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Increasing Water Use Efficiency for Potato Under Different Irrigation Systems and Potassium Fertilizer Rates

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ABSTRACT

Two field trials were carried out through 2019 and 2020 seasons to evaluate irrigation systems outcome and potassium fertilization rates on water efficiencies, productivity, water-saving and financial return for potato crop (*Solanum tuberosum* L.) cv.“Sponta’’. Eight transactions, two of the irrigation systems (surface irrigation & gated pipes technique), and three different rates of potassium fertilization (48, 96, and 144 kg K_2O fad^{-1}.) beside without adding potassium fertilizer were set in a split-plot design. Results indicated that sowing potato and irrigating it by the gated pipes irrigation system and using 96 kg K_2O of the potassium fertilization leads to an increase in productivity by 27.85 %, more water-saving about 25.33 % per year, recorded the maximum productivity of irrigation water and water productivity (6.76 and 10.01 kg m^{-3}, respectively), and also the topmost values of income, production, and the net return of irrigation water. Therefore, the economics of irrigation water turns out to be very essential for implementing irrigation management projects where farmers' over-irrigation traditions generally lead to low irrigation efficiency, waterlogging, and water losses. Therefore, the study recommends using the gated pipes technique with 96 kg K_2O fad^{-1} under El Minia governorate circumstances and other corresponding conditions.

Keywords: Gated pipe, Potassium fertilization, Potato, Water saving, Water use efficiency

INTRODUCTION

Egypt is facing a steady growth in its population and in the meantime it suffering the stability of both agricultural areas and available water supply, this fact caused increasing in the food gap between production and consumption. Therefore, the governments are considering carrying out horizontal development programs to enhance new areas to the present agricultural areas, taking into consideration, its protection against random urban extensions. Also, it is giving its care to water resources development; it’s securing, increasing its usage efficiency, and maximizing its returns.

In the regions with a large population and limitation of fresh water, there is a significant stress on the agricultural part to reduce the consumption of inadequate freshwater for irrigation and the other sectors (Hozayn *et al*., 2016; Abdelraouf and Abuarab, 2012; Abdelraouf *et al*., 2020). In Egypt, the water budget is confined to the country's share of Nile water, which is fixed at 55.5 billion m^3 per year, in addition to minor quantities of rainfall in the coastal regions. So, although irrigation considers one of the most important cultural practices in vegetable crops production, it is necessary to ascertain to what extent the water is depleted in the root zone to produce high economic yield by using little water applied. Increasing the crop water productivity stays an important aim to decrease the gap of the demand increasing of population growth (Okasha *et al*., 2013; Abdelraouf and Ragab, 2018; Bakry *et al*., 2012 and Eid and Negm, 2019). Many methods improved for the surface irrigation performance, depending upon the main factors that matter to soil characteristics, leveling, and application method, (Hassan, 1998). So, working on new ways of conserving water through designing another technique of furrow irrigation, such as a gated pipes system.

The gated pipes technique is a capable practice in improving surface irrigation (the convenient irrigation method in Egypt) and is predictable as a more effective system of surface irrigation. Using the gate pipe system provided many benefits such as demonstrating applied water more evenly and more efficiently, provided controllable, consistent, and accurate delivery of the water right, (Smith *et al*., 1997), good uniform delivery of irrigation water, Low energy needed, high water saving, and added about 10 % cultivated lands, (El-Hadidi *et al*., 2011), and simply used by low experienced workers. Goyal, (2014) informed that the irrigation application efficiency could reach up to 81% for gated pipes.

Abo Soliman *et al*. (2008) stated that wheat and soybean grain yields were increased significantly with gated and concrete pipes and with shorter border length and width. Sonbol *et al.* (2010) found that the drip and the gated pipes irrigation systems achieved the maximum water distribution efficiency.

