crop water productivity (kg m^{-3}),
Y = Yield (kg ha^{-1})
ETa = Actual evapotranspiration (m^{3} ha^{-1})

2.8 Economic Water Productivity

Economic water productivity (EWP) was calculated with the equation given in Mengiste (2015) and Tewelde (2019):

$$EWP = \frac{GI}{IW}$$

$$GI = (PTG * YLDg)$$

where;
EWP = Economic water productivity (\$ m^{-3})
GI : Gross income (\$ ha^{-1})
IW : Irrigation water (m^{3} ha^{-1})
PTG: Peanut sale price (\$ ton^{-1}),
YLDg: Yield (ton ha^{-1}),

2. 9 Production Cost Calculation

The paddy production cost calculation data was used from Tas (2021), which was previously made in the study area. In comparison, Dardanelles Provincial Directorate of Agriculture and Forestry in 2016 production costs, sales prices, average irrigation water amount in flooded method and average yield values were taken into consideration.

3. RESULTS AND DISCUSSIONS

3.1 Evapotranspiration, Irrigation Water Amount And Economic Analysis Indicators

The results obtained in the research and the irrigation indicators calculated accordingly are shown in Table 3. Irrigation water between 513-820 mm was applied to the research treatment. On the other hand, evapotranspiration values varied between 565-855 mm. CWP values varied between 0.84-1.35 kg ha^{-1} m^{-3} and IWUE values between 0.95-1.49 kg ha^{-1} m^{-3}. The water productivity value calculated on the gross income is 0.79-1.24 \$ m^{-3}. Depending on the treatments, the yield values were changed between 4882 and 10305 kg ha. According to the data of the Dardanelles Agriculture and Forestry Provincial Directorate, the average yield is around 8410 kg ha^{-1}. When the yield of paddy produced by drip irrigation is compared with flooded irrigation, it was calculated that the yield increase in Osmancık cultivar was 29%, 28% for Baldo and 24% for Ronaldo at the I_{150} irrigation water level in the 2-day irrigation interval. The lowest yields were found to be 39% in the Baldo variety, 24% in the

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ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

Osmancık variety and 31% in the Ronaldo variety from the I_{75} irrigation water level, which was irrigated every 4 days. According to the yield from the I_{150} application, where water stress is not created, it is higher than the yield from conventional production. The reason for this was evaluated as the plant forming more siblings in rice production under aerobic conditions and the use of the fertigation method in fertilization. The paddy seeds used in the study are uncertified seeds obtained directly from the farmers. It is predicted that the yield obtained (up to approximately 25%) will increase further in the case of using certified seeds. In the Dardanelles region, around 2500 mm irrigation water is applied to the paddy irrigated by the flooded method. Considering the treatment of I_{150}, where the most irrigation water is applied, 67% irrigation water savings have been achieved compared to conventional production. The highest water saving was determined as 80% in the I_{75} application, where the least irrigation water was applied. The benefit-to-cost (B/C) ratio was calculated between 1.11-2.33. EWP values for over gross income were changed between 0.79-1.24 kg ha^{-1} m^{-3} and for over net income were changed between 0.08-0.60 kg ha^{-1} m^{-3}. When calculating the irrigation fee in surface irrigation, a total of 960 hours (4 mounts*30 days *8 hours day^{-1}) labor work in four months until May-August. A fee of labor costs approximately 140.6 $/ha/season. Under these conditions, the surface irrigation labor cost is 0.15 $ h^{-1}. This is not the case with drip irrigation. However, since a labor cost must be calculated, 0.01 $ h^{-1} has been taken into account as a labor cost. On the other hand, the cost of irrigation water was 201.68 $ ha^{-1} (for 2500 mm of irrigation water in surface irrigation). Considering this situation, the fee for one m^3 of water was 0.0067-0.0080 $. In line with the recommendations of Enciso et al., (2005), the cost of the irrigation system is considered to be 2100 $ ha^{-1} and the economic life of the system is 7 years. The annual cost of the irrigation system is calculated over this value (2100/7=300 $ $year^{-1}$).

Table 3. Evapotranspiration, irrigation water amount and economic analysis indicators

