ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Integrated Management for Drainage Water of Fish Ponds in Agriculture Using Sprinkler Irrigation System

Okasha E.M.[1], A. Ramadan[1*], M.A. El-Shawadfy[1] and H.H.H. Tarabye[2]

[1] Water Relations & Field Irrigation Department, National Research Centre, Egypt.
[2] Agricultural Engineering Department, Faculty of Agriculture and Natural Resources, Aswan University

ABSTRACT

One of the alternative solutions via traditional or non traditional resources such as reusing the drainage water of fish Ponds “DWFP”. Two field experiments were carried out during growing seasons 2014 and 2015, it was executed in research farm of National Research Centre, El-Nubaria Province, El- Behira Governorate, Egypt. The aim of this study is maximize utilization from drainage water of fish ponds in irrigation of crop, through the study of the effect of irrigation using two types of water (drainage water from fish ponds "DWFP" and traditional irrigation water “TIW”) and fertilization rates "FR" (40%, 60%, 80%, and 100% from recommended dose of N) on soybean growth parameters , seed Yield, harvest index "HI", water productivity "WP ", oil content and protein content. Statistical analysis of the results indicated that, the highest values of seed yield (3.88 ton ha-1), HI, WP, oil (19.89%) and protein content (35.63%) of soybean were achieved under DWFP. Also, the highest values of dry weight/plant, leaves area/plant and chlorophyll content (%), were obtained by using drainage water from fish ponds compare with traditional irrigation water. Effect of interaction between DWFP and FR100% N recorded the highest significant values of seed yield (4.43 ton ha-1), WP, oil content (22.52%) and protein content (39.96%). It could be concluded that under the conditions of the experiment or any other similar conditions irrigation using drainage water of fish ponds are recommended as a new source for irrigation due to their superiority in seed yield/ fed. with higher water productivity (WP) as well as will save 100% from traditional irrigation water and save 20% from minerals fertilizer of nitrogen under sprinkler irrigation system and consequently higher net profits/ fed.

Keyword: Drainage water of fish ponds, fertilization rates, soybean crop, Water Productivity (WP), sprinkler irrigation system.

***Corresponding author:** abdelrouf2000@yahoo.com*

ISSN: 0975-8585

INTRODUCTION

Water resources in Egypt are limited as the main source is the Nile River (55.5 billion m3) and 80% of the all resources consumed in agriculture. Therefore, it is imperative reuse wastewater as one of the requirements of water resources planning. In the more arid areas of the world, wastewater is used in agriculture, releasing high quality water supplies for potable use. Frequent pollution of aquatic systems even at small levels of pollutants causes biochemical dysfunctions and damages to fish **[1].** This diverted attention to fish farming. However, recycling the drainage water (DW) of fish farming, rich with organic matter for agriculture use can improve soil quality and crops productivity **[2],** reduce the total costs since it decreases the fertilizers use, which demand became affected by the prices and the framer's education **[3].** Meanwhile, organic matter content supports the cation exchange process in soils, which is important to the nutrition of plants **[4]. [5] and [6].** Study the effect of irrigation systems, fertilization rates and using the wastewater of fish Ponds in irrigation of potato crop under irrigation systems (sprinkler irrigation system "SIS" and trickle irrigation system "TIS), water quality (traditional irrigation water "TIW" and wastewater of fish Ponds "WWFP") and fertilization rates "FR" (20%, 40%, 60%, 80% and 100% from recommended dose from NPK). The results showed that maximum values of yield were obtained under SIS x $FR_{100\%\ NPK}$ x WWFF, also indicated that, there were no significant differences for yield values under the following conditions: SIS x $FR_{100\%\ NPK}$ x WWFP > SIS x $FR_{80\%\ NPK}$ x WWFP > SIS x $FR_{60\%\ NPK}$ x WWFP > TIS x $FR_{100\%\ NPK}$ x TIW this means that, using wastewater of fish Ponds in the irrigation can save at least 40% from mineral fertilizers and 100% from irrigation water under sprinkler irrigation system. They mentioned also, Clogging ratio was increased under trickle irrigation system more than sprinkler irrigation system. Yield of potato was decreased under WIT more than WWFP this may be due to increasing of bio-components in WWFP than in WIT. This research compared the output parameters of DW of tilapia (DWT) and DW of catfish (DWC) and DW of catfish reared on recycled DW of tilapia (DWTC). The research aimed to come out a better irrigation water quality that would enhance soil properties, secure water resources sustainability and provide additional food security. Fish feed provides most of the nutrients required for plant growth. Dissolved nitrogen, in particular, can occur at very high levels in recirculating systems. Fish excrete waste nitrogen, in the form of ammonia, directly into the water through their gills. Having a secondary plant crop that receives most of its required nutrients at no cost improves a system's profit potential.

