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Productivity of Maize Cultivars Under Irrigation with Two Water Sources

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ABSTRACT

Today, one of the biggest issues in the world is excessive water usage. One solution to this issue is the using aquaculture effluents to irrigate cropland instead of their discarding to substitute directly using irrigated water supplemented with fertilizers. This study was conducted to determine the effects of fish ponds and normal water irrigation on developing two cultivars of maize crops. This experiment was conducted from June to November 2022 in the Fish Resources Department research field, Grdarasha Field, College of Agricultural Engineering Sciences, Salahaddin University, Erbil, Kurdistan Region. Two cultivars of maize (Glorya Zemun Polje and DKC 6664 Monsanto) were used in this study irrigated with two different sources of water (Normal water and Fish Pond water) in Factorial Randomized Complete Block Design, each with three replications. The plot area is about 7.5 m^2 (3 m × 2.5 m). The leaf area index, dry mass, tassel, and ear length were measured every two weeks after the emergence of plant high. The results showed that no significant (P>0.05) differences were observed among cultivars, source of water, and their interaction on plant height, leaf area index, dry mass, tassel and ear length, and grain yield parameters, except fish pond water significantly (P<0.05) increased leaf dry weight compared to the normal water at eight weeks after emerges. Also, the interaction between both cultivars with normal water significantly (P<0.05) increased the leaf area index compared to the interaction between cultivar two with fish pond water two weeks after emergence. This irrigation is important because it is organic, environmentally friendly, and a sustainable type of farming.

Keywords: Maize, Management, Fish Pond, Production.

1. Introduction

Maize is the third most significant cereal in the world. Wheat and rice, being a regular food for more than 1.2 billion people on the earth. To increase the quantity and quality of water resources for irrigation and support the sustainability of agriculture, the use of water fish ponds for irrigation has proven to be a successful solution[1]. Worldwide the water supply for agriculture about 70% is used in irrigation[2]. Historically, the water used for aquaculture was discarded after the fish was raised, but research in recent years has revealed that the water from fish ponds may help plants thrive.

Fish ponds have begun to serve as reservoirs for the irrigation of plants because the effluent of fish deposited in the water is important for the growth of plants[3]. Integrating aquaculture and hydroponics for growing crops without soil has become popular globally.

Cob numbers per unit area, grain numbers per cob, and grain mass unit are all variable factors that affect the grain yield of maize[4]. Grain yield is a quantitative property that is greatly impacted by changing environmental conditions; these factors mostly influence the kernel numbers per cob and kernel numbers per row[5, 6]. The yield of maize will rise due to agronomic procedures such as sustainable soil nutrient management, which includes water sources that have a good impact on the grain components[7].

Therefore, this study aimed to determine the potential effects on the productivity of two maize cultivars using different aquaculture water sources for irrigation.

Therefore, the main objective of this review is to show natural fibers that well suited to Iraqi environmental conditions and their uses such as (Cotton, Flax, Jute, Kenaf and Date Palm).

2. Material and Methods

2.1 Experimental design

The research was conducted in the Fish Resources Department, Grdarasha Field, College of Agricultural Engineering Sciences, Salahaddin University, Erbil, Kurdistan Region. The experiment was implemented from June to November 2022, with GPS coordination at 36° 4' N, 44° 2' L, and 400 m elevation.

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Two cultivars of maize Glorya Zemun Polje (C1) and DKC 6664 Monsanto (C2), and two irrigation water sources, Normal water (NW) and Fish Pond water (FPW), with three replications. The area of each plot was 3 m long and 2.5 m wide. In each plot, four rows were set up about 50 cm apart and 15 cm between the plants on a line. Two rows in the middle of each plot were utilized to measure the parameters. The soil was prepared a week before planting with a rotavator, and planting two kernels in a hole was performed manually.

2.2 Studied characteristics

2.2.1 Plant height (cm)

Following seedling emergence, every two weeks, the plant height was measured. Five plants randomly chosen in each plot were measured from the ground's surface to their growing points, and the average plant height was then calculated (cm).