Treatment	Irrigation water (mm)	Irrigation water (m^3 ha^{-1})	Irrigation duration for the irrigation season (h)	Labor cost for irrigation ($ h^{-1})	Total cost for irrigation labor ($) (3 x 4)	Water price ($ m^{-3})	Water cost ($ ha^{-1}) (2 x 6)	Crop production costs ($ ha^{-1})	Irrigation system cost for 1 ha ($ ha^{-1})
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
2 D- I_{75} -B	513	5125	385	0.01	3.85	0.007	35.9	3309	2100
2 D- I_{100} -B	615	6150	461	0.01	4.61	0.007	43.1	3309	2100
2 D- I_{125} -B	718	7175	539	0.01	5.39	0.007	50.2	3309	2100
2 D- I_{150} -B	820	8200	615	0.01	6.15	0.007	57.4	3309	2100
2 D- I_{75} -O	513	5125	385	0.01	3.85	0.007	35.9	3309	2100
2 D- I_{100} -O	615	6150	461	0.01	4.61	0.007	43.1	3309	2100
2 D- I_{125} -O	718	7175	539	0.01	5.39	0.007	50.2	3309	2100
2 D- I_{150} -O	820	8200	615	0.01	6.15	0.007	57.4	3309	2100
2 D- I_{75} -R	513	5125	385	0.01	3.85	0.007	35.9	3309	2100
2 D- I_{100} -R	615	6150	461	0.01	4.61	0.007	43.1	3309	2100
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2 D- I_{150} -R	820	8200	615	0.01	6.15	0.007	57.4	3309	2100
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4 D- I_{125} -B	718	7175	539	0.01	5.39	0.007	50.2	3309	2100
4 D- I_{150} -B	820	8200	615	0.01	6.15	0.007	57.4	3309	2100
4 D- I_{75} -O	513	5125	385	0.01	3.85	0.007	35.9	3309	2100
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4 D- I_{150} -R	820	8200	615	0.01	6.15	0.007	57.4	3309	2100

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ISSN: 2284-953X
ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

Table 3. Continue

Treatment	Yearly cost of the irrigation system ($ ha^{-1}) (9/7 years)	Total cost for 1 year ($ ha^{-1}) (5+7+8+10)	Yield (kg ha^{-1})	Product sale price ($ kg^{-1})	Gross income per ha ($ ha^{-1} year^{-1}) (12 x 13)	Net income ($ ha^{-1} year^{-1}) (14 – 11)	ET (mm)	IWUE (kg ha^{-1} m^{-3})	CWP (kg ha^{-1} m^{-3})
	10	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*
2 D- I_{75} -B	300	3649	7639	0.83	6340	2692	565	1.49	1.35
2 D- I_{100} -B	300	3657	8434	0.83	7000	3344	659	1.37	1.28
2 D- I_{125} -B	300	3665	9211	0.83	7645	3980	753	1.28	1.22
2 D- I_{150} -B	300	3673	10232	0.83	8492	4820	845	1.25	1.21
2 D- I_{75} -O	300	3649	6925	0.83	5748	2099	565	1.35	1.23
2 D- I_{100} -O	300	3657	7663	0.83	6361	2704	659	1.25	1.16
2 D- I_{125} -O	300	3665	9130	0.83	7578	3913	753	1.27	1.21
2 D- I_{150} -O	300	3673	10305	0.83	8553	4881	845	1.26	1.22
2 D- I_{75} -R	300	3649	7186	0.83	5965	2316	565	1.40	1.27
2 D- I_{100} -R	300	3657	7664	0.83	6361	2704	659	1.25	1.16
2 D- I_{125} -R	300	3665	9354	0.83	7764	4099	753	1.30	1.24
2 D- I_{150} -R	300	3673	9893	0.83	8211	4539	845	1.21	1.17
4 D- I_{75} -B	300	3649	4882	0.83	4052	404	580	0.95	0.84
4 D- I_{100} -B	300	3657	5911	0.83	4906	1249	673	0.96	0.88
4 D- I_{125} -B	300	3665	6787	0.83	5633	1969	763	0.95	0.89
4 D- I_{150} -B	300	3673	9551	0.83	7927	4255	855	1.16	1.12
4 D- I_{75} -O	300	3649	6081	0.83	5047	1398	580	1.19	1.05
4 D- I_{100} -O	300	3657	7814	0.83	6485	2829	673	1.27	1.16
4 D- I_{125} -O	300	3665	8020	0.83	6657	2992	763	1.12	1.05
4 D- I_{150} -O	300	3673	9962	0.83	8269	4596	855	1.21	1.17
4 D- I_{75} -R	300	3649	5525	0.83	4585	937	580	1.08	0.95
4 D- I_{100} -R	300	3657	6158	0.83	5111	1454	673	1.00	0.91
4 D- I_{125} -R	300	3665	7804	0.83	6478	2813	763	1.09	1.02
4 D- I_{150} -R	300	3673	9239	0.83	7668	3996	855	1.13	1.08

3.2 Morphological features and yield

3.2.1 Panicle Length

As a result of the analysis of variance, the effect of irrigation interval on panicle length in paddy is statistically insignificant ($P \geq 0.05$). In contrast, the impact of IWL×Variety, II×IWL, II×Variety and II×IWL×Variety interactions were determined significant ($P < 0.05$). As a result of multiple comparisons of the means with the Student's t-test; Varieties were listed as Baldo, Ronaldo and Osmancık from the longest to the shortest in panicle length and took place in different groups (Table 4). As the irrigation water level decreased, the panicle length decreased and statistically different groups were formed. The longest panicle length average value was obtained from the subject at I_{150} and the lowest panicle length average value was obtained from the I_{75} irrigation water level. The fact that the panicle length was different according to the Varieties brings to mind the idea that the panicle length is affected by the genetic structures of the Variety. The fact that the irrigation water level is effective on the panicle length indicates that the panicle length is affected by environmental conditions. When we look at the grouping of triple interactions in Table 5, it was determined that the 2-day irrigation interval was I_{150}, the irrigation level, and the Baldo variety gave the highest average value for the panicle length, followed by the Ranolda variety, and the Osmancık variety in the last place. It is understood that the effect of irrigation water level on the length of the panicle length is more pronounced than the irrigation interval.

