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# RESPONSE OF EGYPTIAN HYBRID ONE RICE CULTIVAR TO POTASSIUM SPLIT APPLICATION UNDER DIFFERENT IRRIGATION INTERVALS.

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## ABSTRACT

Two filed experiments were conducted during 2012 and 2013 seasons at the Experimental Farm of Rice Research and TraIning Center, Sakha, KafrEl-Sheikh, Egypt. The experiment aimed to study the effect of irrigation intervals and potassium splitting on Egyptian hybrid one (EHR1) rice cultivar. The study was performed in strip plot design with four replications. The irrigation intervals; irrigation every 3, 6 and 9 days were placed in the horizontal plots, while the potassium splitting treatments, namely; $K_1$: All basal (B), $K_2$: ½ B + ½ mid tillering (MT), $K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI) and $K_4$: ¼ B + ¼ MT + ¼ PI + ¼ booting stage (BT) were distributed in the vertical plots. Some growth characteristics, chlorophyll content, leaf area index and dry matter production $m^{-2}$ were assessed at heading stage. Yield and yield attributes were measured at harvest .Some water relations were also estimated during current study.

The resulted indicated that irrigation intervals had significant effect on all studied traits in both seasons of study. The prolonging irrigation intervals up to 9 days significantly reduced rice growth, yield attributing characteristics, rice grain and straw yields as well as harvest index. The irrigation intervals every 3 and 6 days were placed at the same level of significant in both seasons of study regarding the rice growth, yield contributes, grain yield and harvest index. The irrigation interval every 3days treatment consumed the highest amount of total applied water (13492.9 and 13609.8$m^{/3}$ $ha^{-1}$) with the lowest values of water use efficiency (0.811 and 0.814 $kg/m^3$) during first and second seasons, respectively. The irrigation interval of 9 days gave the highest values of yield reduction (18.01 and 19.22%), water save (20.23 and 21.50 %) and medium value of water use efficiency (0.833 and 0.838 $kgm^{-3}$) in 2012 and 2013 seasons, respectively. The irrigation interval of 6 days had the highest values of water use efficiency (0.894 and 0.899 $kgm^{-3}$) with mild yield reduction of (1.65 and 1.81%) and its water save was amounted to be 10.76 and 11.03% in the first and second seasons, respectively.

The potassium split treatments significantly improved rice growth, yield contributes, rice grain and straw yields as well as harvest index comparing to one dose application as basal. The potassium splitting into four equal doses, ¼ B + ¼ MT + ¼ PI + ¼ BT significantly surpassed the rest of treatments whereas; it gave the highest values of all measured traits, while potassium application as one dose gave the lowest values of all measured traits under current study in both seasons. The potassium split into four equal doses gave the highest values of water use efficiency (0.897 and 0.905$kgm^{-3}$) in both seasons of study. Generally, both of potassium splitting into three equal doses, ⅓ B + ⅓ MT + ⅓ panicle initiation (PI) and potassium splits into equal four doses were placed in the same group regarding superiority effect on dry matter $gm^{-2}$, number of paniclesm$^{-2}$, total number of grainspanicle$^{-1}$, number of filled grainspanicle$^{-1}$, 1000-grain weight, grain yield, straw yield and harvest index as well as water productivity.

The interaction between irrigation intervals and potassium treatments had significant effect on chlorophyll content, leaf area index, dry matter production $m^{-2}$(only in 2012 season), plant height cm, and number of paniclesm$^{-2}$, number of total grains panicle$^{-1}$, number of filled grains panicle$^{-1}$, 1000-grain weight, grain yield, straw yield and harvest index in both seasons of study. Generally, the results of interaction proved that irrigation interval of 6 days could be recommended for rice cultivation with potassium splitting in four equal doses to save water and high water use efficiency.

It could be concluded that the potassium splits in to four equal doses including PI and booting stage could be recommended under 6 days irrigation interval to ensure high grain yield and water productivities. Potassium splitting applications at critical different rice growth stages confirms an adequate amount of potassium supply at the correct time mitigating the adverse effect of water stress and produced considerably yield.

**Keywords*,*** Rice, hybrid rice, irrigation, potassium splits, water use efficiency.

## INTRODUCTION

Water scarcity under climate change and overpopulation in Egypt threats agriculture production, especially rice, since rice crop is big consumer crop water. Because of continued population growth and economic developments, the demand for fresh water to meet industrial and domestic needs is also competitor for agriculture production in Egypt affecting food security. Therefore, it is expected that, in near future, less water will be available for rice growing. Thereby, developing new technology for water save in paddy fields without yield reduction is a main mission for rice scientists in Egypt ensuring food sustainability. Furthermore, water efficient irrigation regimes for rice have been tested, advanced, applied and distributed in different regions in Egypt.

The reduced water inputs and increased water productively of rice grown just under saturated soil conditions were compared with traditional flooding rice (Tabbal et al*.,* 2002). Zayed et al. (2007) found that prolonging irrigation interval from three to nine days significantly decreased chlorophyll content, leaf area index, yield attributing traits and rice grain yield. The irrigation intervals of 3 and 6 day were at apar in rice grain yield and most of grain yield components. The irrigation intervals of 6 days gave the highest values of water use efficiency, while the 9 days irrigation interval gave the lowest one. Majied (2012) and El-Habet, Howida (2014) stated that watering at various irrigation intervals induce variation in rice growth, yield attributing traits and grain yield, as well as water use efficiency and water save. El Refaee et al. (2008 and 2012) found that rice growth and grain yield and its components were significantly affected by irrigation intervals. They pointed out that irrigation every 3 days while, saturation treatments induced 3-5% reduction in grain yield and gave higher water productivity.

Balanced, integrated and efficient use of fertilizers, among other inputs, has a potential to increase crop productivity provided the problems related to soil sustainability, fertilizer use efficiency and declining crop response ratio are addressed appropriately. Development of practices to improve the efficiency of nutrients requires an understanding of the fate of the applied nutrient and their effect on crop production. Greater opportunities exist for increased crop production by increasing rate, timing and improving management of potassium fertilizer. Among the major plant nutrients, potassium is the most abundant plant nutrient in soils. Continuous and an adequate potassium nutrition supply of rice plants at certain growth stage under abiotic stress involving water stress is being an effective in talking water stress harmful resulted in contentment rice grain yield.