In a study carried by Shabana (2010) on using gated pipes as a substitute irrigation method for maize and sugar beet crops cultivation, and fertilizes with the recommended rates of nitrogen lead to effectual water and nitrogen use, and save additional irrigation water without considerable reduction yields especially. Also, the study by Ati *et al.* (2012) found that water use efficiency for improved irrigation methods increased from 5.13 to 7.34 kg m^{-3}, and from 6.91 to 10.26 kg m^{-3} for the furrow and drip irrigation

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treatments, respectively in comparison with the traditional surface irrigation.

On the further hand, one of the most vital factors disturbing the growth and yield of potatoes is fertilization, especially potassium fertilization. Several researchers verified an increase in potato tuber's yield resulting from using high scales of potassium (K) fertilization. Marketable tubers yield was significantly improved with increasing potassium sulfate rates, (Al-Moshileh and Errebi, 2004). Haile (2011) reported that the potassium application increased positively the tuber yield of potato (K) at 150 kg ha^{-1}. El-Sawy *et al*. (2000) stated that 50 or 100 kg K_2o fad^{-1} application to potato plants (Variety, Cara) significantly increased stem length, number of main stems, number of leaves per plant, and dry matter content, and were better than the other K levels (i.e., 0, 150 or 200 kg K2o fad^{-1}). Habib *et al*. (2011), and Jasim (2013) presented that foliar fertilizer had a significant effect on plant height, tuber weight, and yield. Abd El-Mottaleb (1987) showed that K slightly fertilization decreases water consumption used by sorghum plants, also, noticed that K application had no obvious effect on water use efficiency calculated, either on the dry matter, or grain productions.

Potato (*Solanum Trberosum L.*) was carefully chosen in this study for economic importance, and it is the foremost export vegetable crop and one of the cash crops in Egypt. One of the major production problems for potatoes is proper irrigation where potato plants are drought-sensitive and respondent to irrigation. healthy and quality crops require not only accurate crop water to get the optimum water use efficiency but also non-excessive use of fertilizing usually and potassium fertilization in particular. So, the study aims to evaluate the outcome of the irrigation system and potassium fertilization on yield, water and economic efficiencies.

MATERIALS AND METHODS

Experimental site Location and design

Two field experiments were conducted in 2019 and 2020 for the Autumn and the winter periods, at Mallawy water requirements research station, Water Management Research Institute (WMRI), National Water Research Center (NWRC) (27^{o} 9^{-} latitude, 30^{o} 5^{-} longitude, altitude is about 44 m above mean sea level), Minia Governorate, Egypt to evaluate effects of improved surface irrigation by gated pipes, and different potassium fertilization rates (in the form of potassium sulfate, 48 % K_2O) on the yield and water relations for the potato crop.

The experiments were set up in a split-plot design with four replications, where the two irrigation systems (surface irrigation and the improved surface irrigation by the gated pipes) were distributed in the main plots, and the three different rates of potassium fertilization (without potassium fertilization K_0, potassium fertilization at the rate of 48 (K_1), of 96 (K_2), and 144 (K_3) K_2O per fad) were randomly distributed in the sub-plots.

The experiment consists of 32 plots each plot was 64 m^2 included 10 ridges of 8 m in length and about 80 cm apart. The gated pipes are located at the head of the field canal across the furrows and connected directly with the water pump. Recommended phosphorus (38 kg P_2O_5) was applied in the form of calcium superphosphate, 15.5 % P_2O_5 during soil preparation before the cultivation, while nitrogen fertilizer (180 kg N per fad) was given in the form of ammonium nitrate (33.5 % N) and were applied twice with equal quantities at side-dressing at 45 and 60 days after planting. Other agronomic practices were done as recommended except for the irrigation treatments and potassium rates.

Experimental soil analysis

Before the soil preparation, soil samples were taken from different depths to estimate some physical and chemical properties of the experimental soil, (Jackson, 1985). bulk density, field capacity (FC, %), and the permanent wilting point (PWP) was determined by using the undistributed core samples, the field method, and the pressure cook apparatus, respectively (Klule, 1986). The available water (AW) was calculated as a difference between the F.C and PWP, Table 1.

Table 1. Mean of some physical and chemical soil properties before the sowing for the two growing seasons.

