Eco. Env. & Cons. 26 (2) : 2020; pp. (756-761)
Copyright@ EM International
ISSN 0971–765X

Effect of different irrigation regimes and potash fertilizer on water use efficiency of rice *Oryza sativa* L. yasameen cultivar

Hamza N.A. Al-Delamee and Kholoud N. A. Al-Zini

Directorate of the Breeding of Babylon, Ministry of Education, Babylon, Iraq
*****Al- Qasim Green University College of Agriculture, Iraq***

(Received 10 November, 2019; accepted 15 December, 2019)

ABSTRACT

A field experiment was carried out in Iraq to investigate effect of irrigation regimes and potash fertilizer on Water-Use Efficiency of rice using (RCBD) Design, Irrigation regimes were the first factors namely continuous flooding Irrigation (I_1) as control, every 5 days Irrigation (I_2), every 7 days Irrigation (I_3) and every 10 days Irrigation (I_4) and the second factor was fertilizer levels namely, 30 Kg D^{-1}(K_1) as control 40 Kg D^{-1}, (K_2), 50 Kg D^{-1} (K_3) and 60 Kg D^{-1} (K_4), means were compered using (L.S.D) test and the results show the following: (I_2) treatment was significant superior on traits of plant height by 4.8 % and (WUE) by 270% in comparison with control (I_1) and there was no significant difference with biological yield and grain yield at the same time there were significant superiority of most potash fertilizer treatments specially (K_4) with different percentages 10% plant height, 17.1 % biological yield, 32.6% grain yield and for (WUE) by 86% approximately so, (K_4) treatment decrease water utilization by 24.5% significantly (I_2) treatment clearly decreased the quantity of utilization water of plant life cycle with sustainability of productivity ability without significant difference as compared with control (I_1) which using plenty of water, and importance of potash fertilizer treatments became clear, for productivity increment by superiority of (K_4) treatment as compared with control (K_1) for all studied traits on these conditions during clearly synergistic relationship among (K) and (I) treatments.

Key words : *Oryza sativa L, Potash fertilizer, K, Rice cultivars, Irrigation regimes*

Introduction

Rice planting was banned in Iraq for many seasons due to water shortage problem. Boman, (2001) indicated that global average of irrigation water quantity was 2500 liters for one crude Kg of rice product, this quantity was different from field to another within range of 800-5000 (LW Kg^{-1}) depended upon crop management and irrigation regime one of them, Cabangon *et al.,* (2002) remind that flooding irrigation regime with pre puddling during growth season was dominant cultivation rice crop.

At present, many irrigation regime were following to guarantee plant (WUE), contrary optimal production, global predictions indicate to water crisis probability more specifically at Asia continent that consume more than 85% of rice crop water (IRRI, 1995).

The nutrients balance in the soil and meet the basic requirements of plant nutrient elements throughout the growth stages it in better to use organic fertilizer. It also reduces the intensive needs of mineral fertilizers, Reduce the loss of nutrient elements forms, the organic fertilization can behave as a slow releasing material for nutrients to the soil and achieving the nutrients equilibrium after the end of plant growth for subsequent seasons (AL-Taey *et al*., 2018; AL-Taey *et al*., 2019)

Materials and Methods

A field experiment was carried out at the Rice Research Station at Al-Mishkhab - Najaf province - Iraq related to International Rice Researches program during 2018 season to study effect of different irrigation regimes and potash fertilizer on Water - Use Efficiency (WUE) of rice yasmeen cultivar during following plant growth and yield ,the field soil was prepare for tillage, fining and flattening and analysis, results mentioned on Table 1.