Zayed (2002) found that potassium application for rice crop under water stress significantly alleviated the stress of salt and water withholding. However, potassium significantly improved rice growth, grain yield components and grain yield .thereby, increasing the efficiency of potassium mode of action under stresses could be achieved by potassium splitting. Velaysyauthan *et al.(*1992), Poonam et al.(1993) Ghoshi *et al.*(1995), Devasenapathy (1997), Thakur et al.(1999), Meena et al. (2003) ,Natarajan et al. (2004), Ramteke et al. (2004) and Zayed et al. (2006) reported that rice crop preformed better when splitting application of potassium was followed over one doses as basal application of potassium was flowed over one doses as 50%basal+25% at tillering stage+25% at panicle initiation (PI) or 1/3 babal+1/3 Tillering stage (T)+1/3 panicle initiation (PI) were the most effective splits ,whereas they significantly increased rice growth, all yield attributing traits and grain yield ,as well as nutrient contents leaf, such as 70% basal+30% panicle dressing significantly increased seed setting, number of filled grains ,1000-grain weight, N and K uptake at heading and grain yield of rice crop. Pillal and Aiasuya (1997) claimed that the maintenance of $K^+$ concentration in the three leaves at the levels higher than 2.76 at the mid tillering stage was too much essential for achieving maximum grain yield. Ravichandran and Sriramachandraekharan (2011) and Uddin et al.(2012) stated that potassium splitting application was found to be effective in improving rice growth, yield and yield attributes than those obtained by one dose application as basal. They also found that potassium splits at panicle initiation or booting stage was efficient in improving chlorophyll content, leaf characteristics, other growth traits, yield and yield components. Zayed *et al.*(2007) claimed that triple potassium as 1/3B+1/3MT+1/3PI could be recommend under water stress regarding rice growth, yield component, yield and water use efficiency.

The present study aimed to tested rice water productivity as affected by irrigation and potassium splitting treatments for hybrid rice.

## MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during summer seasons of 2012 and 2013 to study the effect of irrigation intervals and potassium splitting on Egyptian Hybrid one rice cultivar. Before land preparation, soil samples were taken into 0-30 cm depth of soil surface from the experimental sites during the two seasons of study. The soil samples were completely mixed, dried and grounded, then, physically and chemically proprieties were analyzed according to Black *et al*. (1965). The physical and chemical proprieties of experimental sites were presented in Table 1.

**Table 1: Physical and chemical analysis of the experimental sites during 2012 and 2013 seasons**

| Characters | 2012 | 2013 |
|---|---|---|
| Physical analysis: | | |
| Sand (%) | 17.0 | 16.5 |
| Silt (%) | 28.0 | 30.0 |
| Clay (%) | 55.0 | 53.5 |
| Soil texture | Clayey | Clayey |
| Chemical analysis: | | |
| E.C. (ds/m) | 2.15 | 2.00 |
| Organic matter (%) | 1.91 | 1.93 |
| pH | 8.03 | 7.98 |
| Available N (ppm) | 29 | 30 |
| P (ppm) | 13 | 14 |
| K (ppm) | 352 | 356 |
| Fe (ppm) | 4.05 | 5.10 |
| Zn (ppm) | 1.09 | 1.00 |

Egyptian hybrid one rice cultivar was used in this study .The experiment were laid out in strip plot design with four replications. The horizontal plots were devoted to three irrigation intervals; irrigation every 3, 6 and 9 days. Meanwhile, potassium splitting treatments; $K_1$: All basal (B), $K_2$: ½ B + ½ mid tillering (MT), $K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI) and $K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT) were distributed in the vertical plots. The plot size was 12 $m^2$ (3x4m)

The experimental sites were well tillage. Pre-germinated seeds were broadcasted in the nursery on 2 and 5 of May in 2012 and2013 seasons, respectively. Seeds at the rate of 24 kg /ha were soaked in excess of water for 24 hours and further incubated for another 36 hours to enhance germination. Two seedlings 25 days old, were transplanting at 20x20 cm distance between hills and rows. The weeds were controlled chemically using Saturn 50% at the rate of 5 liters /ha at four days after transplanting. The nitrogen in the form of urea (46.5% N) at the rate of 165 kg/ha was applied as recommended in two doses; 2/3 basal application+ 1/3 at panicle initiation. The recommended phosphorous in the form of calcium super phosphate (15.5% $P_2O_5$) at the rate of 37kg/ha was applied before land preparation. The potassium in the form of potassium sulphate at the rate of 50kg$K_2O$ $ha^{-1}$was applied as it indicated above. Zinc fertilizer at the rate of 24 kg $ZnSO_4$ $ha^{-1}$ was mixed with sand and manually broadcasted before transplanting. Then, the irrigation treatments were applied as aforementioned 10 days after transplanting. Each Irrigation treatment was tightly separated by ditches with 2 m wide and 1 m depth to isolate each other.

At heading stage, plant samples of five hills from each plot were randomly collected to estimate chlorophyll content (SPAD value), leaf are index (LAI) and dry matter production g $m^{-2}$ according to Yoshida et al. (1976).Leaf area index is the ratio between the leaf area ($cm^2$) of the plant divided by ground area occupied by the plant ($cm^2$) and chlorophyll content was estimated by chlorophyll meter (Model Li3000L).

At harvest, panicles of five random hills from each plot were counted, then converted to number of panicles $m^{-2}$ and plant height (cm) was measured. Ten main panicles from each plot were randomly packed to determine number of total grains panicle$^{-1}$, number of filled grains panicle $^{-1}$ and 1000-grain weight.

Area of 10 m$^{2}$ from central rows in each plot were harvested, dried, threshed, then grain and straw yields were determined at 14 % moisture content and converted into t ha$^{-1}$.

The volume of irrigation water applied in each plot was measured by a calibrated water meter with water pump. The amount water for land preparation of permanent field was recorded as well as water required for irrigation treatments of all experiments. Water use efficiency was calculated as the weight of grains per unit of irrigation water received during crop growth (kg grains m$^{-3}$ water input) according to Michael (1978).

All data collected were subjected to standard statistical analysis following the proceeding described by Gomez and Gomez (1984) using the computer program (MSTAT). The treatment means were compared using Duncan's multiple range test Duncan (1955). * and ** symbol used in all Tables indicate the significant at 5% and 1% levels of probability, respectively, while, NS means not significant.

