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Potentials of the use of brackish ground water in integrated aqua-agriculture systems

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ABSTRACT

Water scarcity is a great challenge and a growing problem for all countries. The present researchfocuses on the rational utilization of water resources with different quality through studying the effects of different parameters on water use efficiency and productivity, the investigation used different parameters such as water resources, sowing dates and water shortage on the amount of water applied, water use efficiency, yieldand net return of barley, in a semi-arid region during growing season 2014-2015. A Split plot layout with three replications was used. Two main plots represent water resources (fresh and brackish water). Sub plots were represented by the sowing dates of: 15th Dec.,1st Jan.and 15th Jan.with water supply rates of: full irrigation, 80% and 60% of amount of water requirements.

The results indicated that, the highest value of irrigation water quantity using brackish water and fresh water were 2285 m^3/fed and 2135 m^3/fed respectively at planting date of 15 December to add leaching needs and at 100% of irrigation water, while the lowest value for the quantity of irrigation water using brackish water and fresh water at 60% deficit was1237 m^3/fed and 1156 m^3/fed respectively at the planting date of January 15 in 60% deficit due to the low number of irrigation times. In the meantime, average water use efficiency was 1.28, 1.46 and 1.53 kg/m^3 when using 100%, 80% and 60%, respectively, with a yield reduction of 10% and 38% for the use of water 80% and 60% respectively compared to 100%. The average efficiency of water uses when using brackish water was 1.48, 1.65 and 1.64 kg/m^3 when using 100%, 80% and 60% irrigation deficit respectively with a decrease in yield of 13%, 51% for the use of fresh water 80% and 60% respectively compared to 100%.

Key words: Irrigation, freshwater, barley, fish farms, net return.

INTRODUCTION

Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants.Farming implies some form ofintervention in the rearing process to enhance production, such as regular stocking, feeding, protection from wild species, etc. Farming also are implemented through individual or corporate investments of the stock being cultivated.

Barley is considered as the fourth most important crop after rice, wheat and maize in terms of cultivated area in the world. Below normal precipitation noticed in the recent years has resulted in countries like Egypt, Arab countriesto have a serious water shortage that could be defined as a crisis of irrigation water.

Aquaculture activities in Egypt are mostly located in the Northern part of the Nile Delta, clustered in the surrounding areas of the four northern Delta Lakes (*Maruit, Edko, Boruls and Manzala*). The command area occupied by this aquaculture is about (151,757 ha) producing annuallyfrom 2.8 to 8 tones/ha (Macfadyen *et al*., 2011).

Drainage water are reusedin the fish farming activity as a new source, rich with organic matter and it can also improve soil fertility and therefore the crops' productivity, this is expected to reduce the costs of added fertilizers and partially reduce the pollution in soil. The yield of potato crop and water use efficiency were 8 ton/fed (1 ha = 2.4 fed) and 2.9

kg/m^{3}from fish farms using drainage water compared with 7.8 ton/fed and 2.9 kg/m^3 under traditional irrigation water (Abdelraouf & Hoballah, 2014).

Also, the effect of irrigation shortage strategy needs to be investigated. Deficit irrigation is considered as an optimized strategy under which cultivated areas are made to suffer of irrigation water shortage and reduction in yield (English & Raja, 1996; Ghaemi & Tabarzad, 2014).The main idea of applying deficit irrigation practice is to know how far we can safe irrigation water and minimize irrigation times maintaining the least impact onthe crop yield.

Shabani *et al.* (2010) indicated that deficit irrigation hasdirect negative impact on the yield and yield quality of rapeseed such as weight of 1000-grain weight, seed oil and seed protein content.

Andrew (2008) determined planting date (mid-April (early), late May (mid), and mid-June (delayed)) influenced crop and water use (WU) of barley. Early planting resulted in excellent forage yields. Water use was higher for the first planting date than for the second and third dates.

The main problem of the present research is to face the growing challenge of water resources scarcity and to investigate the potentials of using the brackish water as a water source for cultivation of strategic crops with an added economic value through the use of aqua fishponds.

The general objective is to develop and evaluate the use of a different quality of brackish water for integrated food systems in new lands, and to identify a number of crops that can be grown with brackish in the desert environment.*The specific objectives* are to study the effects of different parameters on water use efficiency and productivity, used different parameters such as water resources, sowing dates and water shortage on the amount of water applied, water use efficiency, yield and net return of barley crop, in a semi-arid region during growing season 2014-2015.

A Split plot layout with three replications was used to perform the experiment. Two main plots represent water resources (fresh and brackish water). Sub plots were represented by the sowing dates of: 15th Dec., 1st Jan. and 15th Jan. with water supply rates of: full irrigation, 80% and 60% of amount of water requirements.

MATERIALS AND METHODOLOGY

Field experiments were carried out in open field conditions during the season of 2014-2015 at Wadi EL NatronResearch Station, Water Management and Irrigation Systems Research Institute, El-Behera Governorate to study the use of brackish ground water in integrated aqua-agriculture systems in new land in Egypt.

Study area

Wadi El-Natron research station is located at 30° 23' 19.89″ N latitude, 30° 21' 41.06″ E longitude, while the altitude is 17.98 m above the sea level.

The experimental soil is classified as sandy soil. Undisturbed soil samples were collected from three different soil depths of (0 – 20, 20 – 40 and 40 – 60 cm) before cultivation to determine the physical and chemical characteristics of the experimental soil site. Some physical and chemical characteristics of the soil measured before the experiment under investigation are given in Tables (1 & 2).

Table (1): Some Physical Characteristics of the Experimental Soil.