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Current Trends in Natural Sciences
Vol. 11, Issue 21, pp. 455-473, 2022
https://doi.org/10.47068/ctns.2022.v11i21.050
Current Trends in Natural Sciences (on-line) ISSN: 2284-953X ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom) ISSN: 2284-9521 ISSN-L: 2284-9521

Table 3. Continue

Treatment	Economic water productivity over gross income ($ m^{-3})	Economic water productivity over net income ($ m^{-3})	The benefit-to-cost (B/C) ratio	Water saving (%)	Change in yield (%)
	19	*20*	*21*	*22*	*23*
2 D- I_{75} -B	1.24	0.53	1.74	80	-5
2 D- I_{100} -B	1.14	0.54	1.91	75	5
2 D- I_{125} -B	1.07	0.55	2.09	71	15
2 D- I_{150} -B	1.04	0.59	2.31	67	28
2 D- I_{75} -O	1.12	0.41	1.58	80	-13
2 D- I_{100} -O	1.03	0.44	1.74	75	-4
2 D- I_{125} -O	1.06	0.55	2.07	71	14
2 D- I_{150} -O	1.04	0.60	2.33	67	29
2 D- I_{75} -R	1.16	0.45	1.63	80	-10
2 D- I_{100} -R	1.03	0.44	1.74	75	-4
2 D- I_{125} -R	1.08	0.57	2.12	71	17
2 D- I_{150} -R	1.00	0.55	2.24	67	24
4 D- I_{75} -B	0.79	0.08	1.11	80	-39
4 D- I_{100} -B	0.80	0.20	1.34	75	-26
4 D- I_{125} -B	0.79	0.27	1.54	71	-15
4 D- I_{150} -B	0.97	0.52	2.16	67	19
4 D- I_{75} -O	0.98	0.27	1.38	80	-24
4 D- I_{100} -O	1.05	0.46	1.77	75	-2
4 D- I_{125} -O	0.93	0.42	1.82	71	0
4 D- I_{150} -O	1.01	0.56	2.25	67	25
4 D- I_{75} -R	0.89	0.18	1.26	80	-31
4 D- I_{100} -R	0.83	0.24	1.40	75	-23
4 D- I_{125} -R	0.90	0.39	1.77	71	-2
4 D- I_{150} -R	0.94	0.49	2.09	67	15

Table 4. Effects of applications on panicle length and student's t multiple comparison test results

II		**IWL**		**Variety**	
2	16.111	I_{150}	17.427 a	B	18.590 a
4	16.331	I_{125}	16.611 b	R	15.595 b
		I_{100}	15.839 c	O	14.478 c*
		I_{75}	15.004 d*		
LSD			**0.257**		**0.364**

*: The difference between the means shown with the same letter in the same column is not statistically significant (P<0.05).

3.2.2 Number of grains in a panicle

As a result of the analysis of variance, the effects of II×IWL, IWL×Variety and II×IWL×Variety interactions on the number of grains in a panicle were statistically insignificant (P≥0.05), while the effects of irrigation interval, irrigation water level, Variety and II×Variety interactions were significant (P<0.05). As a result of multiple comparisons of the means with the Student's t-test; varieties were ranked as Baldo, Osmancik and Ronaldo from the highest to the lowest in terms of the number of grains per panicle, and they took place in different groups (Table 6). When the irrigation interval increased from 2 days to 4 days, the number of grains in the panicle decreased and statistically different groups were formed. The number of seeds in the panicle decreased as the irrigation water level was low, and all irrigation water levels were in separate groups in terms of the number of seeds in the panicle.

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Vol. 11, Issue 21, pp. 455-473, 2022
https://doi.org/10.47068/ctns.2022.v11i21.050
Current Trends in Natural Sciences (on-line) ISSN: 2284-953X ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom) ISSN: 2284-9521 ISSN-L: 2284-9521

***Tablo 5. Effects of application interactions on panicle length and results of student's t multiple test* comparisons**