## RESULTS AND DISCUSSIONS

**Irrigation intervals effect:**

Data presented in Table 2 revealed that chlorophyll content, leaf area index (LAI) and dry matter production (g m$^{-2}$) significantly decreased, when rice irrigated every 9 days. Meanwhile, the irrigation interval of 6 days gave the highest values of the previous-mentioned traits without any significant differences with those obtained by irrigation every 3 days in the both seasons of study. Data in the same table indicated that irrigation every 3 days gave the highest chlorophyll content followed by irrigation every 6 days. Meanwhile, irrigation every 9 days gave the least values of chlorophyll content. Couple irrigation intervals of 3 and 6 days was at the same level of significant regarding leaf area index and dry matter production in both seasons of study. The decrease in the previously mentioned characters might be due to high osmotic pressure outside plant cell, water imbalance inside the plant resulted in decline in cell division and elongation as well as degradation in chlorophyll consequently reduction in photosynthesis and dry matter production. Similar data had been reported by Yang *et al.* (2002), El- Ekhtyar (2004), Zayed *et al.* (2007) and Majid (2012)

Results of variance analysis show that the measured properties, plant height, number of panicles m$^{-2}$, total grains number panicle$^{-1}$ and number of filled grains panicle$^{-1}$ had a significant difference in irrigation intervals (Table 6). Prolonging irrigation interval up to 9 days significantly inhibited the yield attributes giving the lowest values of those traits. The irrigation intervals every 3 days exhibited the highest values of the number of paniclesm$^{-2}$, total number of grains panicle$^{-1}$ and filled grains number panicle$^{-1}$ followed by irrigation intervals every 6 days without significant differences with those produced by irrigation interval every 3 days regarding the plant height in both seasons and number of panicles m$^{-2}$ in the first season as well as number of filled grainspanicle$^{-1}$ in second season (Table 6). Since water stress significantly restricted rice growth and might other metabolism processes of rice plants as well as increasing catabolism against anabolism that resulted poor yield attributes. Similar results under had been reported by El-Ekhtyar (2004) and Ali et al. (2012) as well as El-Habet, Howida (2014).

Data inserted in Table 11 showed that the irrigation intervals had significant effect on 1000- grain weight, grain and straw yields as well as harvest index in both seasons of study. The irrigation intervals every 3 days gave the highest values of 1000-grain weight, grain and straw yields as well as harvest index in both study seasons. Interestingly, the irrigation treatments of 3 and 6-days interval were statically placed at the same group regarding the1000-gain weight, grain and straw yields in both season of study as well as harvest index in 2012 season. Thereby, the irrigation interval of 6 days could be recommended under current water shortage and HER1 cultivar as tolerant variety for water stress keeping high yield with save water. The minimum values of 1000- grain weight, grain and straw yields as well as harvest index were produced when rice plants were subjected to irrigation interval of 9 days in both seasons of study (Table11). Water stress significantly restricted yield components particularly, plant population unit area$^{-1}$ and panicle characteristics, whereas the water stress might be affected panicle peduncle elongation, low assimilates translocation due to more exertion of ABA which blocks this translocation, affecting current photosynthesis resulted in low grain filling rate leading to light panicle, low filled grains and high sterility% and ultimately low yield. As previously mentioned, stress restricts rice growth during the early growth stages and poor vegetative growth might have resulted in fewer assimilates, lower carbohydrate formation, dry matter production and poor population leading to poor yield attributes. A second possibility is that the stresses might block stored assimilates to grains resulting in poorly-filled grains panicle-1 and high sterility% by releasing more abscisic acid (ABA). Yet another possibility is stress-induced interference with photosynthesis resulting in poor grain filling and subsequent high sterility, light panicles and poorly-filled grains panicle$^{-1}$ because of shorter active grain filling periods. Drought is an abiotic stress, and it affects plants at various levels of their organization. Under prolonged drought, many plants will dehydrate and die. Water stress in plants reduces the plant-cell's water potential and turgor, which elevate solute concentrations in the cytosol and extracellular matrices. As a result, cell enlargement decreases leading to growth inhibition and reproductive failure (Ali et al., 1999), which is followed by accumulation of abscisic acid (ABA) and compatible osmolytes like proline, which cause wilting. Drought not only affects plant-water relations through the reduction of water content, turgor and total water, but it also affects stomatal closure, limits gaseous exchange, reduces transpiration and arrests carbon assimilation (photosynthesis) rates ( Razak et al., 2013). Negative effects on mineral nutrition (uptake and transport of nutrients) and metabolism leads to a decrease in the leaf area and alteration in assimilate partitioning among the organs that could by potassium application to ensure an adequate potassium content of plant Ali *et al.,* 1999 and Razak et al., 2013). Similar results were claimed by El-EKhtyar (2004) and Majid (2012**).**

**Table 2: Some growth patterns of Egyptian Hybrid Rice 1 cultivar as affected by irrigation intervals and potassium split application during 2012 and 2013 seasons.**

| Treatments | Chlorophyll content (SPAD value) | | Leaf area index (LAI) | | Dry matter ($gm^{-2}$) | |
|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Irrigation intervals (I): | | | | | | |
| 3 days | 43.90a | 42.81a | 7.08a | 6.83a | 1562a | 1579a |
| 6 days | 42.17b | 41.17b | 6.85a | 6.66a | 1441a | 1456a |
| 9 days | 36.60c | 36.85c | 5.91b | 5.56b | 1159b | 1205b |
| F. Test | ** | ** | ** | ** | ** | ** |
| Potassium split application (k): | | | | | | |
| $K_1$ | 36.69d | 35.83d | 5.61d | 5.45c | 1148b | 1196b |
| $K_2$ | 38.70c | 39.11c | 6.11c | 5.89b | 1242b | 1325b |
| $K_3$ | 43.20b | 42.30b | 7.26b | 6.95a | 1554a | 1528a |
| $K_4$ | 44.90a | 43.87a | 7.47a | 7.12a | 1605a | 1604a |
| F. Test | ** | ** | ** | ** | ** | ** |
| I x K Interaction: | ** | ** | ** | ** | * | Ns |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
***,** and N.S.: Significant at 0.05 and 0.01 levels and not significant, respectively.**
**$K_1$: All basal (B).$K_2$: ½ B + ½ mid tillering (MT).$K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**K: 4¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