Soil layer (cm)	Particle size distribution %			Texture class	Bd (gm/cm^{-3})	Moisture content by weight (%)		
	Sand	Silt	Clay			F. C	W.P	A.W
0 –20	94.5	3.5	2.0	Sandy	1.65	8.03	3.33	4.7
20-40	95.0	3.3	1.7		1.56	9.13	3.14	5.99
40-60	95.7	3.0	1.3		1.44	10.07	2.99	7.08

Table (2): Some Chemical Characteristics of the Experimental Soil.

Soil layer	SAR	PH	EC (dS/m) at 25°c	Soluble anions (meq /l)				Soluble cations (meq /l)			
				CO_3^{--}	HCO_3^-	Cl^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^+	K^+
0 –20	1.66	8.23	1.46	0.1	0.93	1.98	9.61	6.23	2.24	3.44	0.51
20-40	1.74	8.11	1.56	0.1	1.15	2.05	9.85	6.45	2.26	3.76	0.58
40-60	1.84	7.97	1.63	0.1	1.33	2.11	10.16	6.65	2.29	3.91	0.65

Materials

- Irrigation system and equipment's:Sprinkler irrigation system was used in the experimental. It contains the following general components:
- Pump: For the ground water well (first source of water). An electrical centrifugal pump was used with 60 hpengine power and a discharge of 100 m^3/h at 4 bar operating pressure head.
  And for the second source of brackish water (reservoir). An electrical surface pump was used with 40 hp engine power and a discharge of 90 m^3/h at 4 bar operating pressure head.
- Control unit: The control unit follows the pump however; its objective is to control the pressures and water quantities. It also used to filter water and can be used to add fertilizers.The control unit consists of: non-return valve, valve, pressure gauge, fertilizer venture, sand filters, water flow meter and air release valve**Figure (1).**

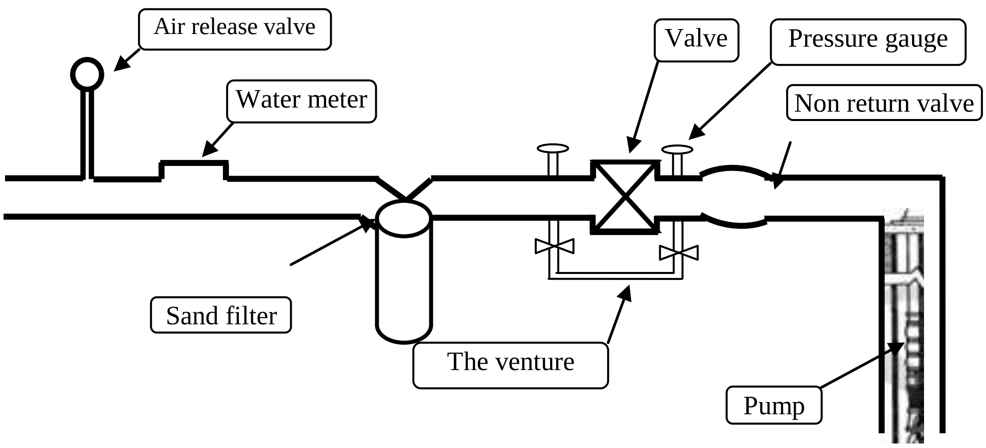

Fig. (1): The diagram of control unit.

- Pipe network:Pipe network consists of a main line, sub mains and secondary pipes.
- Sprinkler irrigation system contents the general components in addition to the following:Riser, manifold pipes, lateral lines, sprinkler riser and rotating sprinklers 0.75 inch out diameter, 1 m^3/h discharge under 2.2 bars operating pressure.

- Soil preparation and planting dates for barley: During soil preparation the land was plowed using chisel plow. Organic manure was added, in addition, chemical fertilizers were added and mixed in the soil by rates as follow through all experimental locations:

a) Super phosphate (15.5% P_2O_5) was added at a rate of 100 kg/fed before plowing.

b) Nitrate (33.5 % N) was added at a rate of 200 kg/fed divided on 5 times the first one after thinning and the other 4 times were applied at 15 days intends.

c) Potassium sulphate (48 % K_2O) was added at a rate of 50 kg/fed on 2 times with nitrate.

- Planting dates: Barelywas planted manually at three dates of 15/12/2014, 1/1/2015 and 15/1/2015.
- Irrigation water: The two quality of water was used (well water and brackish water "reservoir") under this study. The results of some chemical characteristics of the water under investigation are given in Tables (3 & 4).

Table (3): Physical and Chemical Characteristics of Irrigation Water by Well

Location no.	**Experimental**	**Well**	**Law 48/ 1982**
Physical Parameters			
Dissolved Oxygen (O_2) mg/l	5	1	>5
PH	8	8.8	-
Electrical conductivity (EC) µs /cm	1800	2085	-
Total Dissolved Solid (TDS) mg/l	1152	1334.4	≤500
Transparency (cm)	250	-	-
Temperature (C^o)	25	23	-
Chemical Parameters mg/l			
Bicarbonate	12	0	-
Calcium	60.12	60.12	-
Magnesium	36.48	24.32	-
Chloride	450.5	400.4	-
Ammonia	0.538	0.38	≤0.5
Nitrate	4.31	0.79	-
Nitrite	0.039	0.034	≤45
Phosphate	0	0.1	-
Sulfate	125.73	132.42	≤200
Sodium	429	443	-
Potassium	36	35	-
Heavy metals			
Copper	0.53	0.59	≤1
Zinc	0.01	0.03	≤1
Manganese	0.58	0.74	≤0.5
Iron	0.64	0.76	≤1
Lead	0.017	0.019	≤0.1
Nickel	ND	ND	≤0.05

Table (4): Physical and Chemical Characteristics of Irrigation Water by Reservoir

Location no.	**Experimental**	**Reservoir**	Fish Farming Water Quality
Physical Parameters			
Dissolved Oxygen (O_2)mg/l	5	1.2	≥5
PH	8.7	9	7-9.5
Electrical conductivity (EC) us/ cm	1700	2080	-
Total Dissolved Solid (TDS) mg/l	1088	1331.2	< 3000
Temperature (C^o)	19	22	15-35
Chemical Parameters mg/l			
Ammonia	0.365	0.444	< 1
Nitrate	0.02	0.01	0-100
Phosphate	3.98	1.39	0.03-2
Sulfate	154.03	127.94	≤200
Sodium	424	414	-
Potassium	36	35	-

Agro-meteorological data:

The maximum and minimum temperatures, relative humidity, wind speed and sunshine (h) were measured during the running of the experiment (Table 5).

