Water Productivity Journal
Volume 2, Issue 2, 2022
journal homepage: http://www.waterproductivity.net/
EISSN: 2821-1103
PISSN: 2717-3062

Evaluation of rapeseed and barley irrigation management[1]

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Abstract

Introduction: In this study, irrigation evaluation of different cultivars of Rapeseed and barley in 2017-2018 crop year was performed in Sharifabad farm of Qamroud section of Qom. The result led to optimization of cultivation and improved water productivity is in two products, Brassica napus and barley. The Groundwater EC of this farm is salty. Due to the salinity tolerance threshold of barley, barley was predicted without yield reduction. But in canola crop due to less tolerance to salinity, crop reduction was predicted. During one crop season, Brassica napus was cultivated in eleven cultivars by irrigation method, the planting date started from October 26 to October 17, In tape irrigation, it was irrigated between 10 and 13 times. The objectives of this study were a case comparison between different cultivars of *Brassica napus*, both foreign and domestic, resistance of cultivars to cold and water consumption and productivity and yield and most importantly a comparison between irrigation methods in terms of water consumption and water efficiency. Meanwhile, Hayola Shirazi cultivar had the highest yield among all cultivars in the type irrigation system with the lowest water consumption.

1. **Received:** 12 October 2021 ; **Revised:** 22 November 2021 ; **Accepted:** 27 December 2021 ; **Published Online:** 10 April 2022

Published by: Veresk Ettesal.

DOI: 10.22034/wpj.2021.302624.1042

Material and methods: This climate type is characterized by extremely variable temperature conditions, with annual means decreasing and annual ranges increasing poleward, and relatively little precipitation. This climate is typically located deep within the interiors of continents and is contiguous with the tropical desert climates of North and South America and of central Asia. This region type owes its origins to locations deep within continental interiors, far from the windward coasts and sources of moist, maritime air. Remoteness from sources of water vapor is enhanced in some regions by mountain barriers upwind.

The average amount of precipitation for the year in Qom is 12.1" (307.3mm). The month with the most precipitation on average is December with 1.9" (48.3mm) of precipitation. The month with the least precipitation on average is June with an average of 0.1" (2.5mm). There are an average of 71.3 days of precipitation, with the most precipitation occurring in March with 10.5 days and the least precipitation occurring in July with 1.5 days. This research was done in the cropping year of 2018-2019 in one of the endowed lands of the holy threshold of Hazrat Fatemeh Al-Masoomeh located in the northeast of Qom province, Qomrud district. The objective of this study was to compare the water productivity and irrigation management between the two methods of type irrigation and surface irrigation and to compare different rapaseed and barley cultivars at salinity above 8000µmhos/cm.

Rapeseed, (Brassica napus var. napus), is a winter or spring annual oil crop in the Brassica family. It is also known as rape and oilseed rape. Archaeological evidence dates barley cultivation to 5000 BCE in Egypt, 2350 BCE in Mesopotamia, 3000 BCE in northwestern Europe, and 1500 BCE in China. Barley was the chief bread plant of the Hebrews, Greeks, and Romans and of much of Europe through the 16th century. Genetic studies suggest that Tibet was an additional, independent centre of domestication for cultivated barley.

Results: Water productiviy is about 0.77kg/m^3 was calculated in the type irrigation method with water efficiency of 0.66kg/m^3 compared to gravity irrigation (surface) which has a productivity of 0.20kg/m^3. In hydroflow irrigation, it performed better than the previous two methods, but consumed more water (about 34.2%) than type irrigation. Regarding barley, it was cultivated in three cultivars and two types of irrigation methods, Fajr 30 cultivar increases water productivity by 2.2 by irrigating the type.

Conclusion: The most important result of this farm operation was that the water efficiency of type irrigation in repseed is more than 2.3 times that of flood irrigation. On the other hand, strip surface irrigation with hydroflume has a higher performance than the other two methods. On the other hand, Hayola Shirazi cultivar consumed about 14.3% less water and was cultivated in terms of planting time about 15 days after the first planting. Hayola Shirazi cultivar has 9% higher yield than the average canola and has the highest yield after Hayola Qom cultivar. But it has been consumed 15% less water than Hiola Qom cultivar. Therefore, due to the quality of water with a salinity of more than 8000 micro mhos per centimeter, local type irrigation for both barley and canola crops has had more than the highest water productivity and efficiency. Barley yield was obtained by irrigating more than ten tons, which is higher than the national average.