Physical properties

Depth (cm)	Particle size distribution (%) Sand	Silt	Clay	Soil texture class	Field capacity (%)	Wilting point (%)	Bulk density (g/cm^3)	AW (%)
0-15	13.20	31.56	55.24	Clayey	40.30	18.00	1.23	22.30
15-30	14.24	30.80	54.96		38.40	17.50	1.28	20.90
30-45	17.78	29.77	52.45		36.90	17.10	1.32	19.80
45-60	23.49	26.72	49.79		33.20	16.90	1.35	16.30

Chemical properties

Depth (cm)	EC (dS/m^{-1}) soil extract 1:5	pH (1:2.5 soil water suspension)	Soluble cations (meq/l) Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Soluble anions (meq/l) CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}	OM(%)
0-15	0.60	8.19	2.26	1.79	6.70	0.70	-	3.20	7.01	1.40	2.20
15-30	0.67	8.23	2.32	1.93	6.91	0.84	-	3.95	7.02	1.80	1.80
30-45	0.69	8.40	2.40	2.25	7.00	0.99	-	4.50	7.49	2.80	1.78
45-60	0.78	8.42	2.53	2.40	7.00	1.10	-	5.56	7.8	3.01	1.70

Studied water measurements

First of all, irrigation meters applied during every irrigation (Wa) were measured using cutthroat flume size (20*90 cm) for the surface irrigation system and was measured by the flowmeter for the improved surface irrigation (gated pipes), (Brater and King, 1976), gated pipes are PVC (6 inches diameter) and an orifice gated were separated with 80 cm spacing along the pipes and were directly linked with a water pump to deliver the water to the head of the furrows. The water was applied during each irrigation and the total amounts were estimated to be in m^3 fad^{-1} when the growing season ended, (Early, 1975).

Second, monthly and seasonal water consumption use for the 60 cm soil depth was calculated by the water consumed summation for the different successive irrigation through the whole growth season until the harvesting date (Serry *et al.*, 1980). Water consumptive use per fad (4200 m^2) can be gotten by equation 1 described by Israelsen and Hansen (1962).

Thirdly, the water productivity, (WP) and the productivity of irrigation water (PIW) were calculated according to equations 2 and 3, where the WP is the weight of marketable crop produced per the volume of water consumed by plants or the evapotranspiration quantity, (Abd El-Rasool *et al.*, 1971), and the PIW is the marketable crop produced per the volume unit of applied irrigation (Michael, 2009). Finally, Irrigation application efficiency (E_a) was obtained by dividing the water consumptive use on the applied irrigation water, equation 4, (Downy, 1970).

$$\mathbf{CU} = \frac{(\theta 2 - \theta 1)}{100} \times \mathbf{B.d} \times \mathbf{D} \times \mathbf{A} \ \ldots\ \text{Eq (1)}$$

$$\mathbf{Wp} = \frac{\text{Yield}}{\text{Cu}} \ \ldots\ \text{Eq (2)}$$

$$\mathbf{PIW} = \frac{\text{Yield}}{\text{Wa}} \ \ldots\ \text{Eq (3)}$$

$$\mathbf{Ea} = \frac{\text{Cu}}{\text{Wa}} \times 100 \ \ldots\ \text{Eq (4)}$$

Where: **CU, water consumptive use., θ_2, Soil moisture content % by weight after irrigation., θ_1, Soil moisture content % by weight before the next irrigation., B.d, Bulk density (g cm^{-3})., D, 0.6 m soil depth., A, fad area (4200 m^2), Wa, Water applied to the field plot (m^3 fad^{-1}).**

Economic impact statement

A crop enterprise budget is a system for presenting data about a specified enterprise on the costs of input resources (variable costs which include cash costs for purchased inputs like seeds, fertilizer, labor wages, machines…etc. and fixed costs such as land rent, taxes, and management charges, etc.) as well as on the value of output (yield production of potato), where the yield production includes the represented main product for potato crop (ton fad^{-1}), and the average market price for the potato yield (2200 L.E in Egypt, for the studied growing seasons).