From the above mentioned criteria, the present work aimed to study and identify the following:

1. Study the effect of irrigation using two types of water (drainage water from fish ponds "DWFP" and traditional irrigation water "TIW") to irrigate soybean plants under limitation of water resources conditions in Egypt.
2. Select the appropriate fertilization rate under irrigation using types of water.

MATERIALS AND METHODS

1. Site description:

Two field experiments were conducted along two successive summer seasons of 2014 and 2015 at the Experimental Farm of National Research Center, El-Nubaria, Egypt. The experimental area has an arid climate with cool winters and hot dry summers prevailing in the experimental area. The data of maximum and minimum temperature, relative humidity, and wind speed were obtained from "Central Laboratory for Agricultural Climate (CLAC)". There was no rainfall that could be taken into consideration through the two seasons, because the amount was very little and the duration didn't exceed few minutes as shown in fig. (1).

2. Seasonal irrigation waterrequirements for soybean plants:

The amount of irrigation water requirements for soybean crop were calculated according to local weather station of meteorological data, which located near NUBARIA that affiliated to the Central Laboratory for Agricultural Climate (C.L.A.C), where water consumptive use (mm/day) was calculated according to the climate data using the Penman-Monteith method described by **[7]**. The seasonal irrigation water applied was found to be 6086 m3/ha/season under sprinkler irrigation system. In previous published paper under title reuse of drainage water of fish ponds in soybean cultivation under sprinkler irrigation system **[8]** there was a mistake in the irrigation method by drainage water of fish ponds where that some leaves of cultivated plants were burnt because of the high concentration of ammonia in these water but in this study the plants were irrigated by the same kind of water with using different method to avoid the previous mistake. Plants were

ISSN: 0975-8585

irrigated for 10 minutes by using fresh water and then irrigated by using drainage water of fish water and at the end of irrigation time the plants were irrigated for 10 minutes by using fresh water again.

3. Soil properties and irrigation water analysis:

Soil properties (physical and chemical) and irrigation water analysis of experimental site at El-Nubaria farm were determined at the beginning of the experiment and are presented in Tables (1, 2 and 3).

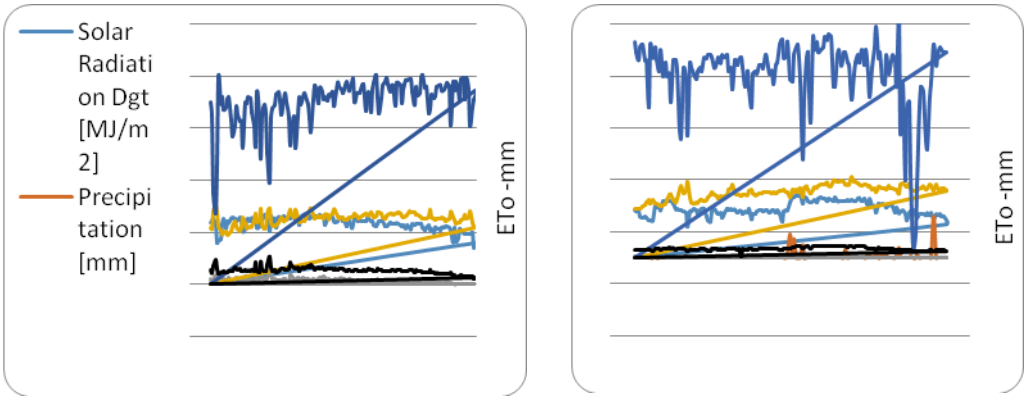

Fig. (1) Monthly climatic data for the two growing seasons 2014 and 2015

Table (1): Physical and hydro-physical properties of soil

Physical properties					
Depth (cm)	**Sand (%)**		**Clay and Silt (%)**	**Textural Class**	
	Fine	**Coarse**			
0 – 20	49.86	47.66	2.48	Sandy	
20 – 40	39.58	56.70	3.72		
40 – 60	59.43	36.76	3.81		
Hydro-Physical Properties					
Depth (cm)	**FC (%)**	**WP (%)**	**AW (%)**	**HC (cmh^{-1})**	**SP** (%)
0 – 20	11.1	4.7	6.4	23.5	25.0
20 – 40	12.5	4.6	7.9	21.0	23.0
40 – 60	11.5	4.6	6.9	24.0	24.0
F.C.: Field capacity P.W.P: Permanent wilting point AW: Available water HC: Hydraulic conductivity B.D.: Bulk density					