Table (5): Average Agro-meteorological data in month at Wadi EL Natrown.

Month	**Temp Out**	**Hi Temp**	**Low Temp**	**Out Hum**	**Dew Pt.**	**Wind Speed**	**Heat Index**	**THW Index**	**Rain Rate**	**Solar Rad.**
November	17.17	17.47	16.89	75.56	12.32	4.58	17.13	17.06	0.02	113.03
December	14.84	15.14	14.56	61.78	6.82	6.56	14.25	13.88	0.00	122.88
January	13.43	13.72	13.16	59.15	4.58	7.43	12.71	12.20	0.01	135.10
February	14.55	14.85	14.25	61.84	6.21	7.60	13.90	13.40	0.00	164.39
March	17.77	18.10	17.45	65.00	10.13	8.08	17.41	17.15	0.00	212.00
April	19.77	20.16	19.40	58.66	9.77	8.26	19.27	19.01	0.04	276.31
May	23.67	24.03	23.34	59.93	14.45	7.80	23.75	23.66	0.00	274.42

METHODS

The methodology of carrying out the experiments were as follows:The total experimental area of the experiment was reached 10368 m^2 divided into three main plots: 3456 m^2 for first planting date, 3456 m^2 for second planting date and 3456 m^2 for third planting date.

The treatments of experiment were based on the following parameters:

- Water quality: Two irrigation water quality were used for irrigating barely
  - Well (fresh water).
  - Fish farms (brackish water)
- Water regime
  - 100% of amount of water applied.
  - 80% of amount of water applied.
  - 60% of amount of water applied.

- Planting dates:Barely was cultivated at three dates as follows:
  - 15th Dec.
  - 1st Jan.
  - 15th Jan.

The layout of sprinkler irrigation systems were illustrated in Figure (2).

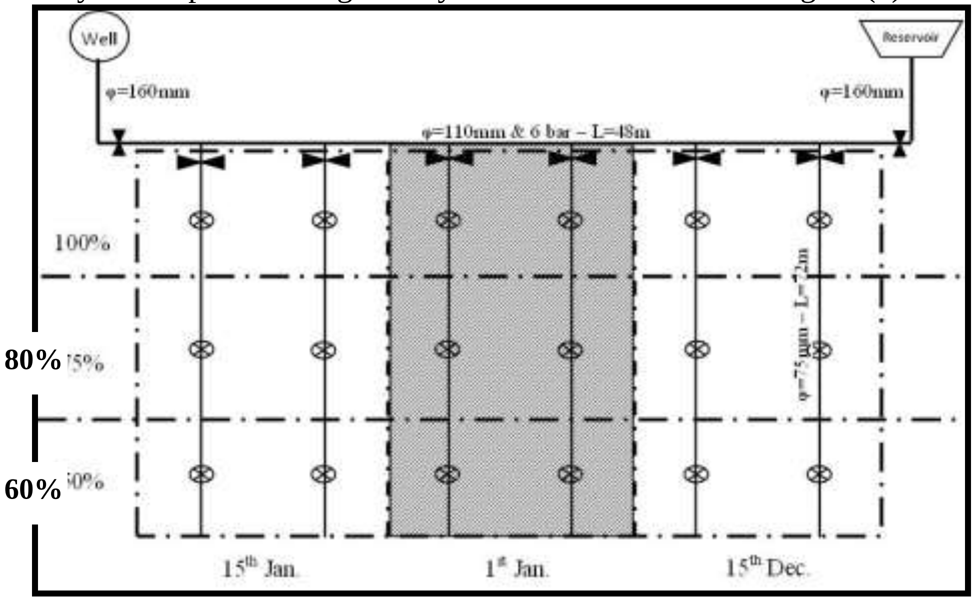

Fig. (2): Layout of sprinkler irrigation system experiments.

Measurement and determinations

- **Irrigation characteristics**

Amount of water applied: The irrigation requirements were calculated according to the equation given by Israelsen and Hansen (1962) as follows:

$$D_{aiw} = \frac{F.C. - \theta_1}{100} \; X \; B_d \; X \; d$$

Where:

D_{aiw} : Depth of irrigation water applied (mm)
F. C.: Soil moisture content at field capacity (%)
Θ_1 : Soil moisture content before irrigation (%)
B_d : Bulk density (g/cm^3)
d : Soil depth (mm)

Yield components at harvest: samples of plants were taken from each treatment to estimate the following:

- Seed yield (kg/fed.).
- Straw yield (kg/fed.).
- Harvest Index (%)

The physiological efficiency of a crop to convert dry matter into economic yield is determined by the harvest index (HI).

$$HI = \frac{\text{grain dry mass}}{\text{total above ground plant dry mass}} \times 100 \,, \%$$