**Table 3: Effect of the interaction between irrigation intervals and potassium split application on chlorophyll content (SPAD value) of Egyptian Hybrid Rice 1 cultivar during 2012 and 2013 seasons.**

| Potassium split application (k): | Irrigation intervals (I) | | | | | |
|---|---|---|---|---|---|---|
| | 2012 | | | 2013 | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| $K_1$ | 39.27ef | 38.37f | 32.43h | 38.46de | 37.11e | 31.93f |
| $K_2$ | 42.36d | 39.89e | 33.85g | 40.84cd | 39.47de | 37.01e |
| $K_3$ | 46.12b | 44.65c | 38.89ef | 45.37ab | 43.25bc | 38.27de |
| $K_4$ | 47.84a | 45.79bc | 41.28d | 46.55a | 44.86ab | 40.19d |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
**$K_1$: All basal (B).$K_2$: ½ B + ½ mid tillering (MT).$K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**$K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

**Table 4:Effect of the interaction between irrigation intervals and potassium split application on leaf area index (LAI) of Egyptian Hybrid Rice 1 cultivar during 2012 and 2013 seasons.**

| Potassium split application (k): | Irrigation intervals (I) | | | | | |
|---|---|---|---|---|---|---|
| | 2012 | | | 2013 | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| $K_1$ | 6.25e | 5.81f | 4.78h | 6.06e | 5.74f | 4.54h |
| $K_2$ | 6.46d | 6.92de | 5.46g | 6.32cd | 6.25cd | 5.11g |
| $K_3$ | 7.78a | 7.53b | 6.48d | 7.43ab | 7.28b | 6.13de |
| $K_4$ | 7.84a | 7.65ab | 6.92c | 7.52a | 7.37ab | 6.46c |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
**$K_1$: All basal (B).$K_2$: ½ B + ½ mid tillering (MT).$K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**$K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

**Table 5:Effect of the interaction between irrigation intervals and potassium split application on dry matter (g/m$^2$) of Egyptian Hybrid Rice 1 cultivar during 2012 and 2013 seasons.**

| Potassium split application (k): | Irrigation intervals (I) | | |
|---|---|---|---|
| | 2012 | | |
| | 3 days | 6 days | 9 days |
| $K_1$ | 1298ef | 1248f | 899g |
| $K_2$ | 1457d | 1297ef | 973g |
| $K_3$ | 1714ab | 1584c | 1365def |
| $K_4$ | 1779a | 1636bc | 1399de |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
**$K_1$: All basal (B).$K_2$: ½ B + ½ mid tillering (MT).$K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**$K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

## Potassium split effect:

Potassium splitting significantly improved affected chlorophyll content, leaf area index and dry matter production measured at heading that is hold true at both seasons (Table2).

Data in Table 2 clarify those four equal splits of potassium as B+ MT+PI+ BT gave the highest values of growth parameters in both seasons of study followed by triple splits. The potassium application in one dose gave the lowest values of growth traits comparing to split treatments. Furthermore, yield attributing characteristics, grain yield, straw yield and harvest index of HER1 were markedly affected by potassium split application in both seasons of study (Tables 6, 11). Potassium splitting into four equal doses gave the maximum means of panicle characteristics; field grainspanicle$^{-1}$, 1000-grain weight and yield properties such as grain yield, straw yield and harvest index that are hold true in both seasons. At the same time, couple potassium treatments of triple and tetra ones were placed at the same level of significant in both seasons regarding the panicle characteristics, grain yield, straw yield and harvest index in both seasons of study (Tables 6 &11). The panicle numbers m$^{-2}$ recorded its maximum mean, when potassium was applied into three equal doses in both seasons of study (Table6). The minimum values of yield attributes was recorded, when rice plants were received the applied potassium in one dose as basal application. Plant height of rice plants reached it maximum mean when rice plants were received its potassium requirement into four equal doses (Table 6). Interestingly, potassium application in one dose, as basal, significantly failed to exert any improvement in rice growth or enhancing its water stress withstanding. The splitting, including dressing at panicle initiation and the beginning of booting stage showed its superiority in enhancing rice tolerance to water stress, subsequently improved rice growth and grain yield. Also, the potassium application at the mid tillering or tillering stage with panicle initiation as well as booting stage encourage rice plant to grow healthy under such stress. The tetra potassium splitting as following; 1/4 basal+1/4maximum tilling (MT) +1/4 panicle initiation (PI) +1/4 booting stage (BT) significantly improved all studied traits. The tetra potassium splitting was found to be efficient to reduce the spikelet sterility, which gave the lowest values of unfilled grain panicle$^{-1}$ in terms of sterility. The one dose application of potassium, as triple or tetra equal doses might encourage early and fast rice growth, which was more convenient under either water stresses. Also, the triple and /or tetra splits of potassium might increase rice tolerance of water stress, epically at sensitive growth stage such as panicle initiation and mid booting stage enhancing photosynthesis rate, kept the normal osmotic of plant cell and its turgid pressure, increased stored carbohydrate at per-heading and boosted more reproductive tillers formation. Moreover, triple and tetra potassium split application might be significantly increased nitrogen, potassium and chlorophyll leaf contents at heading, resulted in delaying leaf senescence occurred under water and salt stresses during grain filling. Furthermore, tetra and triple application of potassium might increase potassium leaf content results in more translocation of stored carbohydrates in stem leaf sheaths and other storage organs to grains, leading to high sink capacity. subsequently, more potassium leaf content of flag leaf might be enhancing the efficiency of current photosynthesis during active filling period resulted in improving panicle characteristics; leading to high grain yield. In addition, tetra and triple potassium application in the study greatly might increase potassium leaf content and nitrogen resulted in more Riblouse 1,5 di-phosphate carboxylase oxygenase, which delay aging and increase photosynthesis rate resulted in more carbohydrates to grains, leading to high sink capacity and, ultimately, higher grain yield. High potassium leaf content might be enable rice plants to be water stress tolerance by organizing stomata conductance well as (Zayed, 2002). Similar data have been reported by El-Habet,Howida(2014) and Zayed *et al.*(2007).