Table (2): Chemical analysis of the soil

	Chemical properties			
Depth (cm)	**Organic Matter (%)**	**pH (1:2.5)**	**EC (dSm^{-1})**	**CaCO3 %**
0 – 20	0.75	8.4	0.37	7.01
20 – 40	0.50	8.4	0.30	2.33
40 – 60	0.35	9.3	0.41	4.58

ISSN: 0975-8585

Table (3): Some chemical characteristics of traditional irrigation water

pH	EC (dSm^{-1})	Cations and anions (meq/L)								SAR %
		Cations				Anions				
		Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	CO^{-}_3	HCO^{-}_3	Cl^{-}	$SO^{=}_2$	
7.36	0.46	1	0.5	2.4	0.2	--	0.1	2.7	1.3	2.8

4. Determine the total amount of drainage water of fish Ponds per season

To estimate the total outflows of drainage water from fish ponds in El-Nubaria station, the volume of water discharged per week must be measured. Where there are 12 basins were used to breed fish and the dimensions of each basin are 5x5x2 m, but the depth of the actual exchange is 1.5 m and therefore the size of the outgoing water per week = 5x5x1.5mx12 basins = 450 m^3/week of drainage water from fish pond as shown in fig. (2).

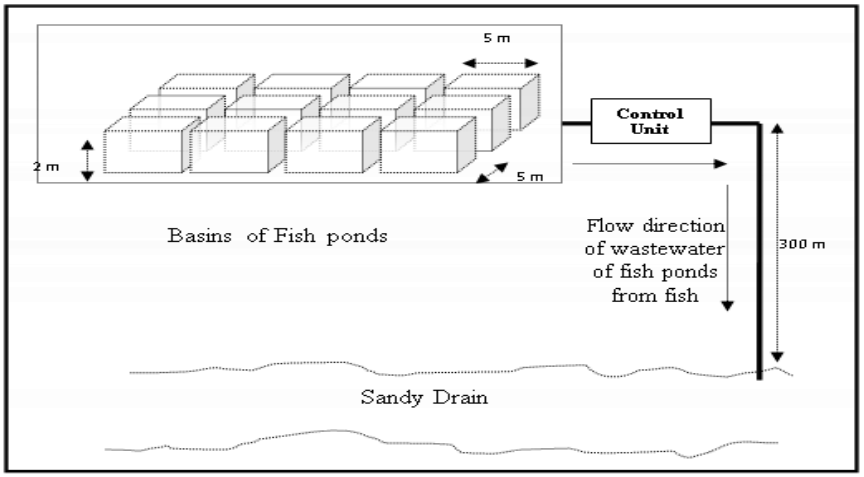

Fig.2. Loss of wastewater of fish ponds

5. Characteristics of chemical and biological for drainage water of fish Ponds:

Samples of drainage water of fish pond were taken at the outlet of basin which used for fish breeding and production. Chemical characteristics of drainage water of fish pond such as: EC, pH, Cr, Cu, Ni, Zn, N, P, K and Na were measured according to **[9].**

Biological characteristics of drainage water of fish ponds such as:

(1) Total viable count of bacteria: TVCB was determined using the standard plate count method and nutrient agar culture medium according to **[9].**
(2) Total count of fungi: was determined using the standard plate count method and Rose-bengal agar culture medium according to **[10].**
(3) Faecal coliform bacteria were counted using MacConky broth **[11]** and most probable number method **[12].**
(4) Total counts of free N2 fixers using Ashby's medium (Kizilkaya, 2009).
(5) Algae enumeration: The grouping of green algae and blue-green algae were accomplished and counted depending on morphological shape under light microscope using the Sedgwick-Rafter (S-R) cell count chamber according to **[9].**

Data mentioned in tables (4&5) illustrated the values of characteristics of chemical and biological for drainage water of fish ponds.