IWL×Variety		II×IWL		II×Variety		II×IWL×Variety	
I_{150} ×B	20.153 a	4×I_{150}	17.801 a	2×B	19.200 a	2×I_{150}×B	21.050 a
I_{125} ×B	18.647 b	2×I_{150}	17.053 b	4×B	17.979 b	4×I_{150}×B	19.257 b
I_{100} ×B	18.112 b	2×I_{125}	16.818 b	4×R	16.094 c	2×I_{125}×B	19.253 b
I_{75} ×B	17.447 c	4×I_{125}	16.406 c	2×R	15.096 d	2×I_{100}×B	18.590 bc
I_{150} ×R	16.770 d	2×I_{100}	15.882 d	4×O	14.919 d	4×I_{125}×B	18.040 cd
I_{150} ×R	16.102 e	4×I_{100}	15.797 d	2×O	14.036 e*	2×I_{75}×B	17.907 cd
I_{150} ×O	16.027 e	4×I_{75}	15.320 e			4×I_{100}×B	17.633 de
I_{100} ×R	15.382 f	2×I_{75}	14.689 f*			4×I_{150}×R	17.243 d-f
I_{125} ×O	14.418 g					4×I_{75}×B	16.987 ef
I_{75}×R	14.127 g					2×I_{125}×R	16.903 ef
I_{100} ×O	14.025 g					4×I_{150}×O	16.903 ef
I_{75}×O	13.440 h					4×I_{125}×R	16.637 f
						4×I_{100}×R	15.480 g
						2×I_{100}×R	15.283 gh
						2×I_{150}×O	15.150 gh
						4×I_{75}×R	15.017 g-ı
						2×I_{150}×R	14.960 g-ı
						4×I_{125}×O	14.540 h-j
						2×I_{125}×O	14.297 ıj
						4×I_{100}×O	14.277 ıj
						4×I_{75}×O	13.957 jk
						2×I_{100}×O	13.773 jk
						2×I_{75}×R	13.237 kl
						2×I_{75}×O	12.923 l*
LSD	**0.572**		**0.286**		**0.404**		**0.809**

*: The difference between the means shown with the same letter in the same column is not statistically significant (P<0.05).

Table 6. The effects of applications and interactions on the number of seeds per panicle and student's t multiple comparison test results

II		IWL		Variety		II×Variety	
2	118.536 a	I_{150}	129.239 a	B	121.538 a	2×B	133.867 a
4	106.253 b*	I_{125}	117.411 b	O	112.958 b	2×O	116.275 b
		I_{100}	109.289 c	R	102.688 c*	4×O	109.642 c
		I_{75}	93.639 d*			4×B	109.208 c
						2×R	105.467 c
						4×R	99.908 d*
LSD	**5.554**		**5.337**		**3.181**		**4.499**

*: The difference between the means shown with the same letter in the same column is not statistically significant (P<0.05).

3.2.3 Grain Weight in a Panicle

As a result of the analysis of variance, the effects of the II×IWL, IWL×Variety and II×IWL×Variety interactions on the grain weight in the panicle were statistically insignificant (P≥0.05), while the effects of the irrigation interval, irrigation water level, Variety and II×Variety interactions were significant (P<0.05). As a result of multiple comparisons of the means with the Student's t-test; While the Baldo variety gave the highest value in terms of grain weight in the panicle, Osmancik and

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Current Trends in Natural Sciences
Vol. 11, Issue 21, pp. 455-473, 2022
https://doi.org/10.47068/ctns.2022.v11i21.050
Current Trends in Natural Sciences (on-line) Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-953X ISSN: 2284-9521
ISSN-L: 2284-9521 ISSN-L: 2284-9521

Ronaldo Varieties gave lower values and were in a different group from the Baldo variety. (Table 7). When the irrigation interval increased from 2 to 4 days, the grain weight in the panicle decreased and statistically different groups were formed. The number of seeds in the panicle decreased as the irrigation water level was low, and all irrigation water levels were in separate groups in terms of grain weight in the panicle. When we look at the II×Variety interactions, it is understood that the effect of the irrigation interval on the grain weight of the panicle is more pronounced than the variety.

Table 7. The effects of applications and interactions on seed weight in panicle and student's t multiple comparison test results

II		**IWL**		**Variety**		**II×Variety**	
2	2.783 a	I_{150}	3.211 a	O	2.664 a	2×B	2.792 a
4	2.355 b*	I_{125}	2.710 b	B	2.523 b	2×R	2.782 a
		I_{100}	2.343 c	R	2.520 b*	2×O	2.776 a
		I_{75}	2.012 d*			4×O	2.553 b
						4×R	2.259 c
						4×B	2.253 c*
LSD	**0.105**		**0.161**		**0.122**		**0.173**

*: The difference between the means shown with the same letter in the same column is not statistically significant (P<0.05).