Water use efficiency (WUE): It was determined according to (Pene & Edi, 1996*)* using the following equation:

$$WUE = \frac{\text{Yield (kg/fed.)}}{\text{Amount of water applied } (m^3/fed)}, kg/m^3$$

Economic analysis

- Total return (LE/fed.) was calculated with the following equation:

Total return = yield of barley(price (LE/kg) × productivity (kg/fed)) + yield of fish (price (LE/kg) × productivity (kg/fed))

- Total costs (LE/fed.) was calculated with the following equation for barley and fish:

Total cost = fixed cost + variable cost

- Net return (LE/fed.) was calculated with the following equation:

Net return = Total return - Total costs

- Water productivity (LE/m^3) was calculated by using the following formula:

$$\text{Water productvity} = \frac{\text{Net return (LE/fed.)}}{\text{Amount of water applied } (m^3/fed)} = LE/m^3$$

RESULTS AND DISCUSSION

Effect of Reuse ofbrackish water on Soil

Table (6) shows that, the soil salinity was reduced to 1.33 dS/m after harvesting compared to salinity level of 1.55 dS/m before planting when fish bond drainage was used, while the salinity of soil after planting using fresh water was about 1.23 dS/m.Also, Nitrogen increased in soil from 177 kg/fed before planting to 253 kg/fed after planting when usingbrackish water while nitrogen increased to 180 kg/fed after agriculture when using fresh water. The amount of potassium in the form of potassium oxide increased from 1321 kg/fed before planting to 2254 kg/fed after planting whenbrackish water was used, while the use of fresh water resulted in potassium oxide to slightly increase to 1350 kg/fed.

Table(6): Chemical analysis of soil and water using fresh andbrackish water

Soil	Water Source	SAR	PH	EC (dS/m)	N (kg/fed)	P_2O_5 (kg/fed)	K_2O (kg/fed)	S (kg/fed)
Before		1.75	8.10	1.55	177	10.13	1321	18.1
After	Fresh Water	1.84	8.2	1.23	180	10	1350	13
	Fish bond drainage water	1.91	8.37	1.33	253	11.34	2254	12.4

Amount of irrigation water applied

Figure (3) shows that, the highest values for the quantity of irrigation water used were when usingbrackish water because of adding leaching needs to prevent accumulation of salts.The highest values for irrigation water were achieved when using the water of fish bond drainage where it reached 2285 m^3/fed.and 2171 m^3/fed.and 2026 m^3/fed. in the planting dates of 15 December and 1 January and 15 January respectively, 100% of the quantity of irrigation water. Also, irrigation water quantities using fresh water at 100% was about 2135 m^3/fed.and 2028 m^3/fed.and 1927 m^3/fed. at the planting dates of December 15, January 1 and January 15, respectively. While the lowest value for the irrigation water using fresh water was 60% of the irrigation water was about 1156 m^3/fed.at the planting date of January 15, while the lowest value of irrigation water usingbrackish water was about 1237 m^3/fed. with 60% of irrigation water at planting date of January 15 due to the low number of irrigations.

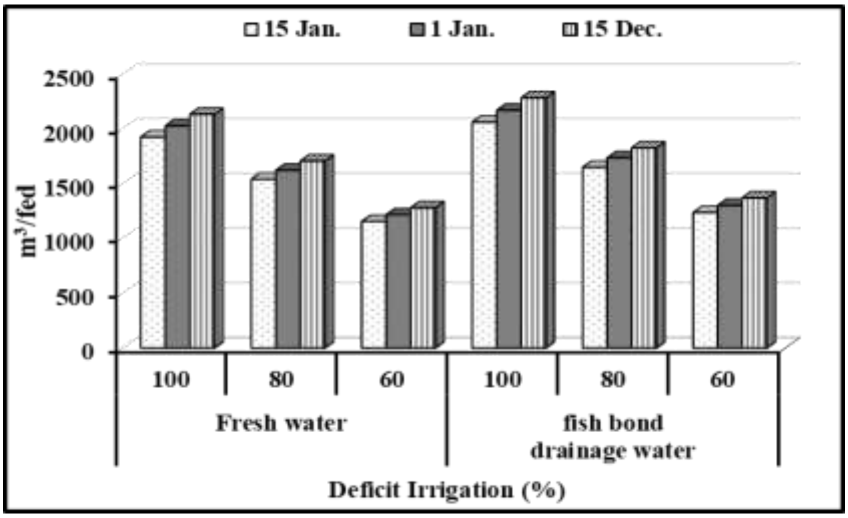

Fig. (3):Amount of irrigation water with deficit irrigation using fresh andbrackish water for different planting dates

Yield components at harvest

Seed yield

With regard the effect of water quality on seed yield, data show that the highest value of seed yield was found under brackish under all treatments. Brackish water increased the seed yield from 127.1 to 175.4 kg/fed. compared with fresh water at planting date 1 Jan. under 100% water regime. Using fresh water reduced the seed yield by 21.3% compared with fresh water under 60% water regimes, 15th Dec. and planting date. The obtained data indicated that the brackish water was significant on seed yield under all treatment compared with fresh water at planting date 1Jan. under 100% water regime (Fig. 4).