ISSN: 0975-8585

Table (4) Chemical determinations for drainage water of fish ponds

Chemical determinant	Value
EC	1.84 dsm^{-1}
pH	7.05
Cr	0.0 ppm
Cu	0.32 ppm
Ni	0.0 ppm
Zn	1.02 ppm
N	4.81 ppm
P	10.3 ppm
K	35.2 ppm
Na	200 ppm

Table (5) Biological determination of drainage water of fish ponds.

Biological determinant	Counts as CFU/ml
Total counts of bacteria	$1.5X10^4$
Total count of faecal coliform	$3X10^2$
Total counts of fungi	550
Total counts of free N_2 fixers	620
Green algae:	
Chlorella sp. Count	430
Scenedesmus sp. Count	170
Pediastrum sp. Count	150
Cyanobacteria:	
Oscillatoria sp. Count	106
Nostoc sp. Count	60

5. Measurements and calculations:

1) Growth parameters: Leaves area cm^2, dry weight/plant – g, Chlorophyll content %
2) Harvest Index- HI
3) Productivity- ton ha-1.
4) Oil content %
5) Protein content %
6) Water Productivity (WP):

Water productivity (WP) is an indicator of effectiveness use of irrigation unit for increasing crop yield. Water productivity of seed yield was calculated from Eqs. 1.

WP of seed yield (kg m^{-3}) = Total seed yield (kg ha^{-1})/Total applied irrigation water (m^3 ha^{-1}) (1)

6. Experiment components:

a. Sprinkler irrigation system: sprinkler irrigation network were Consisted of the follows:-

- Electrical centrifugal pump of 45 m^3 h^{-1} discharge with back flow prevention device.
- Pressure regulator, pressure gauges, flow-meter and control valves.
- PVC main pipe line of 110 mm diameter was used to convey and distribute irrigation water from the source to the main control points in the field.
- PVC pipe lines of 75 mm diameter connected to main line.

ISSN: 0975-8585

- P.E lines (Manifold lines) with 63 mm diameter were connected to sub – main lines through control valve and discharge gauge.
- Sprinkler is a metal impact sprinkler 3/4'' diameter with a discharge of 1.17 $m^3 h^{-1}$, with 100 cm of riser height and wetted radius of 12 m, and working pressure of 250 kPa.

b. Source of drainage water of fish Ponds collected from 12 basins with dimensions (5x5x2m).

7. Experimental Design:

The applied statistical design of the experiments used was split–plot with three replicates, where, types of irrigation water (drainage water of fish Ponds and traditional irrigation water), were assigned as main plots, and fertilizer rates were sub - main plots, respectively as presented in Fig. 4

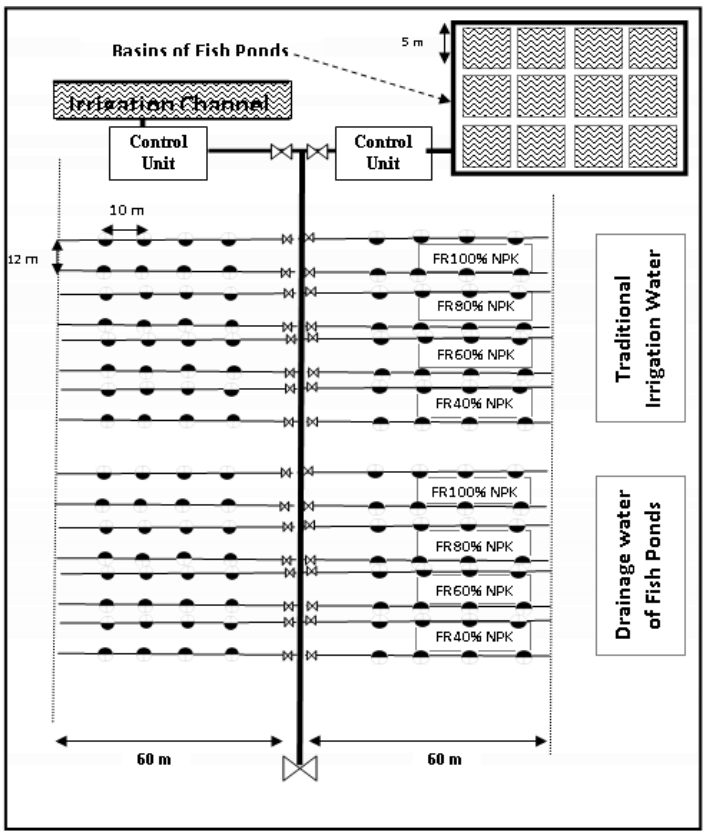

Fig. 4. Layout of experiment design

8. Fertilization program:

The used doses of fertilizer 300 kg/fed of calcium super phosphate monobasic 15% P_2O_5 were added during the seed bed preparation. Booster dose of ammonium sulphate (20 %N per fed.) and 50 kg of potassium per/fed (48 % K_2O) were added immediately before planting. Especially in the new lands adding 80 units nitrogen.