2.2.2 Leaf area index

From the second week through eight weeks after emergence (WAE), leaf area was measured using destructive sampling of five plants from the two middles of plots every two weeks. The leaf area was calculated using Image J software[8]. The leaf area index (LAI) was calculated using leaf area determination. The following equation was used to determine the LAI.[4, 9].

Leaf area index = Plant total leaf area / Area per plant

2.2.3 Leaf dry weight (g)

All samples were weighed after drying at 75 ºC for 48 hours in an oven assisted with a fan (Gallenkamp Oven BS, Model; OV-160, England) until a constant weight was achieved.

2.2.4 Tassel and ear length (cm)

A ruler measured the tassel and ear length at 12 WAE. The length of the tassel was recorded from the flag leaf to the tip, and the ear length, including the husks, was measured from the stalk to the tip.

2.2.5 Yield Parameters

All the measurements were taken from two middle lines of each plot. The measurements include the length of the cob, row numbers per cob, kernel numbers per row, kernel mass, and kernel mass per cob.

2.3 Statistical Analysis

SPSS program was used to analyze the data, using a general linear model and a Factorial Randomized Complete Block design[10]. Descriptive statistics, such as means and standard error, were used to examine the data results. Duncan's multiple range test was applied to find potential significant differences between the values at 0.05 levels[11].

3. Results and Discussion

Table 1 shows the response of two maize cultivars to different water sources and their interaction on plant high. The results showed non-significant (P>0.05) differences among cultivars, water source, and their interaction with plant height at different growth stages. Farm ponds are often a more sustainable water source than groundwater. So, ponds can reduce the water table decline and provide a wide range of ecosystem services[12-14]. Fish ponds have begun to serve as reservoirs for the irrigation of plants because the effluent of fish deposited in the water is important for the growth of plants[15]. Moreover, it is an entirely organic farming approach that respects the environment. This study showed that plants were high in both types of irrigation, and there were no significant differences observed, which means using water from fish ponds instead of normal water to save water. The findings of this study revealed that there were no appreciable changes between the plant heights in both types of irrigation, which means using fish pond water instead of normal water can help save clean water. Plant height features such as plant stem area and length are appreciable in photosynthetic activities and are important features to consider when accounting for a plant's total sunlight interception area[16]. According to research, plants were taller at the end of the study in fish water plots compared with normal water plots. The plants irrigated with normal water grew less because no nutrient was added to the soil[17].

Table 1: Response of two maize cultivars to different water sources and their interaction on plant height.

Treatment	Plant Height (cm) WAE			
	2 weeks	4 weeks	6 weeks	8 weeks
Maize Cultivars				
C1	28.86±0.56	92.93±1.04	141.00±2.49	202.76±2.32
C2	28.63±0.56	91.43±0.99	139.93±2.57	200.83±2.86
P. value	0.76	0.219	0.652	0.437
Water source				
NW	28.86±0.49	92.73±0.90	140.40±2.54	202.00±2.72
FPW	28.63±0.62	91.63±1.71	140.53±2.52	201.60±2.49
P. Value	0.76	0.365	0.955	0.872
Interaction between cultivar and water source				
C1 × NW	28.60±0.69	93.06±1.25	140.13±3.99	202.33±3.25
C2 × NW	29.13±0.72	92.40±1.35	140.66±3.28	201.66±4.49
C1 × FPW	29.13±0.89	92.80±1.71	141.86±3.10	203.02±3.44
C2 × FPW	28.13±0.86	90.46±1.45	139.20±4.07	200.00±3.68
P. value	0.759	0.420	0.878	0.824
C1: Glorya Zemun Polje and C2: DKC 6664 Monsanto NW: Normal Water; and FPW: Fish Pond Water.				

Table 2 shows the response of two maize cultivars to different water sources and their interaction on leaf area index. The results showed non-significant (P>0.05) differences among cultivars, water source, and their interaction on leaf area index, except normal water increased leaf area index compared to the fish pond water two weeks after emergence. Also, the interaction between both cultivars with normal water significantly (P<0.05) increased the leaf area index compared between cultivar 2 with fish pond water two weeks after emergence. The results of this study showed that LAI ranged between 3.1- 3.27. The interaction between cultivar 2 and normal water was recorded as the highest LAI, about 3.27. Previous research on maize crops has demonstrated that for some types, an LAI around 3 to 4 may be suitable for maximizing grain yields[18]. According to research, the higher value of LAIs may be due to the essential for the efficient objection of sunlight at low levels of intensity lightning[19].