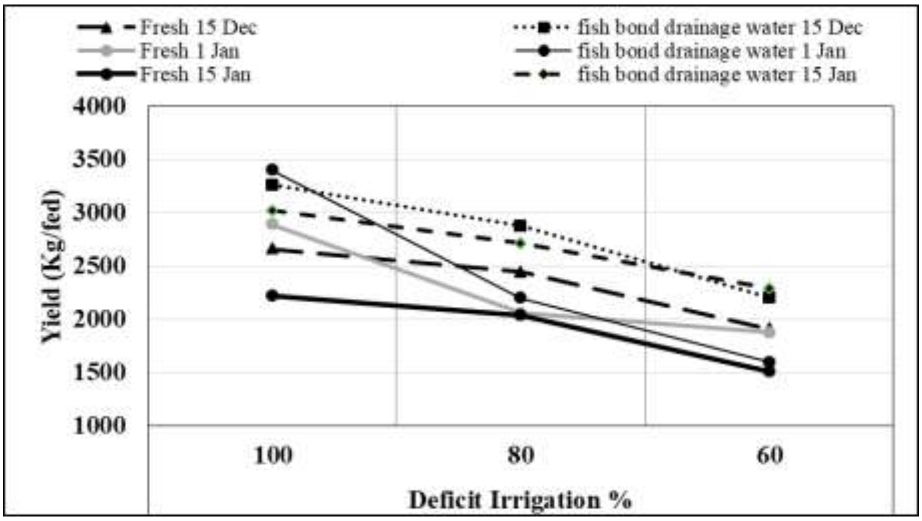

Fig. (4): Yield seed with deficit irrigation using fresh and brackish water for different planting dates

Straw yield

As to using water quality, the obtained results from Figure (5) show that under all treatments the highest value at 100% water regime by using brackish water compared to fresh water and the lowest Value at 60% water regime by using brackish water compared to fresh water. Also, the highest values of the straw yield were 5080 kg/fed under 100% water regime, 1 Jan. planting date by using brackish water, while the lowest values was 3024 kg/fed under 60% water regime, with planting date 15th Dec. brackish water. The results showed that it was significantly on values of the straw yield increased under 100% water regime, 1 Jun. planting date by using brackish water

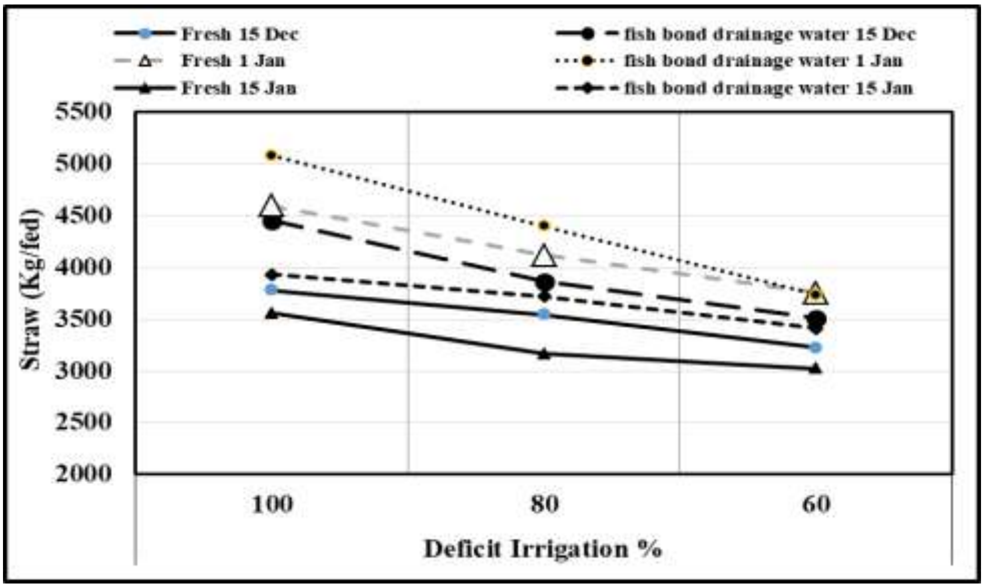

Fig. (5): Straw seed with deficit irrigation using fresh andbrackish water for different planting dates

Harvest Index

Figure (6) shows the comparison of harvest index between fresh water and brackish water with water deficit and different planting dates. The results indicated that the highest values for harvest index were when using fish water compared to fresh water. For water deficit, the highest values were when using a water deficit of 1000% and the lowest value was when using 60% of the irrigation water both in fish drainage and freshwater. For planting dates, the highest harvest index values were January 15 and the lowest value was on January 1, in fresh water. Also, the obtained data indicated that the harvest index was significant with fish water compared to fresh water.

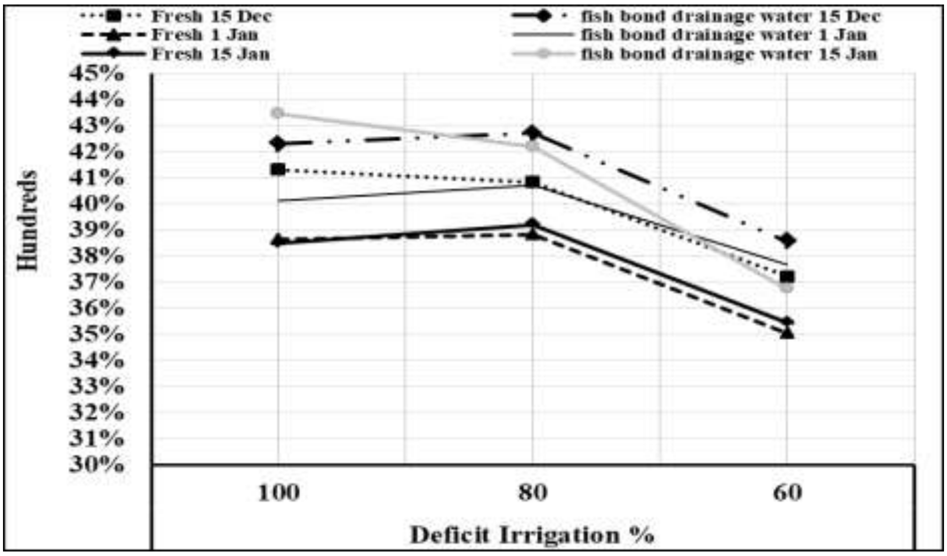

Fig. (6): Harvest Index with deficit irrigation using fresh and brackish water for different planting dates