9. Statistical analysis:

Data were subjected to the proper statistical analysis according to the method prescribed by **[13].** Means were verified according to L.S.D. test at 5% level of significance.

ISSN: 0975-8585

RESULTS AND DISCUSSION

1. Effect the type of irrigation water on vegetative growth parameters of soybean:-

Effect of the type water; i.e. (traditional irrigation water and drainage water of fish Ponds) on vegetative growth parameters of soybean is shown in Table (6). Significant differences were detected regarding the dry weight/plant, leaves area/plant and chlorophyll content (%), where drainage water of fish Ponds showed significantly the highest values in dry weight/plant, leaves area/plant and chlorophyll content (%) compare with traditional irrigation water.

2. Effect of nitrogen fertigation rates on vegetative growth parameters of soybean:-

Data in Table (6) contain the effect of nitrogen fertigation rates ($FR_{100\%}$, $FR_{80\%}$, $FR_{60\%}$ and $FR_{40\%}$ of N) on vegetative growth parameters of soybean as average of the two seasons. Data in the aforementioned tables indicated clearly fertilization rates affected significantly soybean vegetative growth parameters; i. e. dry weight/plant, leaves area/plant and chlorophyll content (%). Generally, it could be safely concluded that fertigation soybean plants with 100% N led to obtaining the highest significant values of the aforementioned vegetative growth parameters followed by 80% N and 60% N, where the lowest values were recorded at 40% N.

3. Effect of interaction on vegetative growth parameters of soybean:-

Effect of interaction between the type of irrigation water and fertigation rates on vegetative growth parameters of soybean plants is presented in **Table (6)** as average of the two seasons.

Significant variation where shown in dry weight/plant, leaves area/plant and chlorophyll content (%), where the highest values were achieved by using 100% N under irrigation with drainage water of fish Ponds. While the lowest values were obtained from fertigation at 40% N under irrigation with traditional irrigation water in the same characters.

Table (6): Effect of the type of irrigation, nitrogen fertigation rates and interaction on vegetative growth parameters of soybean

Treatments	Dry weight/plant (g)	Leaves area/ plant (cm^2)	Chlorophyll content (%)
TIW	105.4 b	5189 b	34.11 b
DWFP	111.4 a	6138 a	40.81 a
LSD at α 0.05 level	**0.6758**	**46.36**	**0.5555**
$FR_{100\%N}$	113.8 a	6381 a	44.50 a
$FR_{80\%N}$	111.3 b	5990 b	39.53 b
$FR_{60\%N}$	107.8 c	5523 c	35.90 c
$FR_{40\%N}$	100.6 d	4760 d	29.91 d
LSD at α 0.05 level	**1.004**	**30.31**	**0.9929**
TIW x $FR_{100\%N}$	113.20 ab	6379 a	43.21 b
TIW x $FR_{80\%N}$	109.50 c	5598 b	35.32 d
TIW x $FR_{60\%N}$	103.00 e	4669 d	30.68 f
TIW x $FR_{40\%N}$	95.62 f	4108 e	27.24 g
DWFP x $FR_{100\%N}$	114.50 a	6382 a	45.79 a
DWFP x $FR_{80\%N}$	113.10 ab	6382 a	43.75 b
DWFP x $FR_{60\%N}$	112.60 b	6378 a	41.11 c
DWFP x $FR_{40\%N}$	105.60 d	5411 c	32.57 e
LSD at α 0.05 level	**1.420**	**42.86**	**1.404**

TIW: Traditional Irrigation Water**, DWFP:** Drainage Water of Fish Ponds**,**
FR: Fertigation Rate

ISSN: 0975-8585

4. Effect the type of irrigation water on harvest index, seed yield, seed quality and water productivity of soybean parameters:-

Data regarding the effect of type of irrigation water (traditional irrigation water and drainage water of fish Ponds) on yield and yield components parameters of soybean crop as average of the two seasons are presented in **Table (7)**. The results indicated that type of irrigation water had significant effects on all studied yield and yield components parameters. The highest values of harvest index, seed yield, water productivity **Fig.(4)**, oil content (%) and protein content (%) were observed when the plants of soybean were irrigated with drainage water of fish Ponds compare with traditional irrigation water.