In Egypt, water is provided without charge to the farmer but the estimation of return per unit of water added can be taken as an index to the relationship between water applied and the value of crop production (University of California (System). Cooperative Extension, 1978), equation 5 and 6

$$\textbf{Return per unit of water} = \frac{\text{Net profit (L.E/fad)}}{\text{Applied water (L.E/fad)}} \ \ldots\ \text{Eq (5)}$$

$$\textbf{Economic efficiency} = \frac{\text{Net profit (L.E/fad)}}{\text{Total costs (L.E/fad)}} \ \ldots\ \text{Eq (6)}$$

Statistical analysis

Data obtained from experimental treatments were subject to the analysis of variance and were compared using the L.S.D method according to Steel and Torrie (1980).

RESULTS AND DISCUSSION

Potato yield (ton fad^{-1})

The total yield is significantly affected by different irrigation systems and potassium fertilization. Results show that the gated pipes irrigation technique achieved better values of the potato yield (12.862 ton fad^{-1}) than the conventional irrigation system (11.738 ton fad^{-1}), and this might be due to that the pipes were a good alternative to irrigation canals, which increased the cultivated land instead of irrigation canals, and reduced the spread of weeds and diseases, (El-Hadidi *et al.,* 2011). On the other side, Potassium considers one of the important factors for increasing potato yield because it affects the activity of many enzymes, thus, accumulating carbohydrates in tubers. Referring to the study data, the highest mean value of yield was obtained from plants that were fertilized by the rate of 96 Kg k_2o per fad for each irrigation system in the two studied seasons, then slightly reduced when the potassium rate increased, these results may be attributed to the presence of a high concentration of K in soil and due to luxury consumption. Interactions between the two studied factors, data show that the highest values (14 ton fad^{-1}) were found from plants irrigated by gated pipes and fertilized with 96 kg K_2O per fad in the two studied seasons with a relative increase of 27.85 % of the yield in comparison with the control treatment (I_1K_0), Table 2.

Irrigation water applied and water-saving (m^3 fad^{-1}):

Water scarcity becoming an economic resource in many areas of the world. From the data obtained, it can notice that the surface irrigation system had the greatest amounts of applied water in comparison with the gated pipe irrigation method, therefore the water supplies under surface irrigation were 2772.95, 2586.87, 2532.51, and 2469.41 m^3 fad^{-1} for K_0, K_1, K_2, and K_3 respectively, while they were under the gated pipes 2200.45, 2091.08, 2070.55, and 2049.35 m^3 fad^{-1} for the same previous parameters, respectively. So, the lowest water applied value was obtained with the gated pipe irrigation and adding the potassium fertilizer 144 kg k_2o fad^{-1} (I_2K_3), whereas the uppermost value was obtained with the surface irrigation without adding the potassium fertilizer (I_1K_0), Table 2.

Table 2. Relative change of the yield (ton fad^{-1}, %), and quantity of water-saving (m^3 fad^{-1}, %) as affected by different treatments.

Treatments	Yield (ton fad^{-1})	Increase in the yield (Ton fad^{-1})	Increase in the yield (%)	Wa (m^3 fad^{-1})	Ws (m^3 fad^{-1})	Ws (%)
I_1K_0 (Control)	10.95	0.00	0.00	2772.95	0.00	0.00
I_1K_1	11.20	0.25	2.28	2586.87	186.08	6.71
I_1K_2	12.85	1.90	17.35	2532.51	240.44	8.67
I_1K_3	11.95	1.00	9.13	2469.41	303.54	10.95
Average (I_1)	11.74			2590.45	243.35	8.77
I_2K_0	11.60	0.65	5.94	2200.45	572.50	20.65
I_2K_1	12.75	1.80	16.44	2091.08	681.87	24.59
I_2K_2	14.00	3.05	27.85	2070.55	702.40	25.33
I_2K_3	13.00	2.05	18.72	2049.35	723.60	26.09
Average (I_2)	12.84			2102.86	670.09	24.16

For yiled, LSD 5 %: I, 0.225., K, 0.186., IK, 0.262., LSD 1 %: I, 0.413., K, 0.254., IK, 0.359.