Water Use Efficiency

Table (7) shows that the average water use efficiency when using fresh were 1.28, 1.46 and 1.53 kg/m^3 when using water deficit 100%, 80% and 60% respectively. The average efficiency of water use when using brackish water was 1.48, 1.65 and 1.64 kg/m^3 when using water deficit 100%, 80% and 60%, respectively. Also, mean average water use efficiency when using fresh water were 1.4, 1.6 and 1.3 kg/m^3 in planting dates 15 December, 1 January and 15 January, respectively. The average efficiency of water use when using brackish water was 1.5, 1.7 and 1.6 kg/m^3 when using no water deficit in planting dates 15 December, 1 January and 15 January, respectively.

Table (7): Water use efficiency with deficit irrigation using fresh andbrackish water

	Fresh Water						Brackish Water					
	Deficit Irrigation			Planting Date			Deficit Irrigation			Planting Date		
	100 %	80 %	60 %	15 Dec.	1 Jan.	15 Jan.	100 %	80 %	60 %	15 Dec.	1 Jan.	15 Jan.
WUE (Kg/m^3)	1.28	1.46	1.53	1.4	1.6	1.3	1.487	1.653	1.647	1.5	1.7	1.6

Figure (7) shows the comparison of water use efficiency between fresh water and brackish water with water deficit and different planting dates. The results indicated that the highest values for water use efficiency were when using fish water compared to fresh water. For water deficit, the highest values were when using a water deficit of 80% and the lowest value was when using 100% of the irrigation water both in fish drainage and freshwater. For planting dates, the highest water use efficiency values were January 1 and January 15 and the lowest value was on December 15, both in fish drainage and fresh water. The highest values of water use efficiency were 1.74 kg/m^3 at 80% water deficit at 1 January planting time usingbrackish water and 1.73 kg/m^3 at 60% water deficit at 1 January planting time usingbrackish water and the lowest value was 1.15 kg/m^3 at 100% irrigation on December 15 using fresh water.

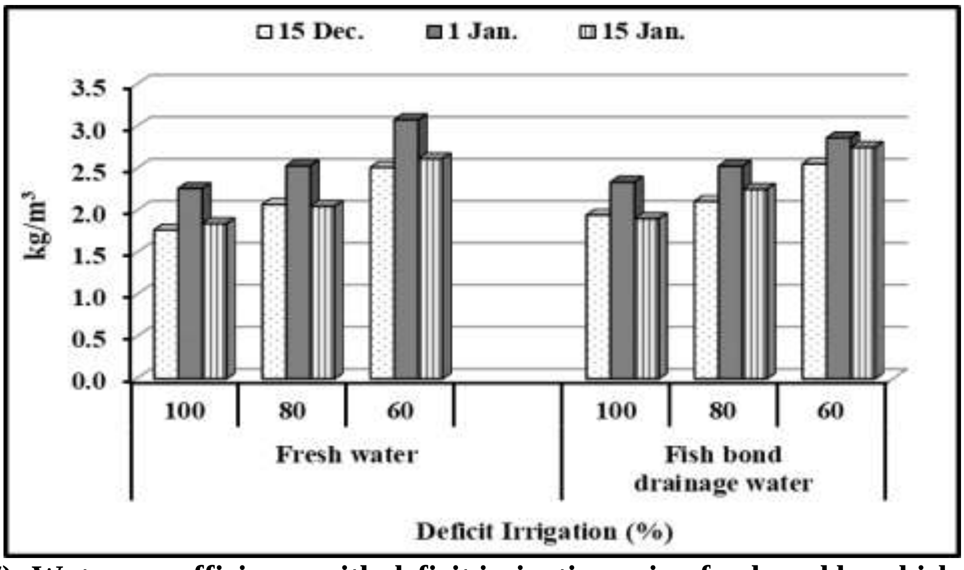

Fig. (7): Water use efficiency with deficit irrigation using fresh and brackish water.

Net return

From Figure (8), results could be summarized as follows:

- The highest net return occurred when brackish water was used compared with fresh water at the date of planting of January 1 using 100% of irrigation water.
- The lowest net yield was at the planting date of January 15 with 60% of the water deficit using freshwater and brackish water.
- The highest net return is about LE 16020/fed. followed by 14249 LE/fed. and 13457 LE/fed.using the water of fish bond drainage at 100% of the irrigation water at planting date of 1 January, 15 December and 15 January respectively, and the net return of about 6501 LE/fed.using fresh water at 60% of irrigated water in January 15.
- The average net return using brackish water was about 11950 LE/fed.while the net return when using fresh water was about 9150 LE/fed.

