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AGRONOMIC PERFORMANCE OF RICE (*ORYZA SATIVA L.*) GROWN UNDER ALTERNATE WETTING AND DRYING (AWD) IRRIGATION REGIMES WITH SPLIT APPLICATION OF POTASSIUM FERTILIZER

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ABSTRACT

The experiment was conducted at the Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi during the period from December 2015 to May 2016 to investigate the effect of alternate wetting and drying (AWD) irrigation regimes and spilt application of potassium fertilizer on the yield and yield components of transplant Boro rice (cv. BRRI dhan28). The experiments consist of factor A, two potassium fertilizer application practices (control or single application, K1 and split application, K2). The result showed that spilt application of potassium has progressive effect on different agronomic parameters but most of the cases, those were not statistically significant. The highest grain yield (6.708 t ha^{-1}), Panicle length (27.345 t ha^{-1}), tiller $hill^{-1}$ (13.33 t ha^{-1}), harvest index (47.304) were obtained from K2 treatment. Factor B, Four irrigation regimes ie. CK or control, irrigation was applied as per farmers practice (continuous flooding); AWD-1, irrigation was applied observing level of water in the field tube at field level; AWD-2, level of water in the field tube at 5 cm below the field level and AWD-3, level of water in the field tube at 10 cm below the field level. Considering irrigation regimes, it was found that most of the cases control irrigation treatment (conventional flooded irrigation) gave the highest grain yield (6.853 t ha^{-1}), panicle length (26.517 t ha^{-1}) tiller $hill^{-1}$(12.50), grain $panicle^{-1}$ (96.78 t ha^{-1}), filled grain (82.12 t ha^{-1}) but all those cases AWD^{-1}, irrigation provides almost similar performance. Although AWD irrigation could not increase rice yield, it can save huge amount of irrigational water. Based on our findings it can be concluded that AWD irrigation was applied observing level of water in the field tube at field level along with split application of potassium fertilizer would be the best practice for rice cultivation in the study area.

INTRODUCTION

Several water-efficient irrigation strategies had been tested where rice grown like any other upland crop, resulting in substantial water savings but also in a significant penalty on grain yield, especially with the use of high-yielding irrigated varieties (Peng*et al.*, 2006). The International Rice Research Institute (IRRI) has developed a new irrigation technology for reducing water use in rice production known as alternate wetting and drying (AWD) (IRRI, 2009).

Rice is considered as the staple food crops in Bangladesh, Rice is grown in over 10 million hectares under diverse ecosystem of irrigated, rain fed and deep water conditions in three distinct seasons, namely Aus, Aman and Boro. During Boro season, rainfall is usually limited in Bangladesh thus a tremendous amount of water is used for the rice irrigation under the conventional water management practices (continuous deep flooding irrigation) consuming about 70 to 80 percent of the total irrigated fresh water resources (Barind Integrated Area Development Project, BIADP) Irrigation system also requires a huge amount of power supply this further create additional shortage for household power requirements. However, irrigation water in Bangladesh is becoming increasingly scarce and costly (Rijsberman, 2006). Rapid population growth, urbanization and multiple competing demands for water (i.e., drinking, industrial uses) have contributed to irrigation water scarcity (Pingali*et al.*, 1997). Tuong and Bouman (2003) estimate that, by 2025, about 2 million ha of Asia's irrigated dry-season rice and 13 million ha of its irrigated wet-season rice will experience physical water scarcity. The occurrence of water scarcity prompted researchers to find waysto optimize water use under water saving systems in irrigated rice fields in the tropicswhere high yield is critical to ensure food security (Rosegrant and Ringler, 1998).

Reducing water input in rice production can have a high social and environmental impact if the water saved can be diverted to areas where competition is high. A reduction of 10 percent in water used in irrigated rice would free 150,000 million m^3, corresponding to about 25 per cent of the total fresh water used globally for non-agricultural purposes (Klemm, 1999). However, rice is very sensitive to water stress. Attempts to reduce water inrice production may result in yield reduction and may threaten food security. The challenge is therefore to develop socially acceptable, economically viable and environmentally sustainable novel water management practice that allow rice production to be maintained or increased in the face of declining water availability.