Keywords: Irrigated Agriculture, Irrigation Planning, Qomrud, Water Productivity.

1. Introduction

Predicting global population growth from 1.4 billion in 1975 to 75 billion by 2020, and depleting available resources, will increase governments' efforts and competition for food, energy, and water security (Akhavan *et al*., 2007). The United Nations estimates the need for a 30 percent increase in the volume of irrigation water needed to provide the amount of food needed in 2025 (Hezar Jaribi *et al*., 2010). Limited water resources and multiple operators require comprehensive water resources management. Also, the development of irrigation systems requires a lot of financial and human investment, so irrigation efficiency and sustainability must be carefully determined and evaluated (Heydarian *et al*., 2007; Darabi *et al*., 2020).

Conventional irrigation methods can be divided into two general categories: surface irrigation methods and pressurized irrigation methods. Surface irrigation methods are a set of methods that have been developed by farmers and practiced for many years and engineering principles are not generally observed in them. At present, about 90% of the country's irrigated lands are covered by these irrigation methods and include flooding, strip and furrowing methods Among water distribution systems, pressurized systems over decades. The past has been further developed because they have significant advantages over open channels (Ardalan *et al*., 2013).

The industrialization of agriculture in most countries of the world, which are facing the problem of water shortage, has led to more control over water consumption, ie water can be used in any volume, whether low or high, whenever the farmer wants. Water scarcity in most countries of the world has caused farmers to use pressurized methods instead of traditional methods to have more control over water consumption.

The process of modernizing irrigation has been accepted as a strategic solution to increase water productivity and crop production, as well as increasing the economic efficiency of large irrigation networks. One of the pressure irrigation methods is drip irrigation using type tapes. The most important feature of these strips is that they do not require a separate dropper and the pressure break grooves (rent lobby) in the pipe wall are properly created (Akhavan *et al*., 2007).

Using the tape irrigation method, with a constant amount of water (compared to the surface irrigation method with reduction), the area under water cultivation can be increased up to three times due to the high efficiency of the system, and even with less water consumption than conventional irrigation (surface irrigation) produced more crops, so due to limited water and

soil resources and the need to produce more causes, the use of high-efficiency irrigation methods, especially for crops that need high water, is justified (Turknejad *et al*., 2006)

Barley is the second most important grain in the world and can directly and indirectly help human nutrition. Barley food uses include animal and poultry feed, malt and alcohol. Barley is one of the most tolerant of fine grains to salinity during germination and growth period. Basically, in arid areas where rainfall and soil conditions are not sufficient for wheat cultivation, barley is a good alternative to wheat (Karimi & Azizi, 1996). Barley does not play a direct role in human nutrition and only feeds in parts of the globe with high latitudes (up to 70 degrees north latitude, such as Norway) or in areas with low rainfall or in areas with saline soils. (King *et al*., 2004)

The term water efficiency was first coined by D-Witt. The purpose of applying water use efficiency is the ability to make quick comparisons between water consuming systems in time and space. Plant water productivity, which in scientific sources is basically referred to as water ~~use~~ efficiency, is defined as the ratio of economic performance (performance presented to the market) to actual plant evapotranspiration. According to available sources, 7% of the world's population lives in areas where water is scarce, but by 2050 this figure is expected to increase to more than 67%. Therefore, it is necessary to increase the water productivity of rainfed (irrigated lands). The average water use efficiency in agricultural production reaches 0.7 kg per cubic meter of water, which unfortunately is a small figure compared to developed countries in the same climate (Sadat Miriei & Farshi, 2003; Alizadeh, 2010). The results of research by Turknejad *et al.* (2006) showed that water efficiency in type irrigation method is twice as much as surface irrigation.