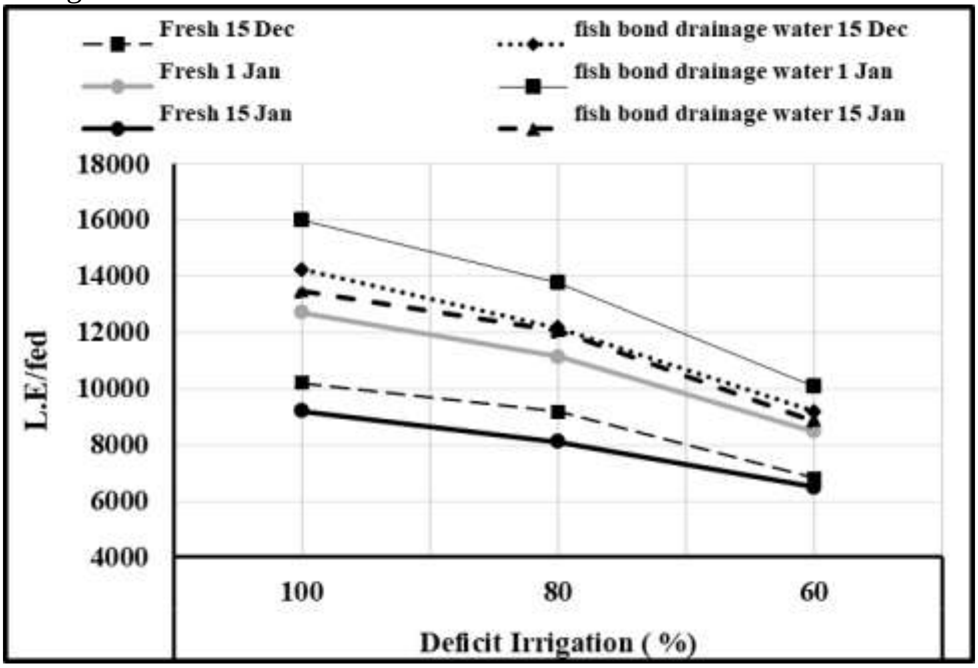

Fig. (8): Net return with deficit irrigation using fresh, and brackish water for different planting dates

Water Productivity

Table (8) shows that the average water productivity when using fresh water was 5.27, 5.84 and 5.97 LE/m^3 when using water deficit 100%, 80% and 60% respectively, and the average water productivity when using the drainage water of fish bond was 6.71, 7.30 and 7.20 LE/m^3 using water deficit of 100%, 80% and 60%, respectively.Also, the average water productivity when using fresh water was 5.16, 6.70 and 5.22 LE/m^3 in the planting dates of December 15, January 1 and January 15 respectively, and the average water productivity when using the drainage water of fish bonds was 6.53, 5.16 and 6.99 LE/m^3 when using 100% water in agriculture dates 15 December, 1 January and 15 January, respectively.

Table (8): Water productivity with deficit irrigation using fresh, andbrackish water

	Fresh Water						Fish Bond Drainage Water					
	Deficit Irrigation			Planting Date			Deficit Irrigation			Planting Date		
	100 %	80 %	60 %	15 Dec.	1 Jan.	15 Jan.	100 %	80 %	60 %	15 Dec.	1 Jan.	15 Jan.
W.P (L.E/m^3)	5.27	5.84	5.97	5.16	6.70	5.22	6.71	7.30	7.20	6.53	5.16	6.99

Figure (9) shows the results of water productivity using freshwater compared to brackish water with water deficit and different planting dates. The results can be summarized as follows:

- The highest values for water productivity were when fish water was used compared to fresh water.
- For water deficit, the highest values were when using water deficit 80% and the lowest value was when using 100% of the irrigation water in fresh water.
- The highest values for water productivity were 7.94 LE/m^3 and 7.75 LE/m^3 usingbrackish water at the planting date of January 1 at 80% and 60% water deficit respectively and the lowest value was 4.79 LE/m^3 using 100% fresh water at irrigation time 15 December.

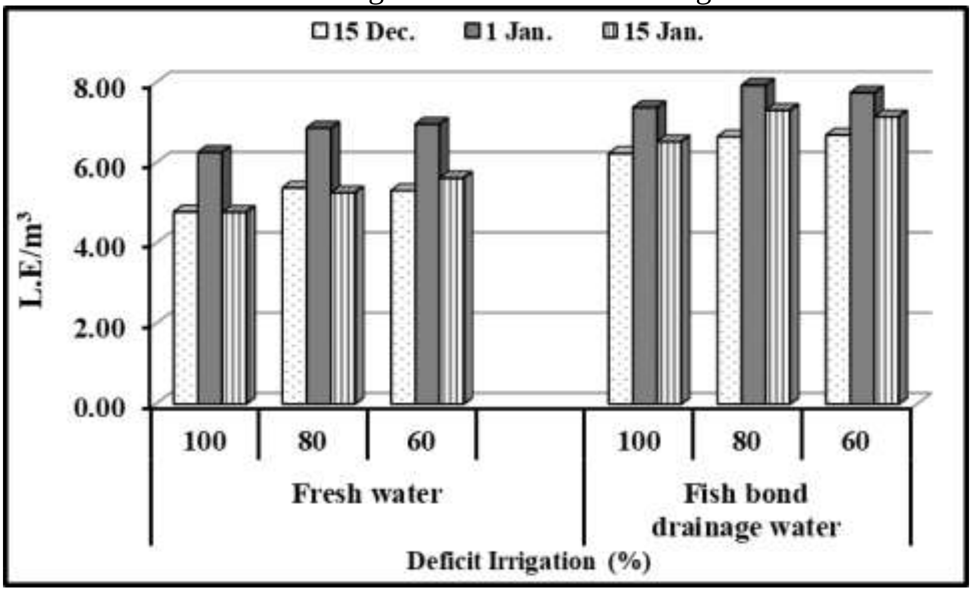

Fig. (9): Water productivity with deficit irrigation using fresh and brackish water