AWD is an irrigation technique where water is applied to the field a number of days after disappearance of ponded water. This is in contrast to the traditional irrigation practice of continuous flooding (i.e., never letting the ponded water disappear). This means that the rice fields are not kept continuously submerged but are allowed to dry intermittently during the rice growing stage. The number of days where the field is allowed to be ‘‘non-flooded’’before irrigation is applied can vary from 1 day to more than 10 days. The under lying premise behind this irrigation technique is that the roots of the rice plant are still adequately supplied with water for some period (due to the initial flooding) even if there is currently no observable ponded water in the field. The AWD irrigation aims in reducing water input and increasing water productivity while maintaining grain yield (Bouman and Tuong, 2001;Tabbal *et al.*, 2002). Zhi (2001) explored the impact of AWD on water use and found that irrigation water use was reduced by 7–25 per cent with the AWD technique. Singh *et al.*(1996) reported that, in India, the AWD irrigation approach can reduce water use by about40–70 per cent compared to the traditional practice of continuous submergence, without asignificant yield loss. Studies by Cabangon*et al.* (2001) and Moya*et al.* (2004) in China also found similar results. In different areas of Bangladesh AWD irrigation technology has also been tested by several researchers and found progressive responses (Bangladesh Rice Research Institute, BRRI). Although AWD is a well-established irrigation technology, it still needs to be improved considering nutrient management and agronomic practices of rice Karim*et al*., (2002). A number of previous researches claims that rice plant often faces drought under AWD and resulted to poor yield. Considering this situation, it is also necessary to consider proper nutrient management that support rice plants to adjust with drought Chandrasekaram*et al*.,(1996).

Out of all the mineral nutrients, potassium (K) plays a particularly critical role in plant growth and metabolism, and it contributes greatly to the survival of plants that are under various biotic and abiotic stresses. There is a remarkable positive relationship between K fertilizer input and grain yield has been described by several authors (Dong *et al.*, 2012).

Moreover, potash plays a major role in spikelet development and ripening. Top dressings of potassium can alleviate the sterility problem in rice. It is known to play vital role in photosynthesis, translocation, activation of enzymes and disease resentence in rice (Alagrasamy and Bhasharan ,1986)

In Bangladesh, K is traditionally applied in rice field just before transplanting or at final land preparation. But split application of potassium at appropriate level can increase filled grain and reduce sterility and thereby increase the yield of rice. Time of potassium application is also an important aspect in rice production. Significantly higher yield of rice have been reported due to split application rather than single application of potassium by many workers (Manzoor *et al.* 2008). Therefore present research was aimed to investigate agronomic performance of rice grown under different alternate wetting and drying (AWD) irrigation regimes and split application of potassium fertilizer.

Objectives: Objectives are

1. To determine the optimum deficit irrigation schedule and amount of irrigational water to be appropriate for rice cultivation.
2. To determine feasibility of split application of potassium fertilizer under deficit irrigation condition.
3. To increase irrigation application efficiency (Ea) and water use efficiency (WUE) of Rice.

MATERIALS AND METHODS

The research was conducted at the Agronomy Field Laboratory, Department of Agronomy and Agricultural Extension, University of Rajshahi, Rajshahi, during the period from January to May 2016, to investigate agronomic performance of rice grown under different alternate wetting and drying (AWD) irrigation regimes and split application of potassium fertilizer. Geographically the experimental field is located at 24°22’36” N latitude and 88°38’27”E longitude at an average altitude of 71 ft above sea level. The experimental area belongs to the subtropical climate under Central Southern Part of High Ganges River floodplain i.e., under the Agro-Ecological Zone-11 (AEZ-11) (FAO, 1988). The land of the experimental field was flat, well drained and above flood level (Medium high land). The soil was sandy loam textured having pH value of 8.1.

The experimental field was under subtropical climate characterized by moderately high temperature and heavy rainfall during the kharif season (April to September) and scantly rainfall with moderately low temperature during the rabi season (October to March). The weather data of the experimental area during the study period (January, 2016 to May 2016) are presented in. The air temperature ranged from6.8˚C to 41.2˚C and mean temperature was 25.5 ˚C. Total rainfall was received 406.5 mm in 22 rainy days. The maximum humidity was 97% and minimum humidity was 27 %. The average humidity was 65.25%.

This study was conducted on BRRI dhan 28, one of the famous rice variety commonly cultivated in the study area. The experiments consists of Factor A, Four irrigation regimes as CK or control, irrigation was applied as per farmers practice (continuous flooding), AWD-1, irrigation was applied observing level of water in the field tube at field level; AWD-2, level of water in the field tube at 5 cm below the field level and AWD-3, level of water in the field tube at 10 cm below the field level and factor B, two potassium fertilizer application practices (control or single application, $_{K1}$ and split application,K_2). Both factors are combined together 8treatments and those were replicated three times using split plot experimental with three replications**.** Potassium doses were placed in the main plot and irrigation regimes were applied at sub-plot. Each plot occupied an area of 20 m^2, and the distance between the main plots and sub-plot unit plots were 2.0m and 1.5m respectively.

