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Performance of potential rice genotypes for growth and yield under alternate wetting and drying intervention

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Abstract

Rice is a staple crop that is grown and consumed all around the globe. It is major food and cash crop of Pakistan sharing a significant position in national GDP. Rice, being an intensive water requiring crop, is facing pressure towards its cultivation due to limited water availability. In light of the current issue, water-saving technologies are needed to be improved and adopted to meet the food demand of a rapidly growing population. Alternate wetting and drying (AWD) is a method of irrigation to raise rice crop even with less irrigation water. Objective of the study was to compare the paddy yield of irrigated rice with AWD technology. The performance of 29 genotypes (hybrids, GSR lines and indigenous varieties) was assessed with two replications and three treatments of irrigation at field area of Rice Program NARC, Islamabad. The results of pooled analysis of data showed significant variation for plant height, number of productive tillers, number of grains per panicle, panicle length, thousand grain weight, days to flowering, days to maturity and paddy yield among all the genotypes. In case of yield, huge variation was observed among hybrids and Green Super Rice (GSR) lines with respect to indigenous varieties. The paddy yield of hybrids ranged between 6.5 to 9.5 kg in a plot size of 7.2 m^2 while others genotypes showed paddy yield ranging around 0.5kg to 2.25 kg/7.2m^2. Paddy yield was significantly increased with reduced input cost of irrigation by implementing the AWD technique as compared to conventional method of irrigation (flooding). AWD method of irrigation is not only conserved the resources but also increased water productivity. It was concluded from this study that farmers can use AWD tube to increase their profitability with reduced irrigations.

Keywords: Paddy yield, Profitability, Reduced irrigation, Water productivity, Water scarcity

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Introduction

Rice is a staple crop grown on more than 167 million hectares each year across the world. It delivers 20 % of daily calories, 13% per capita protein, and 19 % per capita energy requirements to more than half of the world's population (Carrijo et al., 2017). Rice consumption is increasing per capita over the world (Ishfaq et al., 2020). Asia accounts for 87% of world's GDP. Rice being Pakistan's major food crop, covered 3,335 thousand hectares, second to wheat crop producing 8.419 million tons of rice in 2020.

Rice, on the other hand, requires a huge amount of fresh water as irrigation, being a water-intensive crop (Bouman and Tuong 2001). For a developing country like Pakistan, where water scarcity is already a problem, water conservation is critical issue to be addressed. Increasing agricultural water productivity is fundamentally achieving the objective of food security. Value or advantage derived by using per unit water is referred to as water productivity (Descheemaeker, 2013). To produce one kg of rice, traditional rice cultivation requires 300 to 500 gallons of irrigation water (Claro, 2019). Rice is a highly water-intensive crop, according to (Forare, 2008), who claims that one kilogram of rice cultivation consumes 3400 liters of water on average over the world.

In Pakistan, most of the rice belt is under rice-wheat cropping zone (RWCZ), where both rice and wheat are repeated in alternate seasons. Normally the most popular method of rice cultivation is on the puddled field with manual transplanting method that utilized heavy amount of water. Mainly practice under use is traditional transplanting rice (TPR), which is grown on puddled fields and necessitates a large amount of irrigation, is the most popular production system (Rao and Nagamani, 2007). Traditional rice cultivation, in the RWCZ, is declining as the water table drops and rice water sources declining to be scarce (Akram et al., 2013) because of irregular precipitation distribution and rising temperatures (Amin et al., 2018) under a changing climate (Amin et al., 2017). Furthermore, producing an inundation situation for transplanting of rice to puddle the soil demands, more water and is a time-consuming process. In addition, conventional TPR's viability is being affected by an inconsistent and expensive electricity supply. The lack of water conservation methods in irrigated areas, as well as the need for water for the industrial, household, and other non-agriculture sectors, there is a need to improve efficiency of irrigation system (Ishfaq et al., (2020).

According to (Kumar and Gautam,2014), farmers in India must produce 50% more grain by 2020 to meet demand, whereas (CCAFS, 2013) stated that improving food production under changing climatic conditions necessarily requires a reorientation of agriculture from current practices to more sustainable and environmentally friendly practices, with a greater emphasis on climate smart production techniques.