**Table 6:Some yield components of Egyptian Hybrid Rice1 cultivar as influenced by irrigation intervals and potassium split application during 2012 and 2013 seasons.**

| Treatments | Plant height cm | | Number of panicles/m$^2$ | | Total number of grains /panicle | | Number of filled grains/panicle | |
|---|---|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Irrigation intervals (I): | | | | | | | | |
| 3 days | 104.6a | 107.4a | 561a | 573a | 160.5a | 166.2a | 151.7a | 155.0a |
| 6 days | 105.2a | 105.5a | 553a | 562b | 154.6b | 162.1b | 145.6b | 151.7a |
| 9 days | 101.1b | 101.6b | 434b | 446c | 134.1c | 139.7c | 120.8c | 125.2b |
| F. Test | ** | ** | ** | ** | ** | ** | ** | ** |
| Potassium split application (k): | | | | | | | | |
| $K_1$ | 101.3c | 101.6b | 445c | 454d | 136.9b | 144.4b | 125.4b | 130.4b |
| $K_2$ | 103.6b | 104.4c | 499b | 501c | 142.4b | 148.7b | 130.9b | 136.7b |
| $K_3$ | 104.9b | 105.6b | 564a | 583a | 157.1a | 163.0a | 148.3a | 152.7a |
| $K_4$ | 107.1a | 107.6a | 555a | 569b | 162.5a | 167.8a | 153.0a | 156.3a |
| F. Test | ** | ** | ** | ** | ** | ** | ** | ** |
| I x K Interaction: | ** | ** | ** | * | ** | ** | ** | ** |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
***,** and N.S.: Significant at 0.05 and 0.01 levels and not significant, respectively.**
**$K_1$: All basal (B).$K_2$: ½ B + ½ mid tillering (MT).$K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**$K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

**Table 7: Effect of the interaction between irrigation intervals and potassium split application on plant height (cm) of Egyptian Hybrid Rice 1 cultivar during 2012 and 2013 seasons.**

| Potassium split application (k): | Irrigation intervals (I) | | | | | |
|---|---|---|---|---|---|---|
| | 2012 | | | 2013 | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| $K_1$ | 104.1ef | 102.8fg | 97.02i | 105.3c | 102.7d | 96.84e |
| $K_2$ | 105.9cd | 104.3e | 100.6h | 106.7bc | 105.1c | 101.4d |
| $K_3$ | 106.7bc | 106.1cd | 102.0gh | 108.5ab | 106.0c | 102.3d |
| $K_4$ | 108.9a | 107.7ab | 104.4de | 109.0a | 108.1ab | 105.8c |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
**$K_1$: All basal (B).$K_2$: ½ B + ½ mid tillering (MT).$K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**$K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

**Table 8: Effect of the interaction between irrigation intervals and potassium split application on number of Panicles /m$^2$ of Egyptian Hybrid Rice 1 cultivar during 2012 and 2013 seasons.**

| Potassium split application (k): | Irrigation intervals (I) | | | | | |
|---|---|---|---|---|---|---|
| | 2012 | | | 2013 | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| $K_1$ | 501d | 489de | 344g | 504d | 499d | 358f |
| $K_2$ | 534c | 531c | 432f | 542c | 539c | 423e |
| $K_3$ | 612a | 605ab | 476e | 627a | 612ab | 509d |
| $K_4$ | 569ab | 587b | 483de | 618a | 596b | 492d |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
**$K_1$: All basal (B).$K_2$: ½ B + ½ mid tillering (MT).$K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**$K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

**Table 9:Effect of the interaction between irrigation intervals and potassium split application on number of total grains panicle$^{-1}$ of Egyptian Hybrid Rice 1 cultivar during 2012 and 2013 seasons.**

| Potassium split application (k): | Irrigation intervals (I) | | | | | |
|---|---|---|---|---|---|---|
| | 2012 | | | 2013 | | |
| | 3days | 6 days | 9 days | 3days | 6 days | 9 days |
| $K_1$ | 149.5cd | 142.4d | 118.8e | 154.4c | 151.7c | 127.2d |
| $K_2$ | 156.0bc | 146.8cd | 124.4e | 158.8bc | 155.4c | 131.9d |
| $K_3$ | 165.7a | 161.5ab | 144.2d | 173.6a | 168.5ab | 146.9c |
| $K_4$ | 170.9a | 167.9a | 148.9cd | 177.9a | 172.9a | 152.6b |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
**$K_1$: All basal (B). $K_2$: ½ B + ½ mid tillering (MT).**
**$K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**$K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

**Table 10: Effect of the interaction between irrigation intervals and potassium split application on number of filled grains/panicle of Egyptian Hybrid Rice 1 cultivar during 2012 and 2013 seasons.**

| Potassium split application (k): | Irrigation intervals (I) | | | | | |
|---|---|---|---|---|---|---|
| | 2012 | | | 2013 | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| $K_1$ | 138.8d | 133.9d | 103.5e | 142.8cd | 138.3cd | 110.2e |
| $K_2$ | 146.8c | 136.5d | 109.6e | 150.7bc | 141.7cd | 117.6e |
| $K_3$ | 158.1ab | 154.3b | 132.4d | 166.9a | 157.6ab | 132.9d |
| $K_4$ | 163.2a | 157.8ab | 137.9d | 159.6ab | 169.3a | 140.1cd |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
**$K_1$: All basal (B). $K_2$: ½ B + ½ mid tillering (MT). $K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**$K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

**Table 11: 1000-grain weight, grain and straw yields and harvest index of Egyptian Hybrid Rice 1 cultivar as affected by irrigation intervals and potassium split application during 2012 and 2013 seasons.**

| Treatments | 1000- grain weight | | Grain yield (t/ha) | | Straw yield (t/ha) | | Harvest index | |
|---|---|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Irrigation intervals (I): | | | | | | | | |
| 3 days | 26.18a | 26.19a | 10.94a | 11.08a | 13.82a | 14.08a | 44.19a | 44.03a |
| 6 days | 25.77a | 25.83a | 10.76a | 10.88a | 13.67a | 13.99a | 44.03a | 43.71b |
| 9 days | 24.62b | 24.38b | 8.97b | 8.95b | 13.15b | 13.63b | 40.01b | 39.58c |
| F. Test | ** | ** | ** | ** | ** | ** | ** | ** |
| Potassium split application (k): | | | | | | | | |
| $K_1$ | 24.97b | 24.80b | 9.42c | 9.60b | 13.19b | 13.65b | 41.53b | 41.51c |
| $K_2$ | 25.16b | 25.09b | 9.78b | 9.92b | 13.26b | 13.66b | 42.33b | 41.93b |
| $K_3$ | 25.94a | 25.89a | 10.64a | 10.79a | 13.84a | 14.06a | 43.36a | 43.24a |
| $K_4$ | 26.20a | 26.85a | 10.83a | 10.95a | 13.90a | 14.32a | 43.74a | 43.44a |
| F. Test | ** | ** | ** | ** | ** | ** | ** | ** |
| I x N Interaction: | ** | ** | ** | ** | ** | ** | ** | ** |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
***,** and N.S.: Significant at 0.05 and 0.01 levels and not significant, respectively.**
**$K_1$: All basal (B).$K_2$: ½ B + ½ mid tillering (MT).$K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**$K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