The experiment was carried out using Randomized Completely Block Design (RCBD) in a factorial arrangement at three replicates. The means were compared with (LSD) at 0.05 level different irrigation regimes were the first factor which were marked as continuous flooding irrigation (I_1) as control, every 5 days irrigation (I_2), every 7 days irrigation (I_3), and every 10 days irrigation (I_4), fertilizer levels were the second factor which were 30 Kg D^{-1}(K_1) as control, 40 Kg D^{-1} (K_2), 50 Kg D^{-1} (K_3) and 60 Kg D^{-1} (K_4) as K_2O salt added to irrigation water, experiment soil was divided to equally plots (4 x 4) m dimensions as 16m² area with 48 experimental plots, planting doing by equal disperse seeds with the average, 30 kg D^{-1} than following with all agricultural services which needed to rice at that region, the plant height was measure from base to end of panicle cluster randomized for numbers of plants, leaf area, grain yield, biological yield, were calculated based on (1m²) than conversion into (ton ha^{-1}) for every treatment of present experiment, quantity of irrigation water was calculated through controlling water flow by counting it using gauge meter in (m³) unit with 0.001 m^3 accuracy, while Water Use Efficiency (WUE) calculated by divided grain yield (kg grain D^{-1}) on consumed water quantity (m³ Irrigation water D^{-1}) to became (kg grain m^{-3} irrigation water) using WUE = Y ÷ Q tot equation according to Bhushan *et al*., 2007; Amir and Ali, 2015 with change Hectare to Donum (Donum = 2500 m²) in Iraq.

Results and Discussion

Plant height

From Table 2 we notice there is superiority significant different of (I_2) treatment (every 5 days irrigation) of plant height trait with increment 7.7% percentage, plant height reached to 90.4 cm as compared with control that was 83.9 cm, probably due to happening of better nutrient-aquatice quilibration case at this treatment on present conditions, while (I_4) treatment (every 10 days irrigation) gave significant decrease by 8.0% approximately, as compared with control due to athirst case as a result of attrition state that plant met it at that treatment (Borrell *et al*., 2000). K_4 (60KgD^{-1}) treatment caused significant increment by 11.6%, and also, these results indicated to numbers of significant interactions reached highest at (K_4 x I_2) interaction with increment 19.2% percentage that indicate to potassium is importance on rice growth.

Table 1. Physical and chemical properties for experimental soil

Traits	Unit	Value	
soil separates	sand	g.Kg^{-1}	459.2
	silt		440.5
	clay		100.3
soil texture		-	Loam Soil
pH		-	7.75
EC		d*S*.m^{-1}	2.87
???		%	21.5
Organic matter		g.Kg^{-1}	4.44
Total nitrogen		0.75	
NaCl		%	2.1
TDS		ppm	633.9
Negative ions	SO_4^{-}	ppm	6.9
	CL^{-}		35.4
	HCO_3^{-}		7.7
Positive ions	^{++}Mg	ppm	5.6
	^{+}Na		316.1
	K^{+}		32.2

Leaf area

Data in Table 3 show no significant different between (I_2) treatment (every 5 days irrigation) and (I_1) control treatment, while all potash treatments were superiority significant different as increment on that trait in comparison with control (K_1) and increment reached highest at (K_4) treatment (60 KgD^{-1}) by 20% percentage, because of potassium increment in irrigation water that high plants need it very much relatively, lead to leaf growth increment and promote photosynthesis by catalysis different numerous enzymes regimes, (Bahmanar and Ranjbar, 2007), these results agree with what find out Firouzi, 2015 and Tari *et al*., 2009 also, results indi-

Table 2. Effect of irrigation regimes, potash fertilization and it's interactions on plant height cm

K concentrations	Irrigation regimes I_1	I_2	I_3	I_4	Mean effect of K
K_1	81.3	85.9	81.4	71.1	79.9
K_2	83.8	88.8	82.5	75.4	82.6
K_3	84.5	89.9	83.2	76.5	83.5
K_4	86.0	96.9	88.0	85.8	89.2
mean of irrigation period	83.9	90.4	83.8	77.2	
L.S.D 0.05	K = 2.5		I =2.5		I x K = 5.01

cated to many significant interactions of increment for this trait reached highest at (K_4 x I_2) interaction with 21.5 % percentage which shows potassium's importance on that level.