Irrigation and drainage

Each plot was irrigated separately and the amounts of irrigation depth in the field as well as in the field water tubes were measured manually. In the present experiment, field water tubes were used to monitor and measure the gradually receding depth of water level in the field. The field water tube was made from a plastic pipe. 40 cm length of plastic pipe having diameter of 15 cm was used. The bottom 20 cm of this pipe was drilled about 0.5cm each and 2cm away from one another (Figure 1). The field water tubes were installed just before the transplanting. When the field is flooded after each irrigation water application event, the water seeps through the perforations in to the field water tube and the water level inside the tube is the same as that of outside the tube. However, with time as the submergence depth of water level recedes, so in the field water tube the same was monitored and measured in each field tube treatment twice using a scale. All plots remain flooded during seedling establishment and anthesis stage. Irrigation was withheld 10 days ahead of harvest. In case of heavy rainfall events, excessive rainfall was drained off to keep the ponded water within the maximum allowable depths. The field was finally drained out before 15 days of harvest to enhance maturity.

Three hills (excluding the border hills) from each plot were randomly selected to collect data about growth parameters. Selected hills were uprooted, tagged and properly cleaned from dirt materials before collect data. The operation was done at 20 days' intervals up to harvest. The crop was harvested at optimum maturity when grains were filled properly. Harvesting was done on 2 May.

After harvesting, the crop of each plot was separately bundled, properly tagged and then brought to the threshing floor. After drying the crops were threshed by paddle thresher separately plot-wise. Then the grains were dried in the sun and cleaned. Straws were also sun dried properly. Finally, grain and straw yield were adjusted to 14 per cent moisture and converted to ton ha^{-1}. Randomized procedure was followed to collect the data of the growth parameters, yield and yield components.

Biological yield= Grain yield + Stover yield.

Harvest index (%) was calculated with the following formula:

Harvest index (%) = Grain yield/Biological yield × 100.

Statistical analysis

The collected data were analyzed statistically using the analysis of variance technique and the mean differences were adjudged by Duncan's New Multiple Range Test (Gomez and Gomez, 1984) with the help of MSTAT software.

RESULTS AND DISCUSSION

Plant height (cm)

No remarkable difference in plant height was observed for single (K_1) and split (K_2) application of potassium fertilizer at 30,90 and 120 DAT but a significant higher value in plant height was observed for K_2at 60 DAT (**Table 1**).

At 30 DAT, highest plant height (29.363cm) was observed in K_2 and lowest (27.598cm) was in K_1, At 60 DAT, plant height was significantly higher at K_2 which was 11.44% higher than K_1. At 90 DAT, the highest (74.978cm) Plant height was observed in K_2 treatment and the lowest (74.443cm) was in K_1. Plant height was also highest with K_2 at 120 DAT.

Plant height was not influenced by irrigation treatments at 30 and 90 DAT but it was significant at 60 and 120 DAT (**Table** 1). At 30 DAT, highest plant height (29.727 cm) was observed in AWD-1 and the lowest (26.883cm) was in CK, At 60 DAT plant height was found highest (68.62cm) in CK and lowest was in (55.57cm) AWD-3. At 90 DAT, significant higher value in plant height was observed in CK, which reduced slightly 2.13 and 5.27% for AWD-1 and AWD-2 respectively but significantly by 10.52% for AWD-3. At 120 DAT highest plant height (82.005cm) was found in CK and the lowest (72.865 cm) was in AWD-3.

Plant height was not statistically significant due to interaction between split application of potassium fertilizer and AWD irrigation regimes at all observations (30,60,90 and 120 DAT) (**Table** 1).

At 30 DAT, the highest plant height (32.040 cm) was observed for the interaction of K_2 with AWD- 2 and the lowest plant height (24.567 cm) was found for K_1 with CK. At 60 DAT, the highest plant height (72.467 cm) was found for the combination of K_2 with CK and the lowest plant height was (52.267 cm) found in K_1 with AWD-3. At 90 DAT, the plant height was highest (78.433 cm) for the interaction of K_1 with CK and the lowest plant height (68.233cm) was found in the interaction of K_1 with AWD-3. At 120 DAT, plant height ranged from 69.897cm to 82.887 cm and the tallest plant (82.887cm) was obtained from K_2 with CK and the shortest plant height was found in combination of K_1 with AWD-3.