## Interaction effects:

Regarding the interaction effect, data analysis variance stated that the interaction between irrigation intervals and potassium split treatments had significant effect on chlorophyll content, leaf area index and dry matter production $m^{-2}$, of Egyptian hybrid one rice cultivar in both seasons of study (Tables3, 4 and 5). The best combination was potassium splitting in equal four doses of B+MT+PI+BT with irrigation interval of 6day without any significant differences with those of three splits under 3 and 6 irrigation intervals. On the other hand, the combination of 9 days irrigation interval with one potassium dose applied as basal gave the lowest values of studied growth traits(Tables3,4and 5).

The interaction between irrigation interval and potassium split treatments showed significant effect on plant height, panicle numberpanicle$^{-1}$,total grains number panicle$^{-1}$ filled grains panicle$^{-1}$,1000-grain weight, grain yield, straw yield and harvest index in both season of study(Tables7,8,9,10,12,13,14 and 15). The best combination was irrigation interval of 3days with potassium splitting in four equal doses without significant differences with those recorded by the same treatment under 6 days irrigation in all studied traits for yield components and yield as well as harvest index in both seasons of study. Also, the potassium splitting in three equal doses with 6 irrigation interval gave the highest values of harvest index without significant differences with those produced by irrigation interval of 6 day and triple potassium splits without significant differences with those of tetra splits under 6 irrigation interval of 6 day in the second season, while in the first season the combination of tetra potassium splitting with 6 irrigation interval produced the highest value of harvest index without significant differences with those produced by tetra K splitting with the irrigation intervals of 3 days. Generally, the results of interaction proved that irrigation interval of 6 day could be recommended for rice cultivation with K splitting in four equal doses without yield reduction and high water use efficiency. The application of periodical water stress and potassium fertilization has been reported to induce tolerance of rice to osmotic stress (Razak et al*.,* 2013). The maintenance of high plant water status and plant functions at low plant water potential, and the recovery of plant function after water stress are the major physiological **processes** that contribute to the maintenance of high yield under cyclic drought period conditions. In water stressed plants, increased abscisic acid (ABA) levels are known to stimulate the release of potassium from guard cells, giving rise to stomatal closure (Assmann, and Shimazaki,1999). Numerous studies have shown that the application of K fertilizer mitigates the adverse effects of drought on plant growth (Andersen *et al.*, 1992 and Sarkarung *et al.,*1997). Potassium increases the plant's drought resistance through its functions in stomatal regulation, osmoregulation, energy status, charge balance, protein synthesis, and homeostasis.

In plants coping with drought stress, the accumulation of $K^+$ may be more important than the production of organic solutes during the initial adjustment phase, because osmotic adjustment through ion uptake like $K^+$ is more energy efficient (Chen *et al.,* 1997 and Quampah *et al.,* 2011 ). Li (2014) has reported that lower water loss in plants well supplied with $K^+$ is due to a reduction in transpiration which not only depends on the osmotic potential of mesophyll cells, but also is controlled to a large extent by stomata conductance. Similar result were reported by Zayed *et al*.(2007) and El-Habet, Howida (2014).

**Table 12: Effect of the interaction between irrigation intervals and potassium split application on 1000-grain weight (g) of Egyptian Hybrid Rice 1 cultivar during 2012 and 2013 seasons.**

| Potassium split application (k): | Irrigation intervals (I) | | | | | |
|---|---|---|---|---|---|---|
| | 2012 | | | 2013 | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| $K_1$ | 25.78d | 25.29e | 23.83g | 25.62e | 25.21f | 23.57i |
| $K_2$ | 25.93cd | 25.38e | 24.18f | 25.87d | 25.46ef | 23.93h |
| $K_3$ | 26.46a | 26.15bc | 25.21e | 26.56ab | 26.29c | 24.69g |
| $K_4$ | 26.54a | 26.27ab | 25.26e | 26.72a | 26.34bc | 25.32f |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
**$K_1$: All basal (B). $K_2$: ½ B + ½ mid tillering (MT).$K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**$K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

**Table 13: Effect of the interaction between irrigation intervals and potassium split application on grain yield (t/ha) of Egyptian Hybrid Rice 1 cultivar during 2012 and 2013 seasons.**

| Potassium split application (k): | Irrigation intervals (I) | | | | | |
|---|---|---|---|---|---|---|
| | 2012 | | | 2013 | | |
| | 3days | 6 days | 9 days | 3 days | 6 days | 9 days |
| $K_1$ | **10.38b** | **9.95c** | **7.94f** | **10.62b** | **10.07c** | **8.10f** |
| $K_2$ | **10.64b** | **10.38b** | **8.32e** | **10.73b** | **10.56b** | **8.47e** |
| $K_3$ | **11.35a** | **11.32a** | **9.23d** | **11.46a** | **11.40a** | **9.38d** |
| $K_4$ | **11.41a** | **11.39a** | **9.68c** | **11.52a** | **11.48a** | **9.85c** |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
**$K_1$: All basal (B).$K_2$: ½ B + ½ mid tillering (MT).$K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**$K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

**Table 14:Effect of the interaction between irrigation intervals and potassium split application on straw yield (t/ha) of Egyptian Hybrid Rice 1 cultivar during 2012 and 2013 seasons.**

| Potassium split application (k): | Irrigation intervals (I) | | | | | |
|---|---|---|---|---|---|---|
| | 2012 | | | 2013 | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| $K_1$ | 13.31b | 13.04b | 13.22b | 13.66c | 13.53c | 13.77c |
| $K_2$ | 13.38b | 13.26b | 13.15b | 13.72c | 13.68c | 13.59c |
| $K_3$ | 14.26a | 14.17a | 13.09b | 14.37ab | 14.26b | 13.54c |
| $K_4$ | 14.33a | 14.21a | 13.16b | 14.58a | 14.49ab | 13.62c |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
**$K_1$: All basal (B).$K_2$: ½ B + ½ mid tillering (MT).$K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**$K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