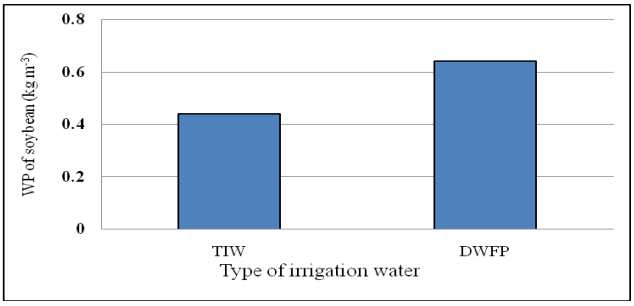

Fig.(4) Effect the type of irrigation water on water productivity of soybean

5. Effect of nitrogen fertigation rates on yield harvest index, seed yield, seed quality and water productivity of soybean parameters:-

Effect of nitrogen fertigation rates ; i.e.: 100%, 80%, 60% and 40% N rates on yield and yield components parameters of soybean is shown in **Figs (5)** as average of the two seasons.

It is clear from data that there are significant differences due to variation of fertigation rates in all studied parameters. Data showed that the highest values of harvest index, seed yield, water productivity, oil content (%) and protein content (%) were exhibited when the plants of soybean were fertilized with 100% N followed by using fertilization at 80% and 60% N, while the lowest values was obtained with using 40% N.

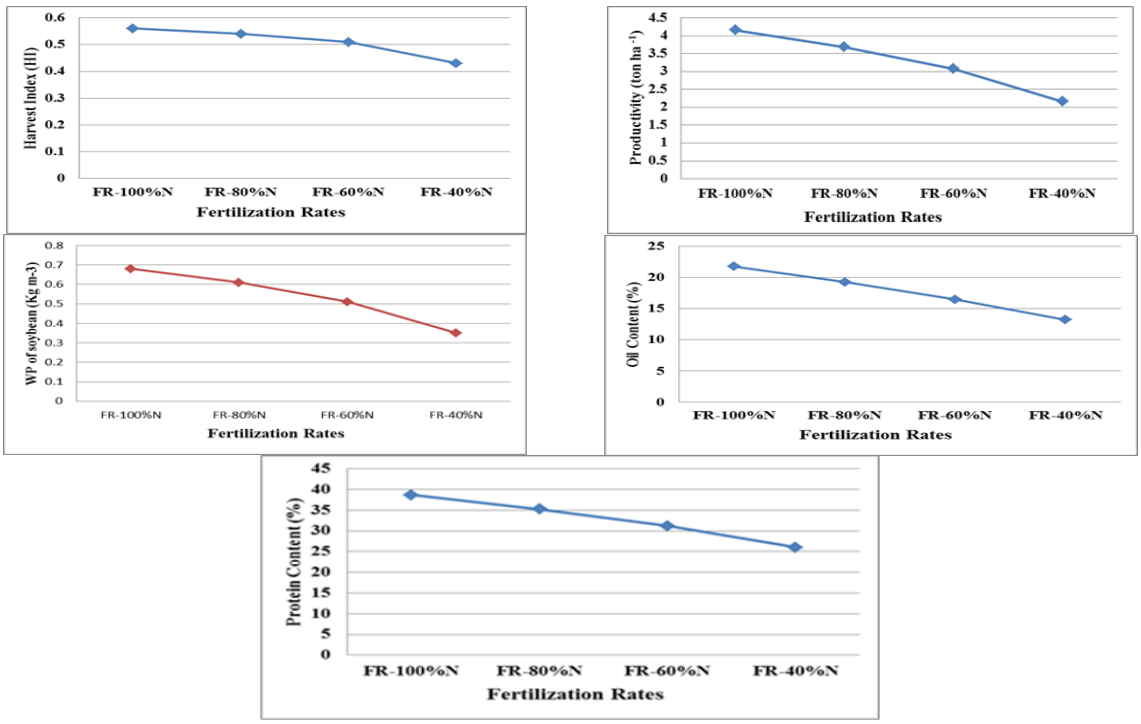

Fig. 5. Effect of fertilization rates on yield harvest index, seed yield, seed quality and water productivity of soybean