The aim of this study was to compare the productivity and irrigation management between the two methods of type irrigation and surface (strip) irrigation and to compare different Brassica napus and barley cultivars at salinity above 8000 µmhos/cm.

2. Material and methods

This project was carried out in the cropping year of 2018-2019 in one of the endowed lands of the holy threshold of Hazrat Fatemeh Al-Masoomeh located in the northeast of Qom province, Qomrud district (Figure 1).

Agricultural water productivity (Equation 1) is defined as the ratio of the actual yield of commercial products to the rate of evapotranspiration.

$$\mathrm{WUE}_C = \frac{Y}{SWD_C} \qquad (1)$$

Using the amount of agricultural water productivity and the amount of crop produced, the amount of water used to produce forage corn was calculated.

2-1. Summary of the Region Meteorology

Knowledge of the climatic conditions of the project site is essential for use in the design, implementation, operation and maintenance of the irrigation system. In large projects, meteorological studies are considered as one of the important parts of the first stage studies. However, in small irrigation projects, a summary of the results of these studies is used. A summary of the meteorological parameters of the project area is presented in Table 1.

2-2. General Characteristics of the Soil

Soil is considered as a source of irrigation water storage and a source of plant nutrients. Some soil properties play a key role in the irrigation system design process. One of the most important of these characteristics is presented in Table 2.

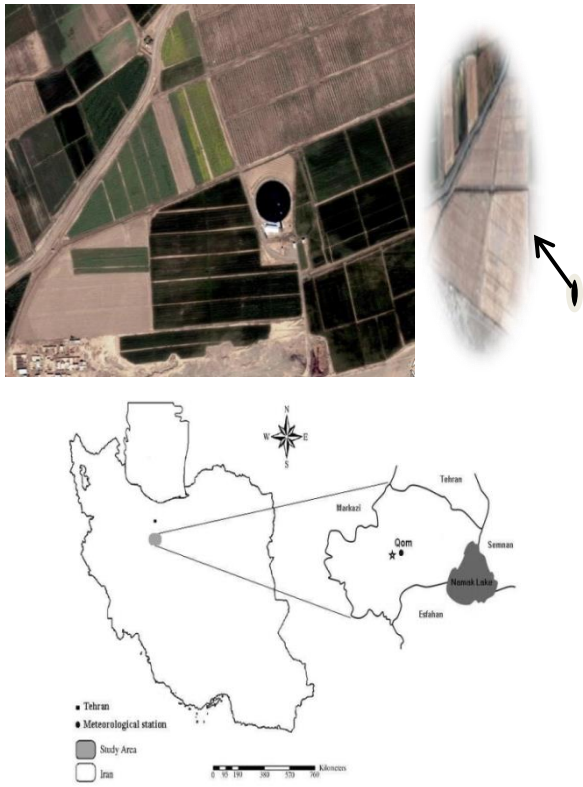

Fig. 1. Farm position map

Table 1. Summary of meteorological parameters (15-year period)

row	Parameter description	unit	amount
1	Absolute maximum temperature	°C	44.7
2	Absolute minimum temperature	°C	-8.9
3	Average maximum temperature	°C	26.3
4	Average minimum temperature	°C	9.9
5	Mean total temperature	°C	17.7
6	Absolute maximum relative humidity	٪	96.7
7	Absolute minimum relative humidity	٪	4.5
8	Mean maximum relative humidity	٪	58.6
9	Average minimum temperature humidity	٪	25.3
10	Mean total	٪	42.1
11	Annual rainfall	mm	143.8
12	Total hours of sunshine	H	2295.7
13	Number of frost days	day	62.9
14	Total annual evaporation	mm	1917.9
15	Maximum wind speed	m/s	17.7
16	Average wind speed	m/s	12.3

Table 2. Important soil parameters in relation to irrigation system design

Description	Specifications
Soil texture	Lumi cilt
Final permeability	12 mm/h
Average moisture content of the soil	192 mm/m
Appearance specific gravity	1.6 gr/cm^3
(FC)	23%
(PWP)	11%

2-3. Water Resources Specifications

In local irrigation, knowing the properties of the water used in terms of clogging and other limitations (salinity, alkalinity, etc.) is of particular importance. Accordingly, according to the results of water tests, the appropriate emitter and the required treatment equipment (to solve the physical problems) are selected.