Conclusions

- Soil salinity decreased from 1.55 dS/m before planting to 1.33dS/m after harvest whenbrackish water was used, while soil salinity after fresh water use was 1.23 dS/m.
- Nitrogen values increased in soil from 177 kg/fed before planting to 253 kg/fed after planting when usingbrackish water compared to 180 kg/fed after planting when using fresh water.
- Potassium oxide increased from 1321 kg/fed before planting to 2254 kg/fed after planting usingbrackish water, whereas in the case of freshwater the value of potassium oxide was 1350 kg/fed.
- The highest value of irrigation water quantity usingbrackish water was 2285 m^3/fed at planting date of 15 December to add leaching needs. The highest irrigation water quantity using fresh water at planting date of 15 December was 2135 m^3/fed at 100% of irrigation water, while the lowest value for the quantity of irrigation water using fresh water at 60% deficit was 1156 m^3/fed at the planting date of January 15, and the lowest quantity of irrigation water usingbrackish water was 1237 m^3/fed in 60% deficit and at the planting date of 15 January due to the low number of irrigation times.
- The highest water use efficiency achieved at 80% irrigation water deficit, then at 60% and 100% respectively using both fresh andbrackish water. In the meantime, average water use efficiency was 1.28, 1.46 and 1.53 kg/m^3 when using 100%, 80% and 60%, respectively, with a yield reduction of 10% and 38% for the use of water 80% and 60% respectively compared to 100%. The average efficiency of water use when usingbrackish water was 1.48, 1.65 and 1.64 kg/m^3 when using 100%, 80% and 60% irrigation deficit

respectively with a decrease in yield of 13%, 51% for the use of fresh water 80% and 60% respectively compared to 100%.

- The highest net return was 16020, 14249 and 13457 LE/fed.usingbrackish water at 100% of the irrigation water in planting dates of 1 January, 15 December and 15 January respectively, and the net return of about 6501 LE/fed. using fresh water at 60% of irrigated water at planting date of January 15.

Recommendations

- The use of brackish water as an additional source of water for aquaculture production is highly recommended as it gives high production rates in addition to the reduction of fertility costs and enhancing the soil characteristics.
- When using the water for aquaculture, two filter stages (sand and screen) must be set to overcome clogging problems.

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إمكانيه استخدام المياه الجوفية الشبه مالحه في أنظمة الزراعة المائية المتكاملة

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المستخلص

نظراً لما تعانى منه مصر من ندرة في مورد المياه ومع التوسع في إنشاء المزارع السمكية للحصول على البروتين الحيواني اللازم لمواجهة الزيادة السكانية والتى تعتمد فى الأساس على المياه مما يعد إهداراً لمورد المياه إذا لم يتم استخدامها في زراعة المحاصيل الزراعية للاستفادة بها مرة أخرى بالإضافة إلى الاستفادة مما بها من مخلفات الأسماك كسماد حيوي لمواجهة ارتفاع أسعار الأسمدة الكيماوية والتخلص من المتبقيات الكيماوية فى التربة والمحصول الناتجة عن استخدام الأسمدة الكيماوية لإنتاج هذه المحاصيل خاصة مع التوسع فى استخدام الأسمدة الكيماوية للأرض الزراعية وما ترتب عليه من زيادة للمتبقيات الضارة فى الأرض الزراعية مما يؤدى لانخفاض رتب الأراضى الزراعية وبالتالى انخفاض إنتاجيتها فضلاً عن انتشار الأمراض الضارة التى تصيب الإنسان والحيوان نتيجة لذلك بالإضافة إلى زيادة أسعار الأسمدة الكيماوية وبالتالى زيادة تكاليف إنتاج المحاصيل وانخفاض العائد الزراعى من إنتاج هذه المحاصيل الزراعية من جهة أخرى.

وكان الهدف الرئيسي للبحث 'مكانية إستخدام ناتج مزارع الإستزراع السمكى فى الرى والتسميد. وقد تم دراسة عدة معاملات فى التجربة منها نوعيات مختلفة من المياه (ناتج الاستزراع السمكى – مياه عذبه) ، مواعيد زراعة مختلفة (15 ديسمبر- 1 يناير – 15 يناير) ومستويات رى مختلفة (100 – 80-60% من كمية مياه الرى المضافه) وتاثر ذلك على كلا من الإنتاجية ، كفاءة إستخدام المياه ، العائد الإقتصادى.

وقد اوضحت النتائج ان أعلى قيمة لكمية مياه الري المستخده تحت نوعيات الرى المختلفة (المياه الشبه المالحة 2285 م^3/ فدان والمياه العذبة 2135 م^3/فدان عند ميعاد زراعة 15 ديسمبر وإضافة 100 ٪ من كميات الرى المطلوبة. بينما كانت اقل كمية باستخدام المياه المالحة 1237م^3/ فدان والمياه العذبة 1156م^3/ فدان عند نقص المياه إلى 60 ٪ من كمية مياه الرى المضافةوميعاد زراعة 15 يناير. وكانت أعلى قيم لكفاءة استخدام المياه عند استخدام الشبه مالحه (حوض السمك) مقارنة بالمياه العذبة. وكانت أعلى القيم عند استخدام كمية مياه رى 80٪ وكانت أقل قيمة عند استخدام 100٪ من مياه الري في عند كلا نوعى مياه الرى.بالنسبة لتواريخ الزراعة ، كانت أعلى قيم لكفاءة استخدام المياه هي 1 يناير و 15 يناير وأقل قيمة كانت في 15 ديسمبر تحت كلا النوعين من مياه الرى. بـلغت قيمة أعلى عائد حوالي 16020 جنيه/فدان تليها 14249 جنيه/فدان و 13457 جنيه/فدان باستخدام مياه الإستزراع السمكى عند الرى بنسبة 100 ٪ من مياه الري في تاريخ الزراعة 1 يناير و 15 ديسمبر و 15 يناير على التوالي . ويوصى الباحثون باستخدام المياه الشبه مالحة كمصدر إضافي للمياه لإنتاج الاستزراع المائي لأنه يوفر معدلات إنتاج مرتفعة بالإضافة إلى خفض تكاليف ال تسميد وتحسين خصائص التربة.