ISSN: 0975-8585

6. Effect of interaction on harvest index, seed yield, seed quality and water productivity of soybean parameters:-

Effect of interaction between the type of irrigation water and fertigation rates on yield and yield components parameters of soybean plants is presented in **Table (7)**, **Fig. (6) and Fig. (7).** It is worthy to mention that all studied yield parameters were significantly affected by the interaction as average of the two seasons except for harvest index. The highest values of seed yield, water productivity, oil content (%) and protein content (%) were achieved from interaction between drainage water of fish Ponds and 100% N. On the other hand, the interaction between traditional irrigation water and 40% N showed the lowest values with the same parameters.

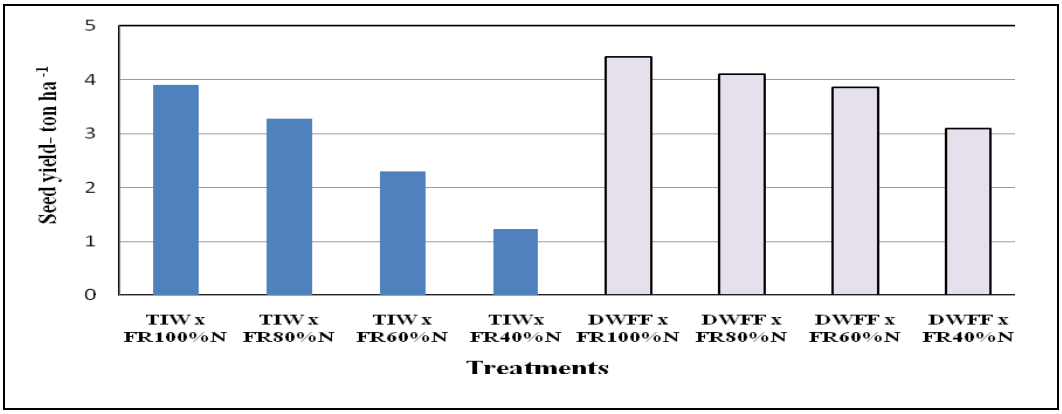

Fig.6. Effect of interaction on seed yield of soybean crop

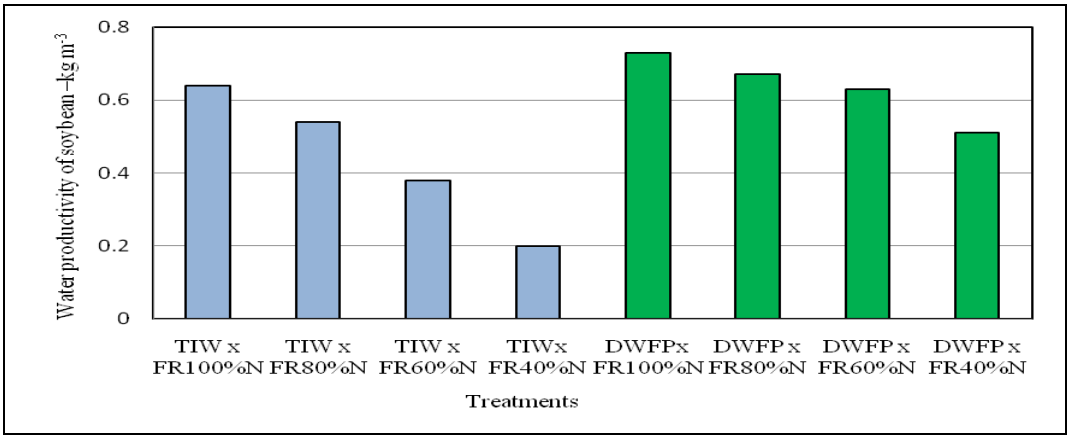

Fig.7. Effect of interaction on water productivity of soybean crop

Table (7): Effect of the type of irrigation water and interaction on harvest index, seed yield, and seed quality of soybean parameters