From the above results, it has been observed that plant height was mostly highest with irrigation availability. Most of the cases highest plant height was observed in plants with control irrigation. A number of previous results claim that plant height of rice plant can be reduced under AWD irrigation Sharma,(1980). However split application of potassium fertilizer also shows some progressive response in plant height especially under less irrigation regimes, this result is further supported by Santoes *et al.*(1999)

Tiller number

Tiller number was not influenced by Potassium fertilizer treatments at all observations (60, 90 and 120 DAT) (Table 1). Results revealed that the highest number of tillers/plant (5.673) was recorded at 60 DAT at K_2 and the lowest number of total tillers plant^{-1} (5.44) was obtained with K_1. Tiller number was not viciously influenced by potassium fertilizer treatment at 90 DAT and the highest tiller number (11.25) was found in K_2 and lowest number (10.75) was obtained at K_1. Tiller number was not widely influenced also by potassium treatment at 120 DAT. The highest tiller (13.333) was found in K_2 and the lowest number (12.833) was recorded in K_1.

Tiller number was not influenced by irrigation treatments at, 60DAT but it is greatly influenced at 90 and 120 DAT (Table 1). Tiller number was not viciously influenced by irrigation treatment at 60 DAT where the highest tiller number (5.87) was found in CK and lowest (5.09) was obtained at AWD-3. Tiller number varied significantly with different levels of irrigation at 90 DAT (Table1). The highest number of tiller (12.50) was found while the crop was irrigated with high rate of irrigation in control treatment which was 33.97% higher than AWD-3 irrigation treatment. Tiller number also showed significant result with the changing pattern of irrigation at 120 DAT and the highest number of tiller (14.17) was found in control treatment which was 19.78% more than AWD-3 irrigation treatment.

The interaction effect of potassium and irrigation are presented imperceptible effect on plant tiller number (Table 1) at all observations (60, 90, and 120 DAT). At 60DAT, highest tiller number (5.97) was noticed inK_2 with AWD-1 and the lowest (4.93) was in combination of K_1 with AWD-3. At 90DAT, the highest tiller number (13.00) was noticed from K_2 with control (CK) treatment and the lowest tiller number (9.00) was observed from K_1 with AWD-3 treatment. At 120DAT, the utmost tiller number (15.00) was noticed from K_2 with control (CK) irrigation treatment and the lowest tiller number (11.00) was observed from K_2 with AWD-3.

Total dry matter (TDM)

Total dry matter was not influenced by potassium fertilizer treatments at all observations (30, 60, 90 and 120 DAT) (Table 1). Results revealed that the highest amount of TDM (31.96g) was recorded at 30 DAT for K_2 and the lowest (30.362g) was obtained at K_1. At 60 DAT, TDM was also not influenced by Potassium fertilizer treatments and the highest value (58.397g) was recorded at K_1 and the lowest TDM (58.275g) was obtained at K_2. At 90DAT highest TDM (166.810g) was noticed from K_2 and the lowest (161.935) was from K_1.Total dry matter was also not influenced by Potassium fertilizer treatment where the highest value (265.599g) was noticed from K_2 and the lowest (252.044) was noticed from K_1.

Total dry matter was greatly influenced by different irrigation treatments at 30, 60, 90 and 120 DAT (Table 1). At 30 DAT, highest TDM (32.70g) was found in control treatment which was 10.43% higher than AWD-3. The TDM value showed significant difference 60 DAT where the highest TDM (64.49g) was found in CK which was 20.20% higher than AWD-3. At 90 DAT, total dry matter was found highest (179.5g) in control treatment (CK) which was 17.70% higher than AWD-3. In addition, TDM also showed significant result at 120DAT, and maximum TDM (293.0g) was obtained in control treatment (CK) which was 18.67 and 29.30% higher than AWD-2 and AWD-3 respectively.

The interaction effect of potassium and irrigation are presented in Table- 1 had no remarkable effect on rice. At 30 DAT, highest TDM (33.473g) was noticed from combination of $K_2$with CK irrigation and the lowest TDM (28.287g) was noticed from K_1 with AWD-3. The interaction of split potassium application and irrigation methods on TDM at 60DAT had marginal distance in their results in case of TDM (Table 1). After 60 DAS the maximum TDM (66.980g) was found in K_1 with control rate of irrigation and the minimum (51.700g) was from K_1 potassium application and AWD-3 rate irrigation. At 90 DAT, highest TDM (179.457g) was noticed from K_2 with high irrigation treatment at control and the lowest TDM (148.950g) was noticed from K_1 with AWD-3. After 120 DAT the highest TDM (293.510g) was obtained from K_2 with CK and the lowest (214.233g) was from K_1 with AWD-3.