As a result, more efficient water management practices – water-saving technologies – are needed to meet the food demand of a rapidly growing population amidst increasing water scarcity, so that rice production levels in Asia (the continent's main staple food) can be maintained or increased even with less irrigation water. Various technologies have been developed to assist rice farmers thus avoiding water shortages and managing deficient resources (Dong et al., 2012; Liu et al., 2015). The alternate wetting and drying (AWD) irrigation system is a water-saving technology that has been developed for rice growing in Asia (Belder et al., 2004; Rejesus et al., 2011; Bouman and Tuong, 2001).

The alternate wetting and drying (AWD) approach, which was initially used by the International Rice Research Institute (IRRI) more than 20 years ago, is one strategy that has been created to reduce overall water use for rice production. IRRI created the AWD method so that rice, despite being a semi-aquatic plant, could be cultivated with very little water without compromising on the paddy yields (IRRI, 2010; IRRI, 2018). The soil remains moist enough for the rice plant to develop while the water level decreases below the soil surface. The AWD technique uses non-conventional irrigation practices to enhance water use efficiency and reduce environmental constraints while gaining a financial advantage. In contrast to farmers' traditional technique of continuous flooding, the technology is also known as controlled irrigation or intermittent irrigation system. In comparison to present practice, the AWD approach may drastically reduce the number of irrigations, perhaps reducing paddy water utility by 25% (Siopongco et al., 2013). AWD technology in combination with laser land levelling has just been implemented in Pakistan, to combat the impact of climatic change. Although Pakistan has been using laser land leveling technology since the 1980s on form water management (OFWM Punjab, 2018; Nizami et al., 2020) but AWD technology is recent advancement.

Alternate wetting and drying (AWD), aerobic rice (AR), and saturated soil culture are some of the irrigation management options that have been studied to reduce water use (Carrijo et al., 2017, Maheswari et al., 2007, Ishfaq et al., 2020). In addition, to maintain or enhance water productivity, a combined system of various practices is practiced that includes shallow water depth with alternate wetting and drying (Zhi.M 2002), ground covering (Qin et al., 2006), direct planting without puddling (Malik et al., 2019) and irregular dry spells (Feng et al., 2007). Another method for reducing water shortage is to combine traditional TPR with AWD. When the water level in water pipes/water tubes gets 15–20 cm below the soil surface in AWD, the field is re-irrigated (Bouman, 2007). AWD is gaining popularity in rice production around the world because it improves water use efficiency (WUE) by reducing water consumption by 23–33% (Carrijo et al., 2017).

The goal of our study was to compare the growth and yield of irrigated rice farmed with various amounts of water supplied following AWD technology. It will also help to observe that how the AWD interventions affect irrigation pattern (e.g., number of hours and frequency), labor, yields, and profitability. The performance of hybrids, varieties, landraces and GSR lines was assessed under different irrigation regimes for yield and yield contributing traits.

Material and Methods

The research work was conducted at Rice Program, CSI, NARC field (latitude 33° 42 N' and longitude 73° 10' E.) during rice growing season 2020. The experiment was carried out in randomized complete block design consisting of 29 rice genotypes (including GSR, hybrids, varieties and landraces), two replications and three treatments. Experimental plots were of 7.2 m^2 with 20cm distance between plants on each side. Three different level of irrigations were applied as treatments as irrigated when water level reached to certain depth of AWD tube as 2" depth, at 4" and at 6" depth.

Fertilizers and weeds management

Fertilizer was applied according to the recommended doses (N: P: K @ 120: 90: 60 per hectare) following standard practices of rice production technology. Weeds were controlled by applying pre-emergence herbicide at standing water condition after transplanting the rice seedlings and post-emergence herbicide was used after 15 days of transplanting.

Data recording

For assessing agronomic traits, five plants were taken from each plot for comparative study of the three treatments. Data regarding plant height, number of tillers per plants, panicle length, grains per panicle, thousand grain weight, days to flowering and days to maturity of each genotype under each treatment was computed. Grain yield of each genotype under each treatment was measured at harvesting.

Weather conditions

The temperature and humidity conditions for the crop period under research are summarized in Fig. 1. Mean Air Temperature of Islamabad during the cited months was fluctuating in between 15 ºC to 32 ºC being maximum in the month of June followed by October (30 ºC). Humidity in the environment was ranging around 46% to 64% being maximum in the month of August (64%) and September (63%), while minimum was in October (48%) and May (50%). Rainfall pattern was much eratic during the crop season as it ranged from 20mm to 400 mm (Fig. 2). rainfall was found to be in average variation from April to July but in the last three months the varition was at maximum. The maximum rainfall was recorded in the month of August, 2020 (398.73 mm) and minimum was in the month of October (20 mm).