Also, due to the current situation of water and control and periodic inspections, the necessary management measures are taken to solve chemical problems during the operation and maintenance of the system. Based on this,

the general water status of the project lands and the results of its chemical analysis are as follows.

The water required for the project lands is continuously supplied from a well located near the lands with a flow rate of 38 liters per second. The chemical properties of water based on the results of analysis of a sample of it are described in Table 3.

According to the classification of the American Salinity Laboratory, this water is in the group of waters with very high salinity and high alkalinity and is in class (C_4S_2).

According to the World Food Organization (FAO) classification, the interpretation of water quality results is as follows:

- The amount of salinity is severely limited in terms of the effect on water uptake by the plant.
- Salinity and alkalinity are not limited in terms of the effect on water penetration into the soil.

Due to the fact that the Langeler Saturation Index (LSI) is positive, irrigation water tends to form carbonate sediments and if the conditions are provided (changes in pressure and pH and temperature increase) these sediments will form and cause emissions to clog. Therefore, care should be taken in selecting the type of outlet and taking the necessary measures in operation and maintenance, including acid washing.

3. Results

10 cultivars of Brassica napus were cultivated by type irrigation, 5 of which were imported cultivars resistant to cold. Date of cultivation of all cultivars in October, foreign cultivars have been irrigated due to earlier cultivation, and 13 irrigations have been done, all cultivars have been irrigated around 4200 ha/m^3 to 4900 ha/m^3. Hayola Kalat cultivar with 10 irrigations had the lowest irrigation cycle and foreign cultivars (Natali, PF, Neptune, Jerry) and domestic Hayola cultivar had the highest irrigation cycle. In general, Hayola Shirazi cultivar with 420 m^3/ha had the least irrigation and Hayola Qom and Flavit cultivar with 4900 m^3/ha had the most irrigation, Table 4.

Hayola cultivar was cultivated using three irrigation methods. In the 4550 m3/ha type method, 7747 m3/ha was used in low pressure irrigation and 9349 m3/ha in gravity irrigation. In gravity irrigation, twice as much water has been used, Table 5.

Table 3. Results of chemical analysis of water samples of project lands

Description	Unit	Unit
pH		7.6
EC	(Ec × 10 6)	8420
Cl	(meq / lit)	50.5
CO3 (meq/lit)	(meq / lit)	-
HCO3 (meq/lit)	(meq / lit)	2.8
SO4	(meq / lit)	6.7
Ca.Mn	(meq / lit)	27
Na	(meq / lit)	35.5
T.D.S	(mgr / lit)	4172
S.A.R.		9.67

Table 4. Specification report of irrigation method of Brassica napus crop type in Sharifabad endowment

Variety	Treatment	Date of cultivation	Plot area	Number of irrigations	Total irrigation hours	Average irrigation hours	Average irrigation flow	Total irrigation volume per plot	Total volume consumed per piece + effective rain	Total volume of water consumption per hectare
Figure			M^2		h	h	l/s	M^3	M^3	M^3
Canola	Compare figures	2018/11/02	5491	13	38	2.92	19.20	2627	3325.2	4783.4
Natalie	Compare figures	2018/11/02	5976	13	38	2.92	20.85	2852	3618.9	4772.9
PF	Compare figures	2018/11/02	3548	13	38	2.92	12.30	1683	2120.3	4742.5
Nepton	Compare figures	2018/11/06	4850	13	38	2.92	16.75	2291	2898.4	4724.5
Hayola	Compare figures	2018/11/06	5309	11	31	2.82	20.65	2304	2991.6	4340.0
Jerry	Compare figures	2018/11/02	2267	11	31	2.82	8.82	984	1277.5	4340.0
Jilius	Kalat treatment	2018/11/06	7942	10	32	3.20	30.89	3558	4587.0	4480.0
Hayola	Shirazi	2018/11/02	4574	12	30	2.50	17.79	1921	2513.0	4200.0
Hayola	Qom	2018/11/14	5096	12	35	2.92	19.82	2497	3157.0	4900.0
Hayola	Flywit	2018/10/30	9607	12	35	2.92	37.36	4707	5952.0	4900.0
Hayola	Witness Kalat	1396/7/22	4703	12	32	2.67	19.82	2283	2892.0	4854.4