3.2.4 Thousand Grain Weight

As a result of the analysis of variance, the effects of the II×IWL and IWL×Variety interactions on the thousand-grain weight of rice were statistically insignificant (P≥0.05), while the effects of the irrigation interval, irrigation water level, Variety, II×Variety and II×IWL×Variety interactions were significant (P<0.05). As a result of multiple comparisons of the means with the Student's t-test; While the Ronaldo variety gave the highest value in terms of thousand-grain weight, Osmancık and Baldo Varieties gave lower values and took place in different groups from the Ronaldo variety (Table 8). When the irrigation interval increased from 2 days to 4 days, the thousand-grain weight decreased and statistically different groups were formed. The thousand-grain weight irrigation water level decreased slightly and all irrigation water levels formed separate groups. When we look at the II×Variety interactions, it is understood that the effect of irrigation interval on thousand-grain weight is more pronounced than the variety. When we examine the II×IWL×Variety interactions, it is seen that the 2D×I_{150}×R interaction has the highest value and the 4D×I_{75}×B interaction has the lowest value (Table 8). It is understood from this that the irrigation interval and irrigation water level have more significant effects than the variety.

3.2.5 Grain Yield

As a result of the analysis of variance, the effects of II×IWL and IWL×Variety interactions on grain yield were statistically insignificant (P≥0.05), while the effects of irrigation interval, irrigation water level, Variety, II×Variety and II×IWL×Variety interactions were significant (P<0.05). As a result of multiple comparisons of the means with the Student's t-test; While the Baldo variety gave the highest value in terms of grain yield, Osmancik and Ronaldo Variety gave lower values and took place in different groups from the Baldo variety (Table 9). When the irrigation interval increased from 2 to 4 days, the grain yield decreased and statistically different groups were formed. Grain yield decreased slightly with irrigation water level and all irrigation water levels formed separate groups.

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Current Trends in Natural Sciences
Vol. 11, Issue 21, pp. 455-473, 2022
https://doi.org/10.47068/ctns.2022.v11i21.050
Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

Table 8. The effects of applications and interactions on thousand-grain weight and student's t multiple comparison test results

II		IWL		Variety		II×Variety		II×SS×ÇEŞİT	
2	28.548 a	I_{150}	31.168 a	R	29.811 a	2×R	31.475 a	$2\times I_{150}\times R$	35.350 a
4	26.465 b*	I_{125}	28.317 b	O	27.957 b	2×O	28.879 b	$2\times I_{125}\times R$	32.383 b
		I_{100}	26.505 c	B	24.751 c*	4×R	28.148 bc	$2\times I_{150}\times O$	31.607 b
		I_{75}	24.035 d*			4×O	27.035 c	$4\times I_{150}\times R$	31.587 b
						2×B	25.288 d	$2\times I_{125}\times O$	30.523 bc
						4×B	24.213 d*	$4\times I_{150}\times B$	30.503 bc
								$2\times I_{100}\times R$	30.310 b-d
								$4\times I_{150}\times O$	30.053 b-e
								$4\times I_{125}\times R$	28.620 c-f
								$4\times I_{125}\times O$	28.220 c-f
								$2\times I_{100}\times O$	27.937 dg
								$2\times I_{150}\times B$	27.910 e-g
								$2\times I_{75}\times R$	27.857 e-g
								$4\times I_{100}\times O$	27.527 f-h
								$4\times I_{100}\times R$	27.523 f-h
								$2\times I_{125}\times B$	25.583 g-ı
								$2\times I_{75}\times O$	25.450 hı
								$4\times I_{75}\times R$	24.860 ıj
								$2\times I_{100}\times B$	24.687 ı-k
								$4\times I_{125}\times B$	24.573 ı-k
								$2\times I_{75}\times B$	22.973 j-l
								$4\times I_{75}\times O$	22.340 kl
								$4\times I_{100}\times B$	21.047 l
								$4\times I_{75}\times B$	20.730 l*
LSD	**1.418**		**0.885**		**0.842**		**1.190**		**2.380**

*: The difference between the means shown with the same letter in the same column is not statistically significant (P<0.05).

When we look at the II×Variety interactions, it is understood that the effect of irrigation interval on grain yield is more pronounced than the variety. When we examine II×IWL×Variety interactions, we can see that $2D\times I_{150}\times O$ and $2D\times I1_{50}\times O$ interactions gave the highest values, and 4×75×B interactions gave the lowest values (Table 10). It is understood from this that the irrigation interval and irrigation water level have more significant effects than the variety.

Table 9. The effects of applications on grain yield and student's t multiple comparison test results (kg ha^{-1})

II		IWL		Variety	
2	8636.389 a	I_{150}	9863.722 a	O	8237.625 a
4	7311.111 b*	I_{125}	8384.333 b	R	7852.833 b
		I_{100}	7273.889 c	B	7830.792 b*
		I_{75}	6373.056 d*		
LSD	**295.253**		**125.851**		**209.712**

*: The difference between the means shown with the same letter in the same column is not statistically significant (P<0.05).