Panicles number

Through data in Table 4 notice, (I_1) control treatment significant superior of panicles number trait with no significant different between it and (I_2) (every 5 days irrigation) treatment, while at this time (I_3 and I_4) treatments caused significant decrease, that confirm on important of (I_2) (every 5 days irrigation) treatment with production panicles number asymptotic to panicles number of (I_1) treatment that was consumed plenty water also, data imply to significant increment at this trait by potash fertilizer at (K_3 and K_4) treatments 50, 60 Kg D^{-1}, respectively reached highest at (K_4) (60 Kg D^{-1}) treatment by 20.1% percentage which confirm on potassium important of that important trait of rice crop component during reproductive growth increment, and also, results indicated to significant interactions by increment this trait at numbers of interactions reached highest at (I_2xK_4) by 12.3% percentage which indicated to necessity of potassium at that level, and there was nosignificant different mentioning of interactions with (I_2) treatment (every 5 days irrigation) instead of (I_1) (continues flooding irrigation) treatment, which indicated to (I_2) treatment important, as be reported by (Al-Esawi, 2004; Tabar, 2013 results), whom agree with these results.

Table 3. Effect of irrigation regimes, potash fertilization and it's interactions on leaf area cm².

K concentrations	Irrigation regimes I_1	I_2	I_3	I_4	Mean effect of K
K_1	27.0	27.2	22.6	20.8	24.4
K_2	28.6	28.4	23.3	21.7	25.5
K_3	31.2	31.5	28.3	21.4	28.1
K_4	32.8	32.5	29.8	21.9	29.3
mean of irrigation period	29.9	29.9	26.0	21.4	
L .S.D 0.05	K = 0.831		I = 0.831		I x K= 1.662

Table 4. Effect of irrigation regimes, potash fertilization and it's interactions on panicles number (panicles m^{-2}).

K concentrations	Irrigation regimes I_1	I_2	I_3	I_4	Mean effect of K
K_1	246.1	241.2	171.5	166.7	206.4
K_2	253.7	250.9	185.2	170.8	215.2
K_3	263.6	263.6	192.0	180.7	225.0
K_4	273.2	276.6	248.4	193.3	247.9
mean of irrigation period	259.2	258.1	199.3	177.9	
L.S.D 0.05	K = 10.5		I =10.5		I x K =21.0

Biological yield

We notice from Table 5 there is no significant difference between (I_2) (every 5 days irrigation) treatment and (I_1) control treatment, potash fertilizer indicated to be superior of K_3 and K_4 (50 and 60 Kg D^{-1}) treatments, respectively on this trait as compare with control treatment, increment reached highest at K_4 treatment with in 9.99 (ton ha^{-1}) by 17.1% percentage as compared with control treatment that was 8.53 (ton ha^{-1}) indicated to necessity of potassium to support growth, results indicated significant interactions in biological yield increment at number of combinations reached highest at (K_4xI_1) combination with increment 16% percentage approximately without significant different mention-

Table 5. Effect of irrigation regimes, potash fertilization and it's interactions on biological yield (ton ha^{-1})

K concentrations	Irrigation regimes I_1	I_2	I_3	I_4	Mean effect of K
K_1	10.33	10.23	7.15	6.40	8.53
K_2	10.58	10.42	7.22	6.97	8.80
K_3	11.62	10.54	8.07	7.17	9.35
K_4	11.98	11.82	8.47	7.70	9.99
Mean of irrigation period	11.13	10.75	7.73	7.06	
L.S.D 0.05	K = 0.393		I = 0.393		I x K == 0.786

ing between it and (K_4 x I_2) combination ,that indicated to (I_2) treatment important at that conditions.

Grains yield

From Table 6 we notice there is no significant different between (I_2) (every 5 days irrigation) treatment and (I_1) control treatment, while (I_3 and I_4) treatments caused significant devaluation on yield, but all potash fertilization shows significant superiority on this trait, reached highest at (K_4) treatment to 6.14 (ton ha^{-1}) by 32.6% percentage as compere with control (K_1) treatment that was 4.63 (ton ha^{-1}), which indicated to potassium important for increment grains yield at this conditions also, results shows significant interactions increment taking place reached highest at (K_4xI_1) by 23% percentage increment approximately without existence of significant different between it and (K_4xI_2) interaction which confirm on (I_2) treatment and potassium role with relative high concentration contributing to vegetative growth increment, represented plant height by 11.6% percentage, Table 2, leaf area by 20% percentage Table 3, that will increase of receiving solar radiation period, transverse of wide plant leaves subsequently increment of photosynthesis produces and increment of panicles number by 21.1% percentage, Table 4 and these results agree with (Das *et al*., 2013; Carrijo *et al*., 2017).