Table 5. Results of water consumption of Brassica napus cultivar Hayola in Sharifabad endowment

Figure	Care	Plot area	Number of irrigations	Total irrigation hours	Average irrigation hours	Average irrigation flow	Total irrigation volume per plot	Total volume consumed per piece + Effective rain	Total volume of water consumption per hectare
		ha	Frequancy	h	h	l/s	M^3	M^3	
Canola	Tape	1	12	32.5	2.7	18.8	4,418	2835.0	4550.0
Canola	Hydro-flum	0.6	11	33	3.00	38.00	4514	5885.0	7747.4
Canola	furrow	23	8	49	6.13	53.00	215,032	5885.0	9349

Water productivity of Brassica napus cultivars along with Brassica napus yield have been compared with Shirazi cultivar about 0.7 kg/ha maximum yield and Hayola Flywit cultivar (domestic) about 0.24 kg/ha and French cultivar Jerry about 0.22 kg/ha have the lowest efficiency. Among them, Hayola, Kalat treatment had the highest yield with 1910 kg/ha and French cultivar Jerry with 500 kg/ha had the lowest yield, Table 6.

Brassica napus yield increases with low pressure irrigation but water saving is about 17% and in type irrigation yield is reduced by about 15% but water saving percentage is about 51%. On the other hand, water efficiency in total type irrigation method is 0.66 Brassica napus cultivars and in hydroflume irrigation is 0.44, Table 7.

For the barley crop, three cultivars and 5 treatments were considered and almost all the treatments were irrigated in the same way and in the type irrigation, about 33600 m of water was given to the crop., Table 8.

Barley was cultivated by type irrigation and gravity irrigation (strip) which was used in gravity irrigation method 2.5 times more than water type irrigation method. Table 9.

Water efficiency for Fajr 30 barley crop is about 2.2 kg/m3 The yield of this crop is about 7898 kg/ha. Table 10.

Water efficiency in tape irrigation is about 1.7 kg/m3 and ancestor performance in type is more than gravity irrigation method. While 60% of water consumption is saved. Table 11.

Table 6. Comparison of water consumption and yield of canola crop in Sharifabad endowment

Treatment	Water consumption reduction ratio	Performance per unit area	Yield per hectare	Performance change ratio	Water efficiency kg/m^3
	%	kg	kg	%	
Natali	48.8	1100	2003.28	-33.22	0.42
PF	48.9	1260	2108.43	-26.57	0.44
Neptoun	49.3	970	2733.93	2.39	0.58
Hayola	49.5	990	2041.24	-30.74	0.43
Jeri	53.6	500	941.80	-183.36	0.22
Jilius	53.6	380	1676.22	-59.21	0.39
Hayola	52.1	1910	2404.94	-10.97	0.54
Hayola	55.1	1340	2929.60	8.91	0.70
Hayola	47.6	1570	3080.85	13.38	0.63
Hayola	47.6	1150	1197.04	-122.94	0.24
Hayola	48.1	1350	2870.51	7.03	0.59

Table 7. Comparison results of three irrigation methods of canola crop in Sharifabad endowment

Figure	Treatment	Date of cultivation	Water consumption reduction ratio	Yield per hectare	Performance change ratio	Water efficiency
			%	kg	%	Kg/m^3
Canola	type	2018/11/06	51.3	3005.2	11.2	0.66
Canola	Hydroflume	2018/11/06	17.1	3415.1	21.9	0.44
Canola	Gravity	2018/11/06	0.0	2668.7		0.29

Table 8. Report on the specifications of barley crop irrigation method in Sharifabad endowment