Treatments	Harvest Index (HI)	Seed yield (ton ha^{-1})	Oil content (%)	Protein content (%)
TIW	0.47 b	2.67 b	15.48 b	29.92 b
DWFP	0.55 a	3.88 a	19.89 a	35.63 a
LSD at α 0.05 level	**0.2664**	**11.19**	**0.1842**	**2.069**
TIW x $FR_{100\%N}$	0.52	3.90 c	21.00 ab	37.34 bc
TIW x $FR_{80\%N}$	0.50	3.27 d	16.85 c	32.43 d
TIW x $FR_{60\%N}$	0.47	2.30 e	12.94 d	26.29 f
TIW x $FR_{40\%N}$	0.39	1.22 f	11.14 e	23.62 g
DWFP x $FR_{100\%N}$	0.61	4.43 a	22.52 a	39.96 a
DWFP x $FR_{80\%N}$	0.58	4.10 b	21.69 a	38.09 b
DWFP x $FR_{60\%N}$	0.55	3.86 c	20.06 b	36.07 c
DWFP x $FR_{40\%N}$	0.46	3.10 d	15.29 c	28.39 e
LSD at α 0.05 level	**N.S**	**17.09**	**1.573**	**1.838**

TIW: Traditional Irrigation Water**, DWFP:** Drainage Water of Fish Ponds**,**
FR: Fertigation Rate

CONCLUSION

It could be concluded that under the conditions of the experiment or any other similar conditions irrigation using drainage water of fish ponds are recommended as a new source for irrigation due to their superiority in seed yield/ fed. with higher water productivity (WP) as well as will save 100% from traditional irrigation water and save 20% from minerals fertilizer of nitrogen under sprinkler irrigation system and consequently higher net profits/ fed.

REFERENCES

[1] Elnwishy, N., M. Ahmed, M. El-Shreif and M. AbdElhameed, (2007). The effect of diazinon on glutathine and acetylecholinesterase in tilapia (Oreochromisniloticus). J. Agric. Soc. Sci., 3: 52–4.

[2] Elnwishy, N., M. Salh and S. Zalat, (2006). Combating desertification through fish farming. The Future of Drylands Proceedings of the International Scientific Conference on Desertification and Drylands Research, Tunisia 19- 21, June UNESCO.

[3] Ebong, V. and M. Ebong, (2006). Demand for fertilizer technology by smallholder crop farmers for sustainable agricultural development in Akwa, Ibom state, Nigeria. Int. J. Agric. Biol., 8: 728–3.

[4] Altaf, U., N. Bhattihaq, G. Murtaz and M. Ali, (2000). Effect of pH and organic matter on monovalent - divalent cation exchange equilibria in medium textured soils. Int. J. Agric. Biol., 2: 1–2.

[5] James, E. R., Michael P. M. and Thomas M. L. (2006). Recirculating Aquaculture Tank Production Systems: Aquaponics—Integrating Fish and Plant Culture SRAC Publication No. 454.

[6] Abdelraouf, R. E.; E. Hoballah and El. A. M. Sahar. (2013). Sustainable Use of Wastewater of Fish Ponds in Potato Cultivation under Arid Regions Conditions. 3rd International conference of Agricultural & Bio-Engineering. Entitled “Engineering Application for Sustainable Agricultural Development”. 24 November, 2013. Conference Hall of the Egyptian International Center for Agriculture, Nadi El-Said St. Dokki- Giza-Egypt.

[7] FAO (1991). Localized irrigation. Irrigation and Drainage, Paper No. 36:144P.

[8] Abdelraouf, R.E., E. Hoballah, M. A. Horia (2014). Reuse of drainage water of fish ponds in soybean cultivation under sprinkler irrigation system. International Journal of Plant & Soil Science. 3(6): 644-658.

[9] APHA, (1998). Standard Methods for the Examination of Water and Wastewater, 20, Edition (American Public Health Association).

[10] Tsao, P.H. (1970). Selective media for isolation of pathogenic fungi. A. Rey. Phytopath. 8: 157-186.

[11] Atlas, R. (2005). Handbook Media for Environmental Microbiology. CRC Press, Taylor & Francis Group 6000 Broken Sound Parkway NW Boca Raton, FL 33487-2742.
[12] Munoz, F., E. and Silverman, M. P.(1979) Rapid, single-step most-probable-number method for enumerating fecal coliforms in effluents from sewage treatment plants. Appl. and Environ. Microbiol. 37(3) 527-530.
[13] Snedecor, G.w. and Cochran, W.G. (1982)." Statistical methods". 7th ed., Iowa State Univ. Press, Towa, U.S.A., 511 pp.