Table 6. Effect of irrigation regimes, potash fertilization and it's interactions on grains yield (ton ha^{-1})

K concentrations	Irrigation regimes				Mean effect of K
	I_1	I_2	I_3	I_4	
K_1	5.40	5.25	4.18	3.70	4.63
K_2	5.47	5.67	4.91	4.57	5.16
K_3	6.52	6.37	5.44	5.07	5.85
K_4	6.64	6.44	5.89	5.60	6.14
Mean of irrigation period	6.01	5.93	5.11	4.74	
L.S.D 0.05	K = 0.121	I = 0.121	I x K =0.242		

Water utilization

From data of Table 7 we notice, the average of irrigation water plants need during its life cycle period reached to (28250) ($m^3 D^{-1}$) at (I_1) control treatment whereas, evidently decrease shows on remainder treatments (I_2, I_3, I_4) reached to (8500,7655,700) ($m^3 D^{-1}$), respectively and by (70%, 73%, 75%) percentages, respectively approximately also, all potash fertilization treatments caused significant decrease of this trait at (K_2,K_3,K_4) treatments, respectively that reached to (13434, 12235, 11067) ($m^3 D^{-1}$) percentages, respectively and by (8.4%, 16.6%, 24.5%), respectively, as compare with control treatment that was 14672 ($m^3 D^{-1}$) indicated to the clear potassium role, (Yousef *et al*., 2019), especially at high concentration (60 Kg D^{-1}) on decrease water utilization average in view of its an important to loss water control by transpiration (Yang *et al*., 2004) also, there were number of interactions have been effected to reduce that trait significantly by percentage 81.7% at (K_4 x I_4) interaction, which reached to 5700 ($m^3 D^{-1}$) whereas, it was 31189 ($m^3 D^{-1}$) at control treatment.

Table 7. Effect of irrigation regimes, potash fertilization and it'sinteractions on water utilization ($m^3 D^{-1}$)

K concentrations	Irrigation regimes				Mean effect of K
	I_1	I_2	I_3	I_4	
K_1	31189	10100	8900	8500	14672
K_2	29234	8800	8300	7400	13434
K_3	27329	8000	7210	6400	12235
K_4	25249	7100	6210	5700	11065
Mean of irrigation period	28250	8500	7655	7000	
L.S.D 0.05	K =500	I = 500	I x K = 1000		

Potassium content

From Table 8 notice, (I_2) treatment caused non-significant increment of potassium leaves content (%) in comparison with control (I_1) treatment, while (I_3 and I_4) treatments caused significant devaluation of potassium leaves content, but potassium fertilization treatments shows significant superiority at (K_4 and K_3) treatments, increment reached highest at (K_4) treatment by 1.558% percentage as compare with (K_1) control treatment which was 1.397% percentage because of potassium soil content increasing (60 Kg D^{-1}), that lead to high potassium absorption by plant roots, also results indicated significant interactions taking place on number of interactions, reached highest increment at (K_4xI_2) by 17% percentage approximately, that confirm on (I_2) treatment impotent. So it be clear from Table 8 results that, when potassium soil content increase as fertilizer the potassium leaves content increase as percentage, Memgel and Kirkby, (2001) make clear that's potassium existence in plant cells with high concentrations decrease water loss by transpiration, that is to say increase the ability of plant water conservation and that's very important in case of water shortage existence specially at arid and semiarid regions, despite potassium did not inter in any organic compound of plant, but it contribute to active more than 70 enzymes like Redox and protein creation enzymes and regulate osmotic pressure into plant cells (Tisdale *et al*., 1997).

Table 8. Effect of irrigation regimes, potash fertilization and it's interactions on potassium leaves content (%).