Treatment	Date of cultivation	Plot area	Number of irrigations	Total irrigation hours	Average irrigation hours	Average irrigation flow	Total irrigation volume per plot	Total volume consumed per piece + effective rain	Total volume of consumption per hectare
Barley		m^2	Frequancy	hr	hr	l/s	m^3	m^3	m^3
Rayheneh	2018/11/06	10300	10	30	3.00	34.33	3708	5041.9	3600.0
Fajr 30	2018/11/10	6900	10	30	3.00	23.00	2484	3377.6	3600.0
Yousef	2018/11/02	12200	10	30	3.00	40.67	4392	5971.9	3600.0
Yousef	2019/10/20	47400	11	32	2.91	158.00	18202	20358.3	3840.0
Yousef	2019/11/20	16000	9	31	3.44	53.33	5952	8024.0	3720.0

Table 9. Results of barley water consumption in Sharifabad endowment

Crop	Irrigation Methods	Plot area	Number of irrigations	Total irrigation hours	Average irrigation hours	Average irrigation flow	Total irrigation volume per plot	Total volume consumed per piece + effective rain	Total volume of consumption per hectare
		ha		h	h	l/s	M^3	M^3	M^3
Canola	Tape	9.28	10.0	30.6	3.1	61.9	34,738	8554.7	3672.0
Canola	Furrow	82	8	49	6.13	53	766.634	10644.2	9349

Table 10. Comparison of water consumption and barley crop yield of Sharifabad endowment

Variety of Barley	Water consumption reduction ratio	Yield per hectare	Performance change ratio	Water efficiency Kg per cubic meter
	%	Kg	%	
Rayhaneh	61.5	6572.8	8.2	1.8
Fajre 30	61.5	7898.6	23.6	2.2
Yousef	61.5	5262.3	-14.7	1.5
Yousef	58.9	5200.4	-16.1	1.4
Yousef	60.2	5506.3	-9.6	1.5

Table 11. Results of comparing two irrigation methods of barley crop in Sharifabad endowment

Crop	care	Water consumption reduction ratio	Performance per unit area	Yield per hectare	Performance change ratio	Water efficiency
		%	kg	kg	%	Kg/ha
barley	tape	60.7	10420.0	6088.1	0.9	1.7
barley	furrow	80	494890	6035.2	0	0.65

4. Conclusion

In this study, according to the census during a growing season, different results were obtained in all aspects of agricultural science such as agriculture, plant conservation, irrigation and cultivar comparison. However, the purpose of this study is focused on water science and engineering. The most important result of this field operation was that the water efficiency of type irrigation in Brassica napus is more than 2.3 times that of flood irrigation. On the other hand, strip surface irrigation with hydroflume has a higher performance than the other two methods. On the other hand, Hayola Shirazi cultivar consumed about 14.3% less water and was cultivated in terms of planting time about 15 days after the first planting. Hayola Shirazi cultivar has 9% higher yield than the average canola and has the highest yield after Hayola Qom cultivar. But it has been consumed 15% less water than Hiola Qom. As a result, Hayolai Shirazi cultivar was resistant to the salinity and obtained the best results by irrigation. Regarding barley crop, almost all cultivars have the same water consumption per unit area and the difference is about 4%, but Fajr 30 cultivar with a yield of more than 23%, the average water efficiency of 2.2 kg/m^3 has given the best results to the research. On the other hand, more than 60% of water has been saved in barley type irrigation. In surface irrigation, there was 9349 m^3/ha irrigation and this amount in the type was about 3672 m^3/ha. On the other hand, water efficiency in barley crop with type irrigation was about 1.7 kg/ha, while in surface irrigation this value was calculated to be about 0.65kg/m^3. Therefore, due to the quality of water with a salinity of more than 8000 micro mice per square centimeter, local type irrigation for both barley and canola crops has had more than the highest water productivity and efficiency. Barley yield was obtained by irrigating more than ten tons, which is higher than the national average. However, it is recommended that after the harvest, due to the fact that water salinity causes the accumulation of salts and salt in half a meter of soil, leaching operations must be carried out and also in areas that do not have the land problems, it should be done every year in the cultivated lands with local irrigation systems.

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