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https://doi.org/10.47068/ctns.2022.v11i21.050
Current Trends in Natural Sciences (on-line) ISSN: 2284-953X ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom) ISSN: 2284-9521 ISSN-L: 2284-9521

Table 10. Effects of interactions on grain yield and student's t multiple comparison test results (kg ha^{-1})

II×IWL		**II×Variety**		**IWL×Variety**		**II×IWL×Variety**	
2×I_{150}	10143.444 a	2×B	8878.917 a	I_{150}×O	10133.833 a	2×I_{150}×O	10305.333 a
4×I_{150}	9584.000 b	2×R	8524.250 b	I_{150}×B	9891.167 ab	2×I_{150}×B	10231.667 a
2×I_{125}	9231.444 c	2×O	8506.000 b	I_{150}×R	9566.167 b	4×I_{150}×O	9962.333 ab
2×I_{100}	7920.444 d	4×O	7969.250 c	I_{125}×R	8579.000 c	2×I_{150}×R	9893.333 a-c
4×I_{125}	7537.222 e	4×R	7181.417 d	I_{125}×O	8575.167 c	4×I_{150}×B	9550.667 bc
2×I_{75}	7250.222 f	4×B	6782.667 e*	I_{125}×B	7998.833 d	2×I_{125}×R	9353.667 b-d
4×I_{100}	6627.333 g			I_{100}×O	7738.500 d	4×I_{150}×R	9239.000 d
4×I_{75}	5495.889 h*			I_{100}×B	7172.500 e	2×I_{125}×B	9210.667 d
				I_{100}×R	6910.667 ef	2×I_{125}×O	9130.000 d
				I_{75}×O	6503.000 fg	2×I_{100}×B	8434.333 e
				I_{75}×R	6355.500 g	4×I_{125}×O	8020.333 ef
				I_{75}×B	6260.667 g*	4×I_{100}×O	7813.667 f
						4×I_{125}×R	7804.333 f
						2×I_{100}×R	7663.667 fg
						2×I_{100}×O	7663.333 fg
						2×I_{75}×B	7639.000 fg
						2×I_{75}×R	7186.333 g
						2×I_{75}×O	6925.333 h
						4×I_{125}×B	6787.000 h
						4×I_{100}×R	6157.667 ı
						4×I_{75}×O	6080.667 ıj
						4×I_{100}×B	5910.667 ıj
						4×I_{75}×R	5524.667 j
						4×I_{75}×B	4882.333 k*
LSD	**177.980**		**296.577**		**419.424**		**593.156**

*: The difference between the means shown with the same letter in the same column is not statistically significant (P<0.05).

3.3 Rice Yield

As a result of the analysis of variance, the effects of irrigation interval and II×IWL and interactions on rice yield were statistically insignificant (P≥0.05), while the effects of irrigation water level, Variety, II×Variety, IWL×Variety and II×IWL×Variety interactions were significant (P<0.05). As a result of multiple comparisons of the means with the Student's t-test; While the Ronaldo variety gave the highest value in terms of rice yield, Osmancik and Baldo Varieties gave lower values and took place in a different group from the Ronaldo variety (Table 11). Rice yield decreased as the irrigation water level decreased, and all irrigation water levels formed separate groups. When we look at the IWL×Variety interactions, it is understood that the effect of the variety on rice yield is more pronounced than the irrigation interval and irrigation water level. When we examine the II×IWL×VARIETY interactions, we can see that the highest values were given by the Ronaldo variety at I_{125} and I_{150} irrigation water levels of both irrigation intervals, while the 2D×I_{75}×B and 2D×I_{75}×O interactions gave the lowest value (Table 12). It is understood that the variety has more pronounced effects according to the irrigation interval and irrigation water levels, since the Ronaldo variety gave higher values than the other Variety in all interactions.

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Current Trends in Natural Sciences
Vol. 11, Issue 21, pp. 455-473, 2022
https://doi.org/10.47068/ctns.2022.v11i21.050
Current Trends in Natural Sciences (on-line)
ISSN: 2284-953X
ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-9521
ISSN-L: 2284-9521

Table 11. Effects of applications on rice yield and student's t multiple comparison test results

II		**S.S**		**Variety**	
2	64.372	I_{150}	66.283 a	R	67.417 a
4	64.392	I_{125}	65.733 a	O	63.342 b
		I_{100}	64.361 b	B	62.388 c*
		I_{75}	61.150 c*		
LSD			**0.760**		**0.646**

*: The difference between the means shown with the same letter in the same column is not statistically significant (P<0.05).