K concentrations	Irrigation regimes I_1	I_2	I_3	I_4	Mean effect of K
K_1	1.420	1.45	1.416	1.303	1.397
K_2	1.530	1.450	1.475	1.320	1.444
K_3	1.600	1.630	1.550	1.380	1.540
K_4	1.621	1.660	1.512	1.440	1.558
Mean of irrigation period	1.543	1.548	1.488	1.361	
L.S.D 0.05	K=0.149		I = 0.149	I x K = 0.298	

Water Use Efficiency (WUE)

From data in Table 9 we notice, all mention data on Table 7 were reflected on (WUE) of rice which is resulted from grains yield (Kg D^{-1}) divided upon consuming water use irrigation (m^3 D^{-1}) Bhushan *et al*., (2007) when consuming water average decrease, the (WUE) average increase on that consuming, so all irrigation water treatment (I) significant superior reached highest at (I_3) treatment that reached to 0.200 by 270% percentage increment as compared with control treatment which was 0.054 (Kg grain m^{-3} irrigation water), results, also shows significant increment taking place for all potash fertilizer treatments reached highest at (K_4) treatment, to 0.199 by 86% percentage approximately as compared with control treatment that was 0.107 (Kg grain m^{-3} irrigation water), and there were number of significant interactions treatments of that trait (research subject) reached highest at (I_3xK_4) interaction reached to 0.259 by 502% percentage and control treatment was 0.043 (Kg grain m^{-3} irrigation water) indicated to imprinted role of potassium playing to increment plant (WUE) during lessening of irrigation water utilization, as result of potassium soil content increment that added to irrigation water (60 ton D^{-1}) subsequently, increment plant content as been appear on Table 8 and water loss adjustment through stomata open and close control (Yang *et al*.,2004) .

Table 9. Effect of irrigation regimes, potash fertilization and it's interactions on (WUE) (Kg grain m^{-3} irrigation water)

K concentrations	Irrigation regimes I_1	I_2	I_3	I_4	Mean effect of K
K_1	0.043	0.130	0.147	0.109	0.107
K_2	0.047	0.161	0.171	0.154	0.133
K_3	0.060	0.199	0.221	0.198	0.169
K_4	0.066	0.227	0.259	0.246	0.199
Mean of irrigation period	0.054	0.179	0.200	0.177	
L.S.D 0.05	K=0.200		I = 0.200	I x K = 0.400	

From present research results, It appears that adoption (I_2) treatment (every 5 days irrigation) and leaving (I_1) treatment which plenty water use, because of there is no significant different existence at grains yield and biological yield as shows on Tables 5, 6, respectively to guarantee not excessive on irrigation water, especially at arid and semiarid regions which Iraq one of them, also potassium active role appear at these conditions on significant increment for grains yield by 32.6% as shows on Table 6 and biological yield by 17.1% as shows on Table 5 and that during increase vegetative growth represented on plant height increment and leaf area as appeared on Tables 3 and 4, respectively, also potash fertilization treatment shows clearly production increment by superiority of (K_4) treatment on control treatment (K_1) for all traits of this conditions during clearly synergistic relationship among (K) and (I) treatments, Thu and Ro, 2002 recommend on his yearly report of Vietnamese experts, it's necessary to fertilization by potassium within the range of (50-80) (Kg D^{-1}) at Al-Mishkhab-Najaf government-Iraq.

References

Al-Esawi, A.W. 2004. *Three Introduced rice cultivars response to watering period and fertilization levels on it'sgrowth,productivity and chemical components*. Ph.D. Dissertation of Kufa University.

Al-Taey, D.K.A., Al-Janabi, A.H. and Rachid, A.M. 2019. Role of Additive in Mitigation of the Negative Effects of Saline Water on Cabbage (*Brassica oleracea* var. *Capitata* L. *Plant Archives.* 19 (Supplement 1) : 78-85.

AL-Taey, D. K. A., AL-Azawi, S. S. M., AL-Shareefi, M. J. H. and AL-Tawaha, A. R. 2018. Effect of saline water, NPK and organic fertilizers on soil properties and growth, antioxidant enzymes in leaves and yield of lettuce (*Lactuca sativa* var. Parris Island) *Res. Crops.* 19 : 441-449.

Amir, T. and Ali, A. 2015. Deficit irrigation and sowing date as strategies to maximize water use efficiency and crop water productivity in semi-arid region. *Biological Forum-An International Journal*. 7 (1) : 30-42.