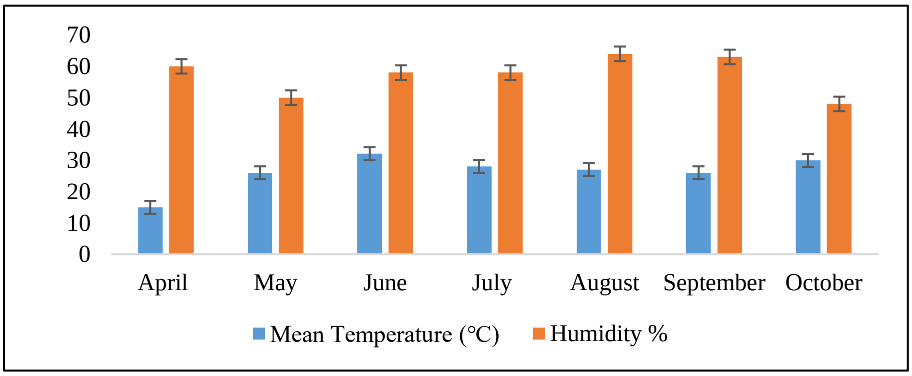

Fig. 1 Fluctuations in temperature and humidity during the crop period (2020)

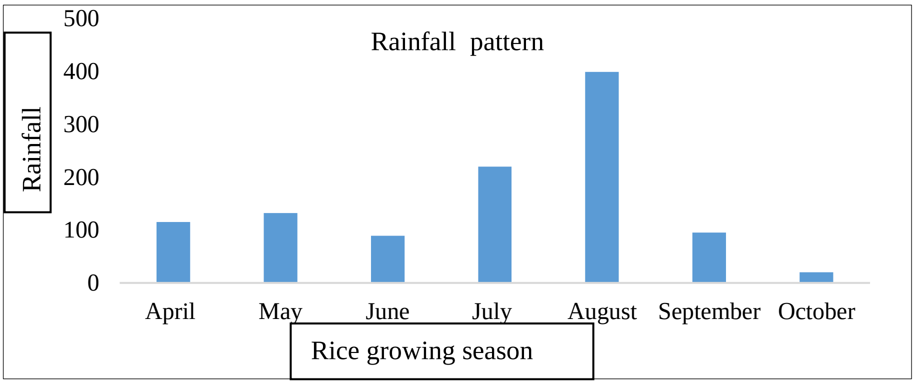

Fig. 2 Rainfall pattern during the crop season 2020

Results

Analysis of variance for yield and yield related attributes

The results of pooled analysis of variance showed that the variations among all the tested rice genotypes were highly significant for all the parameters as plant height, number of tillers, number of grains per panicle, panicle length, thousand grain weight, days to flowering, days to maturity and for yield whereas in case of treatments non-significant difference was observed for days to flowering (Table 1). The coefficient of variation for all traits lies within acceptable range which indicates minimal chances of variation from error and unidentified sources.

Table 1 Pooled analysis of variance for rice genotypes under 3 treatments

SOV	DF	PH	NT	NGP	TWG	DM	PL	YLD
Treatment	1.62^{NS}	899.01**	19.67*	15410.11**	184.58**	20.72*	51.14**	10.46**
Genotype	59.84**	293.13**	9.20*	4042.41**	27.48**	53.37**	6.14**	18.82**
Error	5.71	34.197	3.34	357.7	3.402	5.98	2.05	0.06
CV	**2.54**	**5.94**	**16.51**	**11.16**	**6.95**	**1.97**	**6.20**	**13.65**

SOV = Source of variation; DF = Degree of freedom; PH = Plant height (cm); NT = Number of tillers plant^{-1}; NGT = Number of grains spike^{-1}; TGW = Thousand grain weight (g); DM = Days to maturity; YLD = Yield (kg/ha)

Plant height (cm)