Table 12. Effects of interactions on rice yield and student's t multiple comparison test results

II×IWL		**IWL×Variety**		**II×IWL×Variety**	
4×I_{150}	66.533 a	I_{150}×R	68.400 a	4×I_{150}×R	68.733 a
2×I_{125}	66.033 ab	I_{125}×R	68.217 a	4×I_{125}×R	68.267 ab
2×I_{150}	66.033 a	I_{100}×R	67.467 a	2×I_{125}×R	68.167a-c
4×I_{125}	65.433 b	I_{125}×O	65.667 b	2×I_{150}×R	68.067 a-c
2×I_{100}	65.044 b	I_{75}×R	65.583 b	2×I_{100}×R	67.567 a-d
4×I_{100}	63.678	I_{150}×O	65.283 bc	4×I_{100}×R	67.367 a-d
4×I_{75}	61.922 d	I_{150}×B	65.167 bc	2×I_{75}×R	66.767 b-e
2×I_{75}	60.378 e	I_{100}×O	64.217 cd	4×I_{150}×O	66.367 c-e
		I_{125}×B	63.317 d	2×I_{125}×O	66.133 d-f
		I_{100}×B	61.400 e	2×I_{150}×B	65.833 d-g
		I_{75}×B	59.667 f	2×I_{100}×O	65.200 e-h
		I_{75}×O	58.200 g*	4×I_{125}×O	65.200 e-h
				4×I_{150}×B	64.500 f-ı
				4×I_{75}×R	64.400 f-ı
				2×I_{150}×O	64.200 g-ı
				2×I_{125}×B	63.800 h-j
				4×I_{100}×O	63.233ıj
				4×I_{125}×B	62.833 ı-k
				2×I_{100}×B	62.367 jk
				4×I_{75}×B	61.167 kl
				4×I_{100}×B	60.433 l
				4×I_{75}×O	60.200 l
				2×I_{75}×B	58.167 m
				2×I_{75}×O	56.200 n*
LSD	**1.075**		**1.292**		**1.827**

*: Aynı sütunda aynı harf ile gösterilen ortalamalar arasındaki fark istatistiki açıdan önemli değildir (P<0.05).

3.3 Discussion

Paddy production consumes the largest share of agricultural water use (though it may be as high as 85% depending on the region), and its future depends largely on the development and adoption of technologies and practices that use less water. The water productivity of rice produced by the flooded method was 0.15 kg m^{-3}. When using drip irrigation in rice production, yields can be increased by up to 50%, producing cleaner, higher quality straw, saving 66% in irrigation water, 52% in pumping energy, reducing seed consumption, and improving fertilizer adoption. (Soman, 2012). According to the value of Canakkale Provincial Directorate of Agriculture and Forestry, the average yield in 2019 was 8900 kg ha^{-1}, the production cost of paddy was 0.44 \$ kg^{-1}, using the flooded irrigation method, while in the drip irrigation method was 0.35 \$ kg^{-1} (Tas, 2021)

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Current Trends in Natural Sciences
Vol. 11, Issue 21, pp. 455-473, 2022
https://doi.org/10.47068/ctns.2022.v11i21.050
Current Trends in Natural Sciences (on-line) Current Trends in Natural Sciences (CD-Rom)
ISSN: 2284-953X ISSN: 2284-9521
ISSN-L: 2284-9521 ISSN-L: 2284-9521

Soman (2012) found that the payback period of drip irrigation varied from 1.23 to 2.09 seasons in different regions of India. Also, the benefit-cost ratio is calculated to be between 1.4-2.1. Sharma et al. (2018) reported that they achieved 42% water savings, 11.7% efficiency gains and 13.7% revenue growth through DI. Patasarati et al. (2018) In their study, using surface and sub-surface DI methods resulted in 49.7% water savings. The CWP was determined to be 0.99 kg m^{-3} for the SDI , 0.94 kg m^{-3} for the DI and 0.49 kg m^{-3} for the conventional flooded irrigation method. According to reports, the production of SDI increased by 22.4% and that of DI increased by 19.1%. Research comparing flood and micro-irrigation methods was summarized in Table 11.

There are serious differences between the results of the studies. Among the reasons for these differences are the irrigation method used and the amount of irrigation water. In addition, the results obtained from the studies; climate, soil, the irrigation water quality of the research area, genetic characteristics of sown/planted rice varieties, application methods with applied fertilizers and pesticides, application timings, producer habits, cultural practices, suitability of applications, research subjects, suitability of irrigation applications to irrigation system/method. It is directly related to the application of irrigation time and amount of irrigation water depending on the selected irrigation method and plant demand, and the experience and knowledge of researchers in research. In addition, one or more of the factors mentioned may have affected the results of the studies. On the other hand, in some studies using micro-irrigation methods, yield, water-saving and water use efficiency values were measured lower than the pan irrigation method. It is understood that the reason for this is whether the applied methods are designed in accordance with the technique or not, and the paddy varieties selected as material are not selected in accordance with the methods. In some studies, large differences occurred due to the lack of appropriate system analysis (Tas, 2021).

4. CONCLUSION

Almost 11% of total global methane emissions to the atmosphere come from flooded rice production in India (Moran and Pratt, 2010; Ramesh et al., 2019). Field studies have shown that differences in the use of water, fertilizers, and pesticides in paddy production have a significant impact on greenhouse gases (GHG) emissions from production (Wassmann et al., 2000; Ramesh et al., 2019). The production method made with the flooded method causes very important environmental problems/costs. In addition, In addition, it alone affords 12% of methane emissions, one of the most important GHG (Anonymous, 2021c).