It can conclude that the use of the gated pipes irrigation method in beds is more important for saving amounts of irrigation water estimated by (average 426.74 m^3 fad^{-1} about 15.40 %) than the conventional irrigation, also it was responsible for obtaining high productivity of potato. These results are in agreement with those obtained by Abo Soliman *et al.,* (2002) and Osman (2002), who mentioned that using gated pipes could save water amounts for a lot of crops such as maize, cotton, wheat, and rice by 16.94 % 29.64 %, 29.9 %, and 19.7 %, respectively compared with traditional (flooding) system, and this could be explained because that the use of a perforated pipe technique as a replacement for ditches for distributing the irrigation water over the entire field may improve conventional irrigation, avoid weed growth, avoid loss of productive land, avoid water losses by seepage and evaporation. These results reflex how much irrigation water can be saved to harvest the highest yield with the least possible water applied amounts, El-Sawy *et al*., (2000), and El Shobaky *et al*., (2002).

Actual water consumptive use (ET_a)

The mean of seasonal water consumptive use values were 43.35, 39.81, 38.21, and 37.39 cm for the surface irrigation system under the different potassium fertilizer rates of K_0, K_1, K_2, and K_3 respectively, while it was 35.68, 33.83, 33.49, and 32.54 cm for the gated pipes irrigation technique under previous parameters, respectively. So, the mean values of water consumption used for potatoes are found to be 39.69 and 33.89 cm for I_1 and I_2 respectively, and the water consumption use increases by using the surface irrigation system, while vice-versa by using the gated pipes technique, Fig 1.

Regarding the interactions treatments effects, data show that during both seasons, irrigation by the gated pipes and with potassium fertilization rate of 144 kg K_2O fad^{-1} (I_2K_3) gave the lowest value of actual water consumptive use (32.54 cm per season), whereas surface irrigation without fertilizing (I_1K_0) gave the highest value of actual water consumptive use (43.35 cm per season), Fig 1.

It could be concluded that seasonal water consumption use is reduced by increasing potassium rates in the two studied seasons, and this can be attributed to the more water retained in plant tissues to face the stress and the shortage of water, also stomata turgid cells keep it closed most of the time, accordingly the transpiration rate decreased, on the other side, K is well known to preserve plant tissues and regulate membrane permeability in the plant, therefore less water absorbed by plant roots, (Abdel-Mottaleb, 1987), (Khalak and Kumaraswang, 1996).

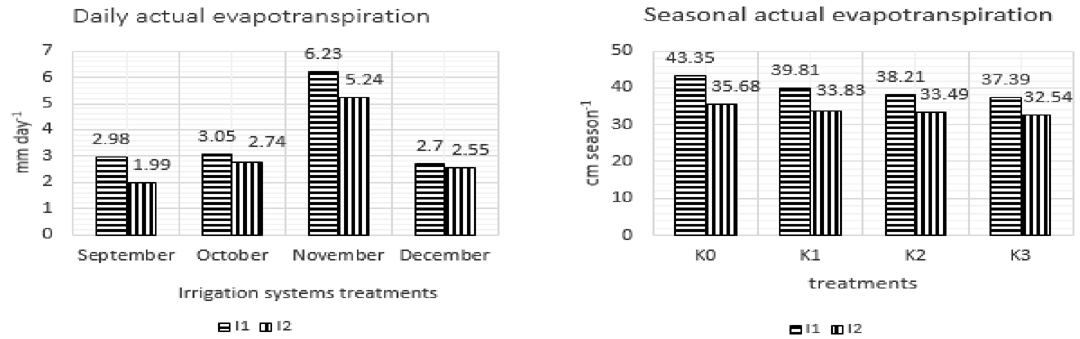

Fig. 1. Average daily and seasonal actual evapotranspiration (Eta, mm day^{-1}, and cm $season^{-1}$) respectively, for potato affected by irrigation systems throughout both seasons.