Table 2: Response of two maize cultivars to different water sources and their interaction on leaf area index.

Treatment	LAI (WAE)			
	2 weeks	**4 weeks**	**6 weeks**	**8 weeks**
Maize Cultivars				
C1	0.50±0.008	0.84±0.01	1.71±0.02	3.16±0.07
C2	0.49±0.009	0.88±0.01	1.72±0.02	3.18±0.11
P. value	0.464	0.243	0.832	0.870
Water source				
NW	0.51±0.008 [a]	0.85±0.01	1.71±0.02	3.20±0.11
FPW	0.48±0.005 [b]	0.87±0.02	1.72±0.02	3.15±0.07
P. Value	0.004	0.596	0.690	0.613
Interaction between cultivar and water source				
C1 × NW	0.51±0.01 [a]	0.83±0.02	1.69±0.03	3.13±0.12
C2 × NW	0.51±0.01 [a]	0.87±0.01	1.72±0.04	3.27±0.19
C1 × FPW	0.49±0.00 [ab]	0.85±0.02	1.73±0.03	3.20±0.07
C2 × FPW	0.47±0.00 [b]	0.89±0.03	1.72±0.02	3.10±0.13
P. value	0.021	0.626	0.942	0.674

Means within each column had the different subscript differing significantly (P<0.05).
C1: Glorya Zemun Polje cultivar and C2: DKC 6664 Monsanto
NW: Normal Water; and FPW: Fish Pond Water.

Table 3 shows the response of two maize cultivars to different water sources and their interaction on dry leaf weight. The results showed there are no significant (P>0.05) differences among cultivars, source of water, and their interaction on dry leaf weight at separate weeks, except fish pond water that significantly (P<0.05) increased dry leaf weight compared to the normal water at eight weeks after emergence. LAI describes the size of the assimilatory apparatus of a plant stand as one of the primary factors determining the total dry matter produced by a crop. Higher LAI is highly desirable where the total biomass (biological yield) is desirable, especially in forage and fodder crops. The capacity of a plant canopy to efficiently intercept and utilize solar radiation determines the amount of the total dry mass per plant[4].

Table 3: Response of two maize cultivars to different water sources and their interaction on dry leaf weight.

Treatment	Dry Leaf Weight (g) WAE			
	2 weeks	**4 weeks**	**6 weeks**	**8 weeks**
Maize Cultivars				
C1	5.23±0.09	8.76±0.09	26.42±0.44	43.12±0.87
C2	5.35±0.11	8.72±0.12	26.22±0.37	43.19±0.64
P. value	0.367	0.788	0.771	0.938
Water source				
NW	5.23±0.81	8.74±0.12	26.29±0.37	41.88±0.45 [b]
FPW	5.35±0.13	8.74±0.09	26.35±0.44	44.43±0.77 [a]
P. Value	0.352	0.989	0.938	0.026
Interaction between cultivar and water source				
C1 × NW	5.12±0.07	8.56±0.12	26.03±0.42	41.31±0.50
C2 × NW	5.34±0.13	8.91±0.19	26.56±0.63	42.45±0.72
C1 × FPW	5.34±0.17	8.95±0.07	26.81±0.79	44.92±1.23
C2 × FPW	5.35±0.21	8.52±0.11	25.88±0.41	43.94±1.04
P. value	0.493	0.092	0.740	0.106

Means within each column had the different subscript differing significantly (P<0.05).
C1: Glorya Zemun Polje cultivar and C2: DKC 6664 Monsanto
NW: Normal Water; and FPW: Fish Pond Water.

The results found by the researcher had a highly significant correlation (r2 = 0.93) between the leaf area index and the total dry mass of maize as influenced by varying soil nutrient status[6].