Effect on crop growth rate (CGR)

CGR was not significantly influenced by split application potassium fertilizer treatments at all observations (60, 90 and 120 DAT) (Table 1). At 60 DAT, highest CGR (1.402) was recorded at the potassium level K_1 and the lowest CGR (1.316) was obtained at K_2. Crop Growth Rate was also not viciously influenced by potassium fertilizer treatment at 90 and 120 DAT and both case highest CGR (5.428 and 4.939, respectively) was found in K_2 potassium level.

CGR was exceedingly influenced by different irrigation treatments at 60, 90 and 120 DAT (Table 1). At 60 DAT, highest CGR (1.590) was found in CK or irrigation treatment which was 32.27% higher than AWD-3 irrigation treatment. At 90 DAT, highest CGR (5.748) was fabricate while the crop was irrigated with high rate of irrigation in control treatment(CK) which was nearly 11% higher than AWD-3 irrigation treatment. CGR was also comprehensively influenced by different levels of irrigation treatment at 120 DAT. In that case the highest CGR (5.677) was identified with high rate of irrigation in control treatment (CK) which was more than 50% higher than AWD-3 irrigation treatment.

The interaction effect of potassium and irrigation are presented non- significant effect on CGR (Table 1) at 60, 90, and 120 DAT. The highest CGR (1.753) was noticed from K_1 potassium application with highest irrigation treatment and the lowest CGR (1.170) was noticed from K_1 treatment with AWD-3 treatment at 60DAT. The maximum CGR (5.873) was noticed from K_2 potassium application with control (CK) treatment and the minimum value (5.027) was observed from K_2 treatment with AWD-3 at 90DAT. The supreme CGR (5.703) was also noticed from K_2 potassium application with control (CK) irrigation treatment and the minimum CGR (4.010) was observed from K_1 treatment with AWD-2 irrigation treatment at 120DAT.

Tiller Fertility Rate

Tiller fertility rate was significant by potassium level. The highest yield (85.404 t ha^{-1}) was found from K_2 treatment and lowest 79.53 from K_1 treatment (Table 2). The tiller fertility rate was significant for irrigation treatment. The maximum tiller fertility rate (87.93 t ha^{-1}) was received from control treatment and lowest (4.33 t ha^{-1}) from AWD-1 treatment (Table 2). The interaction effect of potassium and irrigation on tiller fertility rate reported non-significant effect. (Table 2) The highest tiller fertility rate (89.99 t ha^{-1}) from found from interaction K_2 and AWD-1 Treatment and lowest (73.921 t ha^{-1}) from interaction K_1 and AWD-3 treatment.(Table 2)

Panicle length

The panicle length was Non-significant due to potassium treatment (Table 2). Highest panicle length (27.35cm) was counted from K_2 treatment and the lowest panicle length (23.855cm) was counted from K_2 potassium application. Panicle length showed significant effect in case of irrigation treatment (Table 2). Maximum panicle length (26.52cm) was attained at CK or control irrigation application which were 2.75, 2.30 and 9.677% higher than AWD-1, AWD-2 and AWD-3, respectively. The interaction effect of potassium and irrigation treatment had no spacious difference in respect of panicle length (Table 2). Highest panicle length (28.1cm) was obtained from K_2 treatment with high rate of irrigation in control treatment while the lowest panicle length (22.32cm) was found from K_1 treatment with AWD-3 treatment.

Grain panicle^{-1}

The result revealed no momentous effect on grain per panicle for the potassium treatment (Table 2). The maximum grain per panicle (94.433) was received from K_2 treatment and minimum grain per panicle (90.007) was received from K_1 treatment. The irrigation effect was not significant in respect of grainpanicle^{-1}(Table 2). Numerically the highest grain panicle^{-1} (96.780) was found in control treatment on the other hand the lowest grainpanicle^{-1}(88.318) was found from AWD-3 treatment. The interaction effect was also non-significant in view of grainpanicle^{-1}(Table 2). Though, the highest grain per panicle (99.267) was found from K_2 treatment with maximum irrigation (CK) and the minimum grain per panicle (85.927) was from the interaction of K_1 and AWD-3.