Water use efficiency (WUE):

The highest values of the water use efficiency (PIW and WP, 6.76 and 10.01 kg m^{-3} respectively) were attained with I_2K_2 (gated pipe with K rate of 96 K_2O fad^{-1}) respectively, and this is because the higher yields and decreased of water applied and water consumption, compared with the other fields. whilst the minimal values were found from surface irrigation and without potassium fertilizer adding (I_1K_0) (3.95 and 6.01 kg m^{-3}, for PIW and WP respectively), Fig 2.

Regarding the Potassium effect on crop water use efficiency, data in fig 3 show that as K rates increased the crop water use efficiency increased till reach the 96 kg K_2O fad^{-1}, which achieved the peak values obtained for the two systems of irrigation (the surface irrigation and the gated pipes irrigation), and the next rate for K followed by that (144 kg K_2O fad^{-1}) the values of the field and crop water use efficiency were decreased. Reverse data was obtained by Khalak and Kumaraswamy (1996) who found that the application of 150 Kg K_2O ha^{-1} gave the highest water use efficiency.

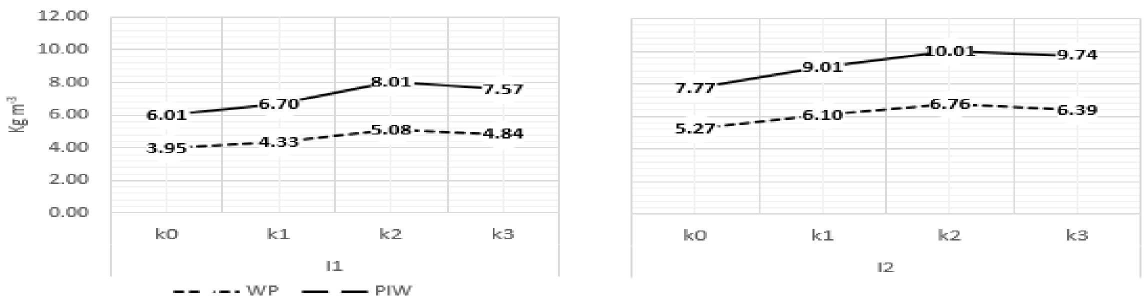

Fig. 2. water use efficiencies (PIW and WP) for different treatments in both seasons.

Irrigation application efficiencies:

The highest irrigation efficiency value (72.87 %) was obtained with the gated pipes irrigation technique and using a rate of 144 Kg K_2o fad^{-1} fertilizer (I_2K_3) while the lowest value (52.29 %) was obtained with the surface irrigation without adding any rates of potassium fertilizer (I_1K_0), these increases in irrigation efficiency for gated pipes irrigation technique than the conventional irrigation were mainly due to the enhancement of water stored within soil layers at high potassium rates, Tarafdar *et al* (1988), and Ething (1997), and the amounts of water applied which decreased for gated pipes than traditional surface irrigation systems, Abou El-Soud (2009), Fig 3.

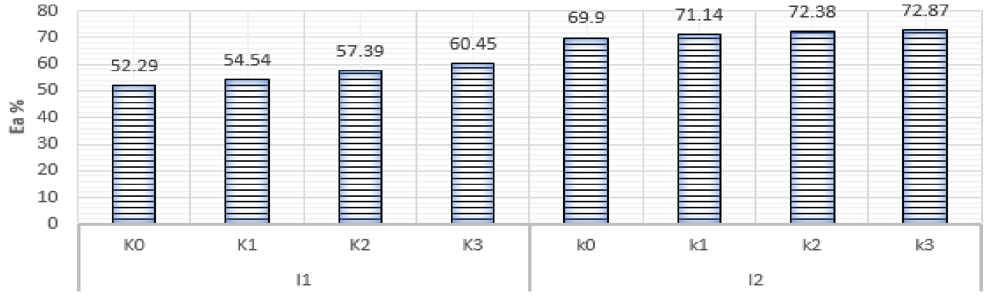

Fig. 3. Average (Ea) for potato as affected by irrigation and potassium fertilization treatments during the two studied seasons.