Bahmaniar, M.A. and Ranjbar, G.A. 2007. Response of rice (*Oryza sativa* L.) cooking quality properties to nitrogen and potassium application. Pak. *J. Bilo. Sc.* 10 (11) 1880-1884.

Bhushan, L. J., Ladha, R., Gupta, S., Singh, A., Tirol, Y., Saharawat, M., Gathala and Pathak, H. 2007. Saving of water and labor in rice system with no tillage and direct seeding. *Technologies Agron. J* . 99 : 1288-1296.

Borrell, A.K., Hammer, G.L. and Henzel, R.G. 2000. Does maintaining green leaf area in sorghum improve yield under drought III-dry matter production and yield. *Crop Sci.* 40 : 1037-1048.

Bouman, B.A.M. 2001. Water-efficient management strategies in rice production. International Rice Research (IRRI). December 2001. LosBaños. Laguna, Philippines. pp. 17-22.

Burhan, A. K. and AL-Taey, D. K. A. 2018. Effect of Potassium humate, humic acid, and compost of rice wastes in the growth and yield of two cultivars of Dill under salt stress conditions. *Advances In Natural and Applied Sciences.* 12(11): pages 1-6

Cabangon, R.J., Tuong, T.P. and Abdullah, N.B. 2002. Comparing water input and water use efficiency of transplanted and direct-seeded rice production systems. *Agric. Water Manage*. 57 : 11–13.

Carrijo, D.R., Lundy, M.E. and Linquist, B.A. 2017. Rice yields and water use under alternate wetting and drying irrigation:Ameta-analysis. *Field Crops Res.* 203: 173-180.

Das, S., Chaki, A. K., Sarker, A. R., Mondal, S., Sarker, M. M. R. and Moniruzzaman, M. 2013. Effect of spacing of transplanting, rateand depth of placement of urea super granules (USG) on the yield Boro rice. *Bull. Inst. Trop.* Agr., Kyushu Univ. 36 : 85-94.

Datta, A., Ullah, H. and Ferdous, 2017 Z. Water management in rice. In: *Rice Production Worldwide;* Chauhan, B.S., Jabran, K., Mahajan, G., Eds. Springer International Publishing: Cham, Switzerland. pp. 255-277.

Firouzi, Saeed. 2015. Grain, milling, and head rice yields as affectedby nitrogen rate and biofertilizer application. *Acta Agricultureslovenica*. 105(2) : 241-248.

IRRI, 1995. Report 4. IRRI. Water crisis on the way for Asia. p.l. Mengel, K. and E. A. Kirkby Principles of plant nutrition. 5th ed Press London.

Tabar, Yosef, S. 2013. Effect nitrogen management on panicle structure and yield in rice (*Oryza sativa* L.). *Intl. J. Agri Crop Sci.* 5 (11) : 1224-1227.

Tari, Davood Barari, Ali Gazanchian, Hemmat Allah Pirdashti and Morteza Nasiri. 2009. Flag leaf morph physiological response todifferent agronomical treatments in a promising line of rice (*Oryza sativa* L.). Am-Euras. *J. Agric. & Environ. Sci*. 5 (3): 403-408.

Thu, D.M. and Ro, P.V. 2002. Result from experiment for differentdoses of potassium fertilizer on rice production at Mishkhab Rice Research Station (MRRS) in rice crop season.

Tisdale, S. L., Nelson, W. L., Beaton, J. D. and Havlin, J. L. 1997. *Soil Fertility and Fertilizers.* Prentice – Hall of India, New Delhi.

Yang, X.E., J.X. Lu, W.M. Wang, Z.Q. Ye, A. and Luo, C. 2004. Potassium internaluse efficiency relative to growth vigor ,potassium distribution and carbohydrate allocation in rice genotypes. *J. of Plant Nutation.* 27 ISSU.5.

Yousef, A.H., Wang, Z., X. Guo, H., Shaghaleh, M. Sheteiwy, Schen, Qiu, R. and Elbashirr, M.M.A. 2019. Effect of different irrigation regimes and soil texture on the potassium utilization efficiency of rice. *Agronomy.* 9(2) : 100, https:// doi.org /10.3390/ agronomy 9020100.