Filled grain

Filled grain showed minute effect in respect of potassium (Table 2). The highest filled grain (78.792) was attained from K_2 and minimum (72.571) was from K_1. The irrigation effect was non-significant as the same manner in respect of filled grain (Table 2). The result showed that the highest filled grain (82.120) was found in control treatment and the lowest filled grain (70.162) was found from AWD-3 treatment. The interaction effect of potassium and irrigation had no spacious difference in respect of filled grain (Table 2). Foremost fertile grain (84.943) was obtained from K_2 treatment with high rate of irrigation while the lowest filled grain (67.880) was found from the interaction of AWD-3 with K_1.

Unfilled grain

The result stated no meaningful effect on unfilled grain for the potassium treatment (Table 2). The maximum unfilled (17.436) was received from K_1 treatment and the least non filled (15.641) was received from K_2 treatment. The irrigation effect was not significant in respect of unfilled grain (Table 2). The result showed that the maximum unfilled grain (18.157) was found in AWD-3 treatment on the other hand the lowest unfilled grain (14.660) was found from control irrigation treatment. The interaction effect of potassium and irrigation failed too to show any extensive effect on unfilled grain (Table 2). Numerically, the highest unfilled grain (18.547) was noticed from K_1 treatment with AWD-1 and the lowest unfilled grain (14.323) was noticed from K_2 with control irrigation treatment.

1000-grain weight

The weight of 1000-grain departed marginally in case of potassium application treatment (Table 2). The maximum 1000-grain weight (25.342) was observed in K_1 treatment and the minimum (25.104g) was fromK_2. Weight of 1000-grain changed marginally for irrigation treatments (Table 2). The highest 1000-grain weight of (25.807g) was noticed from AWD-3 and the lowest (24.732g) was from control treatment. The interaction effect of potassium and irrigation on 1000-grain reported non-significant effect (Table 2). The highest 1000-grain weight (262.07g) was noticed from the interaction of K_1 treatment with AWD-3 irrigation treatment and the lowest 1000-grain weight (246.00g) was noticed from K_1 with control irrigation treatment.

Grain yield

Grain yield varied slightly upon the potassium fertilizer treatment (Table 2). Highest grain yield (6.708 t ha^{-1}) was found from K_2 treatment and lowest (6.125 t ha^{-1}) was found from K_1 treatment. Grain yield was consequential due to irrigation treatments (Table 2). Maximum Grain yield (6.853 t ha^{-1}) was found from high rate of irrigation in the control treatment which is 15.71% higher than lowest rate of irrigation supply in case of AWD-3 treatment. AWD-1treatment also showed higher grain yield (6.637 t ha^{-1}) comparison with AWD-3 treatment which was 11% lower than AWD-1. The interaction effect of potassium and irrigation on grain yield presented imperceptible effect (Table 2). The highest Grain yield (7.133 t ha^{-1}) was noticed from K_2 treatment with high irrigation rate and the lowest grain yield (5.667 t ha^{-1}) was noticed from K_1 potassium treatment with AWD-3 irrigation.

Straw yield

The result stated no meaningful effect on Straw yield for the potassium treatment (Table 2). The maximum Straw yield (7.484 t ha^{-1}) was received from K_2 treatment and the least Straw yield (6.917 t ha^{-1}) was received from K_1 treatment. Together with Straw yield presented changed imperceptibly for irrigation treatment (Table 2). The highest straw yield (7.795 t ha^{-1}) was noticed from control treatment and the lowest straw yield (6.883 t ha^{-1}) was from AWD-3 treatment. The interaction effect of potassium and irrigation on straw yield reported non-significant effect (Table 2). The highest straw yield weight (8.377 t ha^{-1}) was noticed from the interaction of K_2 treatment with control irrigation treatment and the lowest straw yield (6.613 t ha^{-1}) was noticed from K_1 treatment with AWD-2 treatment.

Biological yield

The result stated had no valuable effect on biological yield for the potassium treatment (Table 2). The maximum biological yield (14.193 t ha^{-1}) was received from K_2 treatment and the least biological yield (13.043 t ha^{-1}) was received from K_1 treatment. There was significant difference found in biological yield due to different irrigation treatments (Table 2). The highest (14.65 t ha^{-1}) biological yield was observed in control irrigation which was statistically identical to AWD-1 treatment (13.82 t ha^{-1}). The Biological yield reduced significantly by 14.18%, in AWD-3 treatment with the comparison with control irrigation. The interaction effect of potassium and irrigation on biological yield reported non-significant effect (Table 2). The highest biological yield (15.510 tha^{-1}) was noticed from the interaction of K_2 treatment with control irrigation treatment and the lowest biological yield (12.513 tha^{-1}) was noticed from K_1 with AWD-2 treatment.