Distribution of moisture extraction in the root zone

The distribution of soil moisture extraction percentage in the upper 60 cm of soil depth is presented in Fig 4. Data revealed that under the two studied irrigation systems, Potato extracted a large amount of soil moisture for the surface top layers (0-30 cm) and decreased till reached the deeper soil layers (30-60), and most of the water consumed by potato roots is removed from the soil surface layer under different irrigation systems.

It could be concluded that the extraction pattern of soil moisture from the upper layers by potato roots with the gated pipes technique is slightly lower than that recorded with the surface irrigation system. From data obtained, it was observed that in the top layers (0-30 cm) of soil, whenever the rates of K increased the soil moisture content increased for the two studied irrigation systems I_1 and I_2, while in sub-layers (30-60 cm) of the soil whenever increased rates of K the moisture decreased. So, using the highest rates of potassium fertilizer led to more extracted water from the surface top layer, and less water extracted was for the deepest layers. vise versa, while using the lowest potassium fertilizer rates led to more water extraction for the deepest layer, and this means that the highest rates of potassium fertilizer increased water stored in the surface soil, therefore, the plants which were given high rates of potassium fertilizer were grown under wet soil conditions, (Tarafdar *et al.*, 1988) & (Khalak and Kumaraswmy, 1996).

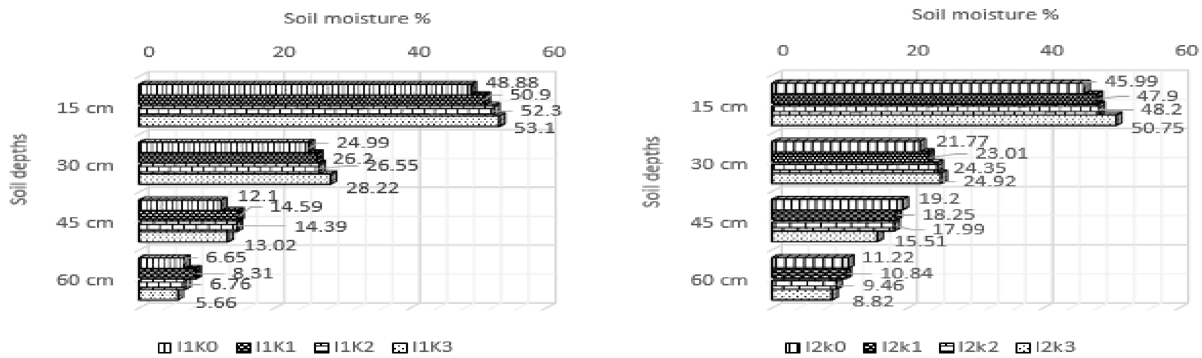

Fig. 4. Extract Moisture by potato plants from different soil depths as affected by irrigation treatments and the sub treatments K_0, K_1, K_2, and K_3 during the two studied seasons.

The Economic evaluation

The gated pipes irrigation technique with adding rate of potassium 96 kg k_2O per fad (I_2K_2) achieved the maximum values of total income, net profit, unit return from irrigation water applied and consumptive use, and economic efficiency. While, the lowest values of the previous parameters were obtained from surface irrigation without adding K fertilizer (I_1K_0), Table 3. The increase in economic efficiency for the gated pipes irrigation system and 96 kg k_2O potassium rate is may due to the enhancement of net profit in this treatment compare with other treatments. From these results, it could be concluded that treatment (I_2K_2) leads to an increase in total income, net profit, and the net return of water and economic efficiency.

Table 3. Average of the total cost production. total income (L.E) and net return per cubic meter of water (L.E m^{-3}) values for different studied treatments for both seasons.