With aerobic paddy production, production can be made in all types of soil and topographic conditions, yield and quality increase with suitable agricultural techniques, low greenhouse gas emissions (CH_4, CO_2 and N_2O), fertilizers and pesticides used in production are used effectively, and at the same time, groundwater pollution caused by them can be prevented, sustainable soil health is ensured, heavy metals accumulated in the seed due to anaerobic conditions are reduced, it provides a transition to polyculture agriculture, paddy can be produced as a second crop under suitable climate and water source conditions (barley, oat, vetch, fodder pea, etc.), while paddy production costs decrease, the total income of the producer increases due to polyculture, the efficiency increases while saving irrigation water, the demand pressure on water resources is reduced, production can be made under limited water supply conditions, production can be made under sufficient leaching conditions in areas with low-quality water and soil resources, during the heavy drought periods of production can be made and the production is not affected by the irrigation water temperature.

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Current Trends in Natural Sciences
Vol. 11, Issue 21, pp. 455-473, 2022
https://doi.org/10.47068/ctns.2022.v11i21.050
Current Trends in Natural Sciences (on-line) ISSN: 2284-953X ISSN-L: 2284-9521
Current Trends in Natural Sciences (CD-Rom) ISSN: 2284-9521 ISSN-L: 2284-9521

Table 11. Comparison of water saving and productivity indicators for flooded irrigation and micro-irrigation system in paddy farm.

References	Irrigation methods	Water Requirement (mm)	Water Saving (%)	Yield (kg ha^{-1})	Increase in yield (%)	Water use efficiency (kg ha mm^{-1})
Anonymous, 2021d	Flooded	1200		5200		4.33
	Drip	619	48	5940	14	9.6
Fawibe ve ark., 2020	Flooded	1144- 1312		9180		0.47
	Drip	556-643	48.6-49	9730	5.7	0.80
Ramesh ve ark., 2019	Flooded	1931		5200		2.69
	Drip	1317	31.8	4800	-7.7	3.50
Sharma ve ark., 2018	Flooded	2000		6153		
	Drip	840	42	6870	11.65	
Sarkar ve ark., 2018	Flooded	600		2290		1.240
	Drip	258	57	3100	35.4	8.126
Singh ve ark., 2018	Flooded			5224.50		
	Drip			8076.25	35.31	
Ozer, 2018	Flooded	1899		7950		
	AWD	1281	32.5	7600	-4.4	
	Spring	1237	34.9	5317	-33.1	
	Drip	1217	35.9	6390	-19.6	
Parthasarathi ve ark., 2018	Flooded	829.8		4181		0.37
	Drip+SDI	647.5	22	5389	28.9	0.66
Sharda ve ark., 2017	Flooded			6273-6846		0.42-0.52
	Drip			7340-8010	17	0.81-0.88
Bansal ve ark., 2018	Flooded	587.4		6225		10.6
	Spring	419.0	28.7	4800	-22.9	11.5
	Drip	407.3	30.7	6950	11.65	17.1
Sharma ve ark., 2017[1]	Flooded	1780-2169		4100-4200	0.51	0.19-0.23
	Drip	675-726	33.5-37.9	2100-3010	-(0.51-0.72)	0.28-0.44
Sharda ve ark., 2017	Flooded			6273-6846		0.42-0.52
	Drip			7340-8010	17	0.81-0.88
Shaibu ve ark., 2015	Flooded	2693-3847		4920		
	AWD	807.9-1923.6	30-50	4740	-3.7	
Rekha ve ark., 2015	Drip	487-846	-	3375-6503		0.31- 0.91
Rao, 2013	Flooded	553.3				
	Drip	291.42	52.7			
Soman, 2012	Flooded			7660		
	Drip		66.3	9390	22.5	
Tuna, 2012	Flooded	4639		8140		
	Drip	1446		7110	-12.7	
Anonim, 2010	Flooded	1806		8000		0.44
	Drip	789	43.7	6900	-13.8	0.88
Atta, 2008	Flooded	1469		8800		
	Furrow	902	38.6	9300	5.7	
Vories ve ark., 2002	Flooded	1680-3310		7040		2.07-4.81
	Furrow	630-840	62.5-74.6	6020	-14.5	5.88-10.41

[1] 60.6-111.5 mm by the DI and 1166-1555 mm by the flooded irrigation was applied irrigation water to support irrigation on production based on rainfall farming (p=614 mm)
AWD: Alternative Wetting Drying in Flooded Irrigation

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5. ACKNOWLEDGEMENTS

We thank Anadolu ETAP (providing the research area) and Netafim (providing drip irrigation pipes) for their contributions to the research.

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Current Trends in Natural Sciences
Vol. 11, Issue 21, pp. 455-473, 2022
https://doi.org/10.47068/ctns.2022.v11i21.050
Current Trends in Natural Sciences (on-line) ISSN: 2284-953X ISSN-L: 2284-9521
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