Harvest Index

Harvest index was not significantly influenced by the potassium level (Table 2). The height harvest index 2.06 (%) was observed from K_1 treatment and lowest 1.889 (%) from K_2 treatment (Table-2). The harvest index was non-significant for irrigation treatment. The highest 2.746 (%) was found from AWD-3 and lowest 1.469 (%) from AWD-2 (Table 2). Harvest index was not significantly influenced by the interaction between potassium and irrigation. The height harvest index 3.673 (%) was found from the interaction between K_1 potassium fertilizer andAWD-3 irrigation and lowest 0.590 (%) from the interaction between K_1 treatment and control irrigation (Table 2).

CONCLUSION

Although AWD irrigation could not increase rice yield, it can save huge amount of irrigational water. Based on our findings it can be concluded that AWD irrigation was applied observing level of water in the field tube at field level along with split application of potassium fertilizer would be the best practice for T. Boro rice (var. BRRI dhan 28) cultivation in the study area.

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Table 1: Effects of potassium, irrigation and it's interaction on plant height (cm), tiller number, TDM and CGR at different after transplanting

Potassium level	Plant height (cm)				Tiller number			Total dry matter (TDM) (g m plant^{-1})				Crop growth rate g m^{2}day^{-1}		
	30 (DAT)	**60(DAT)**	**90(DAT)**	**120(DAT)**	**6(DAT)**	**90(DAT)**	**120(DAT)**	**30(DAT)**	**60(DAT)**	**90(DAT)**	**120 (DAT)**	**60(DAT)**	**90(DAT)**	**120(DAT)**
K_1	27.598	58.717 b	74.443	76.087	5.44	10.75	12.833	30.362	58.397	161.935	252.044	1.402	5.177	4.507
K_2	29.363	66.308 a	74.978	78 .708	5.673	11.25	13.333	31.959	58.275	166.81	265.599	1.316	5.428	4.939
LS	NS	0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Irrigation treatment														
CK	26.883	68.62a	78.22	82.055a	5.87	12.50a	14.17a	32.70a	64.49a	179.5a	293.0a	1.590a	5.748a	5.677a
AWD-1	29.727	63.37a	76.55	78.248a	5.84	11.33a	13.50a	32.11a	60.50a	166.9ab	268.8ab	1.422ab	5.320ab	5.097a
AWD-2	29.69	62.50ab	74.09	76.420ab	5.41	10.83ab	12.83ab	30.23b	54.70b	158.6bc	246.9bc	1.223b	5.195b	4.418ab
AWD-3	27.673	55.57b	69.99	72.865b	5.09	9.33b	11.83b	29.61b	53.65b	152.5c	226.6b	1.202b	5.945b	3.700b
LS	NS	0.05	NS	0.05	NS	0.01	0.01	0.05	0.01	0.01	0.01	0.01	0.05	0.01
Interaction effect														
K1 - CK	24.567	64.767	78.433	81.223	5.88	12	13.333	31.923	66.98	179.457	292.443	1.753	5.623	5.65
K1 - AWD 1	30.44	59.667	77.437	77.333	5.71	11.33	13	31.623	61.253	163.203	265.243	1.483	5.097	5.103
K1 - AWD 2	27.34	58.167	73.667	75.893	5.22	10.66	12.667	29.613	53.653	156.13	236.267	1.203	5.1238.1	4.01
K1 - AWD 3	28.047	52.267	68.233	69.897	4.93	9	12.333	28.287	51.7	148.95	214.223	1.17	0.863	3.263
K2 - CK	29.2	72.467	78	82.887	5.87	13	15	33.473	62.007	179.457	293.51	1.427	5.873	5.703
K2 - AWD 1	29.013	67.067	75.667	79.163	5.97	11.33	14	32.593	59.74	170.59	272.353	1.36	5.543	5.09
K2 - AWD 2	32.04	66.833	74.51	76.947	5.6	11	13	30.837	55.743	161.063	257.6	1.243	5.267	4.827
K2 - AWD 3	27.2	58.867	71.737	75.833	5.24	9.66	11	30.933	55.61	156.13	238.933	1.233	5.027	4.137
LS	NS	NS	0.01	0.01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	11.85	9.85	6.73	5.42	14.24	10.39	6.92	4.85	4.7	4.89	6.25	12.23	8.18	17

In a column figures having similar letters or without letter do not differ significantly, whereas, figures bearing dissimilar letters differed significantly (as per DMRT), LS = Level of significant; NS = Non significant, CV = Co-efficient of variation, K_1 = Potassium level-1, K_2 = Potassium level-2, CK = Control irrigation, AWD = Alternate wetting and Drying irrigation