Table 4 shows the response of two maize cultivars to different water sources and their interaction on the tassel and ear length. The results showed non-significant (P>0.05) differences among the cultivars, water source, and their interaction on the tassel and ear length at 12 weeks after emergences. According to research, the length and number of nodes are regulated by both growth and genetic factors in maize plants[20]. Therefore, if a plant is healthy and well-developed, it is likely that its long ears are a result of the photosynthetic body's larger size, which encourages ear development[21].

Table 5 shows the response of two maize cultivars to different water sources and their interaction on grain yield parameters. The results showed no significant (P>0.05) differences among cultivars, water source, and their interaction on cob length, number of kernels per row, cob/row, kernel numbers per cob, kernel mass, kernel mass per cob and 100 kernel weight.

Table 4: Response of two maize cultivars to different water sources and their interaction on the tassel and ear length.

Treatment	**LAI (WAE)**	
	Tassel length (cm)	**Ear length (cm)**
Maize Cultivars		
C1	44.20±0.64	36.80±1.06
C2	44.20±0.62	34.80±0.66
P. value	0.745	0.165
Water source		
NW	44.60±0.6	35.70±0.95
FPW	43.80±0.64	35.90±0.93
P. Value	0.358	0.885
Interaction between cultivar and water source		
C1 × NW	44.40±0.74	36.0±1.70
C2 × NW	44.80±1.01	35.4±1.07
C1 × FPW	44.00±1.14	37.6±1.36
C2 × FPW	43.60±0.74	34.2±0.80
P. value	0.769	0.389
C1: Glorya Zemun Polje cultivar and C2: DKC 6664 Monsanto NW: Normal Water; and FPW: Fish Pond Water.		

Table 5: Response of two maize cultivars to different water sources and their interaction on grain yield parameters.

Treatment	**Quality Product**						
	Cob Length (cm)	**Rows/Cob**	**Kernels/Row**	**Kernels/Cob**	**Mass/Kernel (g)**	**Mass/Cob (g)**	**Mass/100 seeds (g)**
Maize Cultivars							
C1	19.05±0.65	31.50±1.78	14.16±0.30	332.66±21.49	0.38±0.01	137.69±5.58	33.79±1.44
C2	18.08±0.65	30.00±2.01	14.50±0.42	306.83±18.18	0.35±0.01	131.72±4.14	32.38±1.24
P. value	0.355	0.352	0.599	0.230	0.159	0.304	0.553
Water source							
NW	18.88±0.90	31.16±2.15	14.16±0.47	304.16±19.24	0.37±0.01	135.22±4.53	32.75±1.42
FPW	18.25±0.30	30.33±1.66	14.16±0.22	335.33±12.83	0.36±0.01	134.19±5.58	33.42±1.32
P. Value	0.535	0.596	0.599	0.158	0.826	0.854	0.775
Interaction between cultivar and water source							
C1 × NW	19.43±1.37	31.33±3.17	13.66±0.33	337.66±16.56	0.37±0.20	139.75±5.80	32.27±2.07
C2 × NW	18.33±1.36	31.00±3.60	14.66±0.88	270.66±12.65	0.37±0.02	130.68±6.98	33.23±2.38
C1 × FPW	18.66±0.33	31.66±2.40	14.66±0.33	343.00±18.87	0.39±0.00	135.63±7.86	35.31±1.96
C2 × FPW	17.83±0.44	29.00±2.51	14.33±0.33	327.66±13.40	0.34±0.02	132.76±5.99	31.54±1.14
P. value	0.705	0.612	0.630	0.119	0.304	0.669	0.678
C1: Glorya Zemun Polje cultivar and C2: DKC 6664 Monsanto NW: Normal Water; and FPW: Fish Pond Water.							

Conclusion

In conclusion, one of the two water sources appreciably affected either the maize cultivar's vegetative growth or reproductive development. While both water sources are parallelly encouraged, developing both cultivars' vegetative and reproductive systems is important. Thus, it is concluded from this experiment that using fish pond water rather than normal water to irrigate the plant results in a normal yield production while able to save fresh water for other uses.

Conflict of interests

There is no conflict of interest.

Author contribution

Author has written, drafted, analysed data and finalized the manuscript.

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