**Table 15: Effect of the interaction between irrigation intervals and potassium split application on harvest index of Egyptian Hybrid Rice 1 cultivar during 2012 and 2013 seasons.**

| Potassium split application (k): | Irrigation intervals (I) | | | | | |
|---|---|---|---|---|---|---|
| | 2012 | | | 2013 | | |
| | 3 days | 6 days | 9 days | 3 days | 6 days | 9 days |
| $K_1$ | 43.82ab | 43.24b | 37.52f | 43.74bc | 42.67d | 37.04h |
| $K_2$ | 44.31a | 34.93ab | 38.75e | 43.88abc | 43.52c | 38.39g |
| $K_3$ | 44.29a | 44.44a | 41.36d | 44.37a | 44.43a | 40.93f |
| $K_4$ | 44.34a | 44.49a | 42.39c | 44.14ab | 44.21ab | 41.97e |

**Means: followed by the same litter (s) are not significantly different, according to DMRT.**
**K1: All basal (B).K2: ½ B + ½ mid tillering (MT).K3: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI).**
**K4: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

**Water relations:**

Data listed in Tables17 and 18 refer that irrigation intervals had marked variation in total applied water, water save and water use efficiency in both seasons. The irrigation every 3 days had the highest values of total applied water, while the prolonged irrigation interval of 9 days recorded the minimum values of total applied water. At the same time, the irrigation interval of 9 days gave the maximum amount of water save with medium value of water use efficiency. On the other side, the 3 days irrigation interval gave the least water use efficiency that are hold true in both seasons. The intermittent irrigation interval of 6 days clearly mediated the two irrigation intervals in amount of water save and it recorded the highest values of water use efficiency. Interestingly, the highest mean of water use efficiency was obviously recorded by the intermittent irrigation interval of 6 day with slightly insignificant yield reduction. The prolonging irrigation interval of 9 day gave the highest value of yield reduction. Therefore, the intermittent irrigation interval could be recommended (Tables16, 17 and 18). The potassium spilt application treatments greatly varied in their effect on water use efficiency in both seasons(Table18).The potassium split application into equal four doses of ¼ B + ¼ MT + ¼ PI + ¼ boating (BT) possessed the highest values of water use efficiency in both study of seasons(Table18). On the other hand, the lowest values of water use efficiency were produced by one dose potassium application. Similar data had been reported by Zayed *et al.* (2007), Majid(2012) and El-Habet, Howida (2014) as well as El-Rfaee *et al.*(2012).

From going discussion, the potassium split application into four or three doses had affinity to alleviate the harmful of water stress resulted from prolonging irrigation interval ensuring considerable rice grain yield under such condition and indicating water save.

**Table 16:Water consumed of EHR1 as affected by different irrigation treatments during 2012 and 2013 seasons.**

| Before treatments: | Amount of water consumed ($m^3$/ha.) | |
|---|---|---|
| | 2012 | 2013 |
| Land preparation of the nursery | 180.4 | 195.6 |
| Raising seedling (25 days) | 289.9 | 294.8 |
| Preparation of permanent field | 1880.5 | 1750.6 |
| 10 days before irrigation treatments | 1723.7 | 1693.2 |
| Total | 4074.5 | 3934.2 |
| Through irrigation treatments | | |
| 3 days | 9418.4 | 9675.6 |
| 6 days | 7966.3 | 8174.4 |
| 9 days | 6688.7 | 6748.9 |
| Irrigation intervals | Total water used ($m^3$/ha.) | |
| | 2012 | 2013 |
| 3 days | 13492.9 | 13609.8 |
| 6 days | 12040.8 | 12108.6 |
| 9 days | 10763.2 | 10683.1 |

**Table 17: Some water relations of Egyptian Hybrid 1 rice cultivar as affected by irrigation treatments during 2012 and 2013 seasons.**

| Irrigation treatments | Total water ($m^3$/ha.) | | Grain yield (t/ha.) | | Yield reduction (%) | | Water saved (%) | | Water use efficiency (WUE kg/$m^3$) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| 3 days | 13492.9 | 13609.8 | 10.94 | 11.08 | - | - | - | - | 0.811 | 0.814 |
| 6 days | 12040.8 | 12108.6 | 10.76 | 10.88 | 1.65 | 1.81 | 10.76 | 11.03 | 0.894 | 0.899 |
| 9 days | 10763.2 | 10683.1 | 8.97 | 8.95 | 18.01 | 19.22 | 20.23 | 21.50 | 0.833 | 0.838 |

**Table 18:The effect of interaction between irrigation intervals and potassium split application on water use efficiency during 2012 and 2013 seasons.**

| Potassium split application (k): | Irrigation intervals | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 2012 | | | | 2013 | | | |
| | 3days | 6days | 9days | Mean | 3 days | 6 days | 9 days | mean |
| $K_1$ | 0.770 | 0.826 | 0.738 | 0.778 | 0.780 | 0.832 | 0.758 | 0.790 |
| $K_2$ | 0.789 | 0.862 | 0.773 | 0.808 | 0.788 | 0.872 | 0.793 | 0.818 |
| $K_3$ | 0.841 | 0.940 | 0.858 | 0.880 | 0.842 | 0.941 | 0.878 | 0.887 |
| $K_4$ | 0.846 | 0.946 | 0.899 | 0.897 | 0.846 | 0.948 | 0.922 | 0.905 |
| mea | 0.811 | 0.894 | 0.833 | | 0.814 | 0.899 | 0.838 | |

**$K_1$: All basal (B).$K_2$: ½ B + ½ mid tillering (MT). $K_3$: ⅓ B + ⅓ MT + ⅓ panicle initiation (PI). $K_4$: ¼ B + ¼ MT + ¼ PI + ¼ boating (BT).**

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## استجابة صنف الأرز هجين مصري واحد لاضافة البوتاسيوم علي دفعات تحت فترات ري مختلفة

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**مركز البحوث و التدريب في الأرز ، سخا ، كفرالشيخ، معهد بحوث المحاصيل الحقلية، مركز البحوث الزراعية، جيزة، مصر.**