Table 2: Effects of potassium , irrigation and it's interaction on yield and yield components

Potassium level	Tiller fertility rate (t ha-1)	Panicle length (cm)	Grain panicle^{-1}	Filled grain	Unfilled grain	1000 grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
K_1	79.530b	23.855	90.007	72.571	17.436	25.342	6.125	6.917	13.043	46.9
K_2	85.804a	27.345	94.433	78.792	15.641	25.104	6.708	7.484	14.193	47.3
LS	0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
Irrigation treatment										
CK	86.108ab	26.52a	96.78	82.12	14.66	24.732	6.853 a	7.795	14.65a	47.98
AWD-1	79.558bc	25.79a	94.448	77.693	16.755	25.45	6.637ab	7.183	13.82ab	47.21
AWD-2	77.073c	25.91a	89.332	72.75	16.582	24.905	6.227bc	6.942	13.17b	46.33
AWD-3	87.929a	24.18b	88.318	70.162	18.157	25.807	5.950c	6.883	12.83b	46.87
LS	0.05	0.01	NS	NS	NS	NS	0.01	NS	0.01	NS
Interaction effect										
K1 - CK	47.693	24.933	94.293	79.297	14.997	24.6	6.573	7.213	13.787	47.69
K1 - AWD 1	47.115	24.12	93.44	74.893	18.547	25.94	6.36	6.97	13.33	47.11
K1 - AWD 2	45.1196	24.043	86.367	68.213	18.153	24.623	5.9	6.613	12.513	45.19
K1 - AWD 3	47.607	22.323	85.927	67.88	18.047	26.207	5.667	6.873	12.54	47.6
K2 – CK	48.272	28.1	99.267	84.943	14.323	24.863	7.133	8.377	15.51	48.27
K2 - AWD 1	47.347	27.463	95.457	80.493	14.963	24.96	6.913	7.397	14.31	47.34
K2 - AWD 2	47.465	27.783	92.297	77.287	15.01	25.187	6.553	7.27	13.823	47.46
K2 - AWD 3	46.133	26.033	90.71	72.443	18.267	25.407	6.233	6.893	13.127	46.13
LS	0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	7.732	3.8	5.92	7.5	38.16	3.06	4.53	9.11	6.41	4.13

In a column figures having similar letters or without letter do not differ significantly, whereas, figures bearing dissimilar letters differed significantly (as per DMRT), LS = Level of significant; NS = Non significant, CV = Co-efficient of variation, K_1 = Potassium level-1, K_2 = Potassium level-2, CK = Control irrigation, AWD = Alternate wetting and Drying irrigation

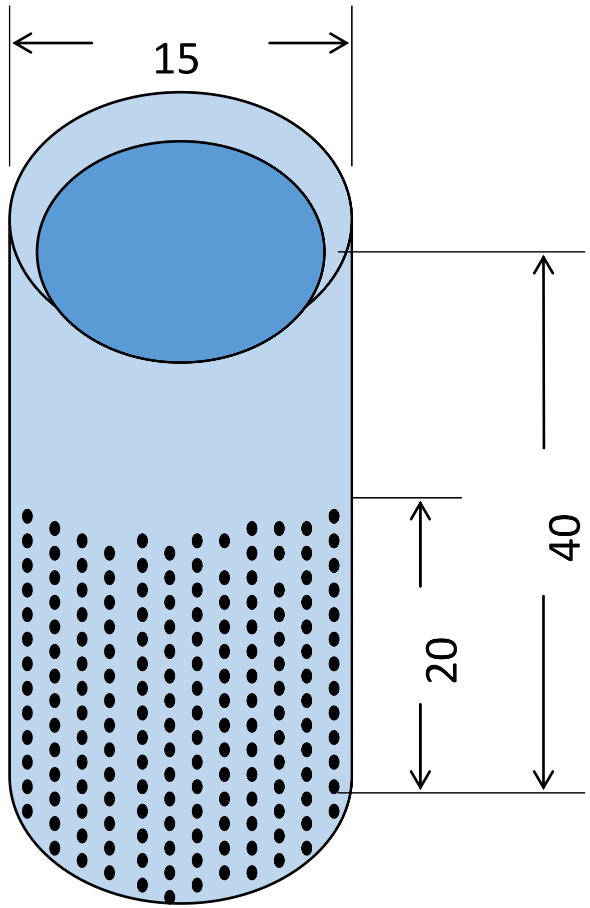

Figure 1: Field water tube

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