Treatments		The total costs (L.E)	Yield (ton fad^{-1})	Total income	Net profit	Water issues (L.E m^{-3})		Economic efficiency
						Net return from unit water consumptive use	Net return from unit water applied	
I_1	K_0	17980	10.95	24090	6110	3.36	2.20	0.33
	K_1	18580	11.20	24640	6060	3.62	2.34	0.33
	K_2	19180	12.85	28270	9090	5.66	3.59	0.47
	K_3	19780	11.95	26290	6510	4.12	2.64	0.33
I_2	K_0	18130	11.60	25520	7390	4.95	3.36	0.41
	K_1	18730	12.75	28050	9320	6.58	4.46	0.50
	K_2	19330	14.00	30800	11470	8.20	5.54	0.59
	K_3	19930	13.00	2800	8670	6.44	4.23	0.55

CONCLUSION

whereas luxury irrigation normally lowers irrigation efficiency and increases water and fertilizer losses. Therefore, estimating the economy of irrigation water enhances irrigation water management planning. So, from economic and water points of view, the results showed that the gated pipes irrigation technique significantly affects crop production and water saving. Also, it could conclude that using gated pipes with fertilization by potassium at the rate of 96 kg K_2o resulted in increasing crop productivity by 27.85 %, reducing water use by about 25.33 % per year, and augmenting the efficiency of irrigation water by 72.38 %. Wide-ranging application of the gated pipe irrigation system coupled with appropriate fertilizer type would necessitate some funding by stakeholders. This could save water use and increase potato production.

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زيادة كفاءة استخدام المياه لمحصول البطاطس تحت نظم الري المختلفة و معدلات من التسميد البوتاسي

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معهد بحوث ادارة المياه – المركز القومى لبحوث المياه

تم إجراء تجربتين ميدانيتين في محطة بحوث ملوي بمحافظة المنيا، معهد بحوث إدارة المياه - المركز القومي لبحوث المياه – مصر، وذلك خلال موسمي 2019 و 2020 وذلك لتقييم تأثير أنظمة الري ومعدلات التسميد المختلفة بالبوتاسيوم على كفاءة استخدام المياه والمحصول وتوفير المياه والتقييم الاقتصادي لمحصول البطاطس (Solanum tuberosum L.) صنف "Sponta" . ثمانية معاملات كانت مرتبة في تصميم القطع المنشقة ، حيث رتبت إثنان من أنظمة الري (الري السطحي ونظام الأنابيب المبوبة) كمعاملات رئيسية، بينما معدلات تسميد البوتاسيوم المختلفة (ثلاثة معدلات 48، 96، 144 كجم من أكسيد البوتاسيوم رتبت كمعاملات شقيه. أشارت النتائج إلى أن زراعة محصول البطاطس تحت نظام الري بالأنابيب المبوبة وتسميدها بالبوتاسيوم بمعدل 96 كجم أدي إلى زيادة الإنتاجية بمعدل 27.85 ٪، ويزيد من توفير كميات المياه المضافة بنسبة 25.33 ٪ سنويًا. كما أنها توفر المياه بنحو 2873551840 مليون م 3 / مساحة (متوسط المساحة المزروعة بالبطاطس في مصر) وذلك بالمقارنة بالطريق التقليدية (المعاملات المقارنه) في هذه المنطقة. كما أشارت النتائج من الناحية الاقتصادية إلى أن نظام الري بالأنابيب ذات البوابات والتسميد البوتاسي بمعدل 96 كجم سجل أعلى قيم لكفاءة استخدام المياه الحقلية والمحصول (6.76 و 10.01 كجم / م 3) على الترتيب. كما أنها أدت إلي قيم أعلى للدخل الكلي والإنتاجية من الوحدة المائية والكفاءة الاقتصادية. ونظراً لممارسات الري المفرطه من قبل المزارعين عادة تؤدي إلى انخفاض كفاءة الري، وإهدار كميات كبيرة من مياه الري المستخدمة، لذلك توصي الدراسة بضرورة الاهتمام بتطبيق نظام الري بالأنابيب ذات البوابات والتسميد بالبوتاسيوم بمعدل 96 كجم للفدان وذلك لإنتاج محصول مرتفع من البطاطس بكميات أقل من مياه الري المضافة وذلك تحت ظروف محافظة المنيا وغيرها من الظروف المماثلة.