اقيمت تجربتان حقليتان بالمزرعة البحثية لمركز البحوث والتدريب في الارز سخا- كفر الشيخ- مصر خلال موسمي ٢٠١٣،٢٠١٢م لدارسة تاثير فترات الري المختلفة و معاملات اضافة البوتاسيوم علي دفعات علي صنف الارز هجين مصري واحد. أجريت التجارب في تصميم الشرائح المتعامدة في أربع مكرارات حيث وزعت معاملات الري وهي الري كل ٣، ٦و ٩ ايام في الشرائح الافقية بينما وزعت معاملات البوتاسيوم وهي كل المعدل الموصي بة دفعة واحدة علي الشراقي ،٢/١ علي الشراقي+٢/١ عند التفريع المتوسط ،٣/١ علي الشراقي+٣/١ عند التفريع المتوسط+٣/١ عند بداية تكوين السنبلة ،٤/١ علي الشراقي+٤/١ عند التفريع المتوسط+ ٤/١ عند بداية تكوين السنبلة+ ٤/١ عند بداية طور الحنبلة في الشرائح الراسية.

عند الطرد تم دراسة بعض صفات النمو وهي محتوي الكلورفيل ، دليل مساحة الورقة و المادة الجافة. عند الحصاد تم تقدير محصول الحبوب و مكوناتة وهي طول النبات، عدد السنابل م$^{-٢}$ ,عدد الحبوب الكلية السنبلة$^{-١}$ ,عدد الحبوب الممتلئة السنبلة $^{-١}$, وزن الألف حبة ،محصول الحبوب، محصول القش و دليل الحصاد. تم تقدير القياسات المائية وهي كمية المياة الكلية المضافة م٣هكتار$^{-١}$ والنسبة المئوية للمياة الموفرة لكل معاملة ري وكفاءة استخدام المياة كجم م$^{-٣}$ و تم تقديرالنسبة المئوية لنقص المحصول الناتج عن تطويل فترات الري .

وقد اوضحت النتائج المتحصل عليها ان معاملات الري اثرت معنويا علي كل الصفات المدروسة ووجد ان معاملة الري كل ٩ ايام قللت كل صفات النمو والمحصول ومكوناتة ودليل الحصاد مسجلة اقل القيم لكل هذة الصفات. وكانت معاملتا الري كل ٣ و ٦ ايام علي نفس المستوي من المعنوية في تاثيرهما علي صفات النمو والمحصول ومكوناتة ودليل الحصاد محققة اعلي القيم. حصلت معاملة الري كل ٣ ايام علي اعلي كمية من مياة الري هي٩,١٣٤٩٢ ،١٣٦٠٩,٨م$^{٣}$هكتار$^{-١}$ واقل قيمة لكفاءة استخدام المياة وهي٠,٨١١, ٠,٨١٤ كجم م$^{-٣}$ خلال الموسم الاول والثاني علي التوالي .و اعطت معاملة الري كل ٩ ايام اعلي قيمة للنقص في المحصول وهي١٨,٠١ , ١٩,٢٢% واعلي قيمة لتوفير المياة وهي ٢٠,٢٣ , ٢١,٥٠ وقيمة متوسطة لكفائة استخدام المياة ٠,٨٣٣ ، ٠,٨٣٨ كجمم$^{-٣}$ في كلا الموسمين . وحصلت معاملة الري كل ٦ ايام علي اعلي قيمة لكفائة استخدام المياة ٠,٨٩٤, ٠,٨٩٩ كجم م$^{-٣}$ وبلغ النقص في المحصول ١,٦٥ , ١,٨١ % وكمية مياة متوفرة بلغت ١٠,٧٦ , ١١,٠٣% في الموسم الاول والثاني علي التوالي.

اظهرت معاملات اضافة البوتاسيوم علي دفعات تاثيرا معنويا و حسنت كل صفات النمو والمحصول ومكوناتة ودليل الحصاد وكفاءة استخدام المياة مقارنة بمعاملة اضافة البوتاسيوم دفعة واحدة علي الشراقي٠ تفوقت معاملة اضافة البوتاسيوم علي٤دفعات ٤/١ علي الشراقي +٤/١ عند التفريع المتوسط +٤/١عند بداية تكوين السنبلة +٤/١عند طور الحنبلة معنويا علي باقي معاملات البوتاسيوم حيث اعطت اعلي القيم لكل الصفات تحت الدراسة وكذللك اعلي قيمة لكفاءة استخدام المياة وهي ٠,٨٩٧ , ٠,٩٠٥ كجم م$^{-٣}$ في كلا الموسمين بينما اعطت معاملة اضافة البوتاسيوم دفعة واحدة علي الشراقي اقل القيم في كل الصفات. كل من معاملة اضافة البوتاسيوم علي ٣ دفعات و٤دفعات كانت علي مستوي واحد من المعنوية في تاثيرهما علي المادة الجافة,عدد السنابل م$^{-٢}$و العدد الكلي للحبوب سنبلة$^{-١}$ وعدد الحبوب الممتلئة سنبلة$^{-١}$, وزن الألف حبة , محصول الحبوب و القش , دليل الحصاد وايضا كفاءة استخدام المياة.

اثر التفاعل بين معاملات الري و البوتاسيوم معنويا علي محتوي الكلوروفيل ,دليل مساحة الأوراق , المادة الجافةم$^{-٢}$( موسم ٢٠١٢) ,طول النبات , عدد السنابل م$^{-٢}$, العدد الكلي لحبوب السنبلة, عدد الحبوب الممتلئة بالسنبلة,وزن الالف حبة , محصول الحبوب و القش وكذلك دليل الحصاد في موسمي الدارسة. ومن نتائج التفاعل وجد ان افضل المعاملات هي الري كل ٦ ايام مع اضافة البوتاسيوم علي اربعة دفعات من حيث المحصول و كفاءة استخدام المياة.

يمكن التوصية باضافة البوتاسيوم علي اربعة دفعات متساوية خصوصا عند المراحل الحساسة لنقص مياة الري وهي فترة التفريع المتوسط و بداية تكوين السنبلة و بداية طور الحنبلة و ذلك تحت ظروف الري كل ٦ ايام للحصول علي اعلي محصول حبوب و اعلي كفاءة استخدام مياة مع توفير قدر من المياة المستخدمة في حقول الأرز.