The plant height was found to exhibit significant difference across genotypes and treatments. Among hybrids G53-F2 showed maximum plant height (146cm) followed by Red Rice (141cm) in treatment 1 (Fig. 3). While considering the performance in treatment 2 a significant reduction was observed in all the genotypes and maximum height was obtained by Red Rice (128 cm) followed by Pride-1 (120cm). For the treatment 3 Red Rice found to occupy the highest position with 117cm height followed by the Pride 1 which attained a height of 108cm. Among all the genotypes the variation for a certain genotype in respective treatments, the maximum fluctuation was observed in genotypes G53-F2 and Red rice indicating values as (146, 110, 90 cm) and (141, 128, 117 cm) for treatment 1, 2, 3 respectively. Across green super rice lines, GSR11 exhibited maximum plant height (107cm) in treatment 1. Among the GSR lines, it was observed that plants grew taller with higher water availability and significant reduction was observed with reduced irrigation pattern as evident in GSR1, 4, 12, 16, 18, 19, 20, 23 and GSR25.

Across landraces and varieties red rice, Chinie and DR-82 followed the trend of G53-F2 hybrid whereas Banali and IR-6 showed the antagonistic trend. Overall, across all genotypes and across all treatments maximum plant height was recorded in G53-F2 hybrid whereas minimum was reported in GSR23 (Fig. 3).

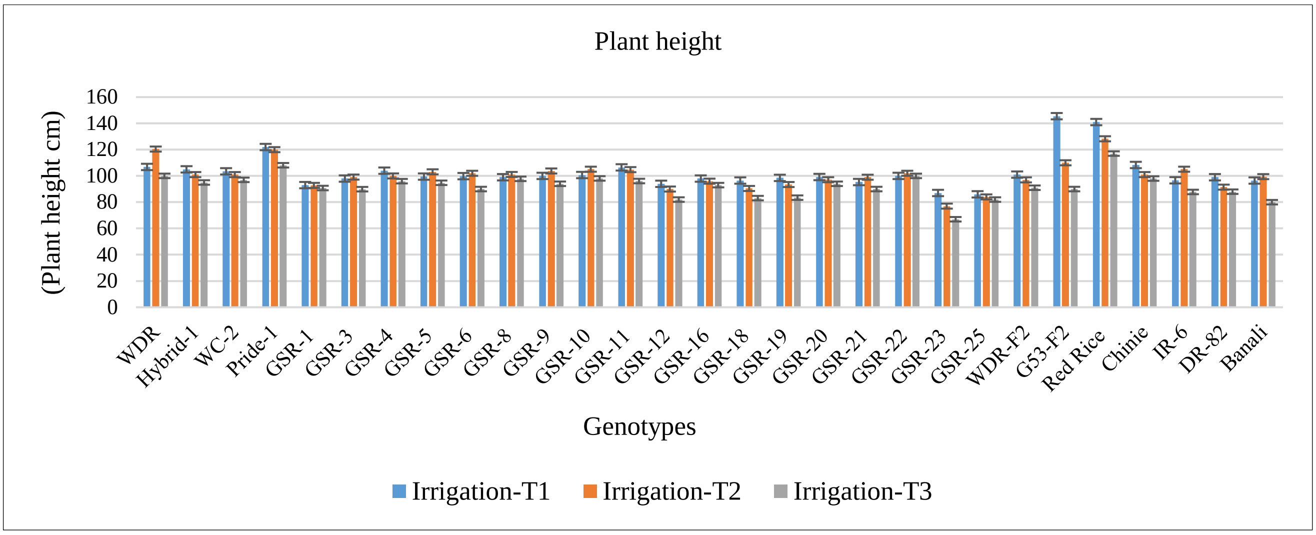

Fig. 3 Variation in plant height of various rice genotypes under different irrigation patterns

Number of tillers per plant

The results of the agronomic trait revealed significant differences among genotypes and treatments. Fluctuation in case of number of tillers was observed to a significant extent in all the treatments irrespective of the irrigation water applied (Fig. 4). The data showed that maximum number of tillers per plant were in land race Chinie (18) followed by GSR 18 (16) under treatment 1 whereas minimum number of tillers was recorded in WC-2 and GSR 20 developing only 7 tillers per plant on average in treatment 2. Among the land races, GSRs, hybrids and verities in all three treatments maximum number of tillers were counted overall in treatment 1 where 12 genotypes got highest rank. Treatment 2 was found to be favoring the average number of tillers. Maximum extent of variation was observed under treatment 03 where minimum water was applied (Fig. 4).

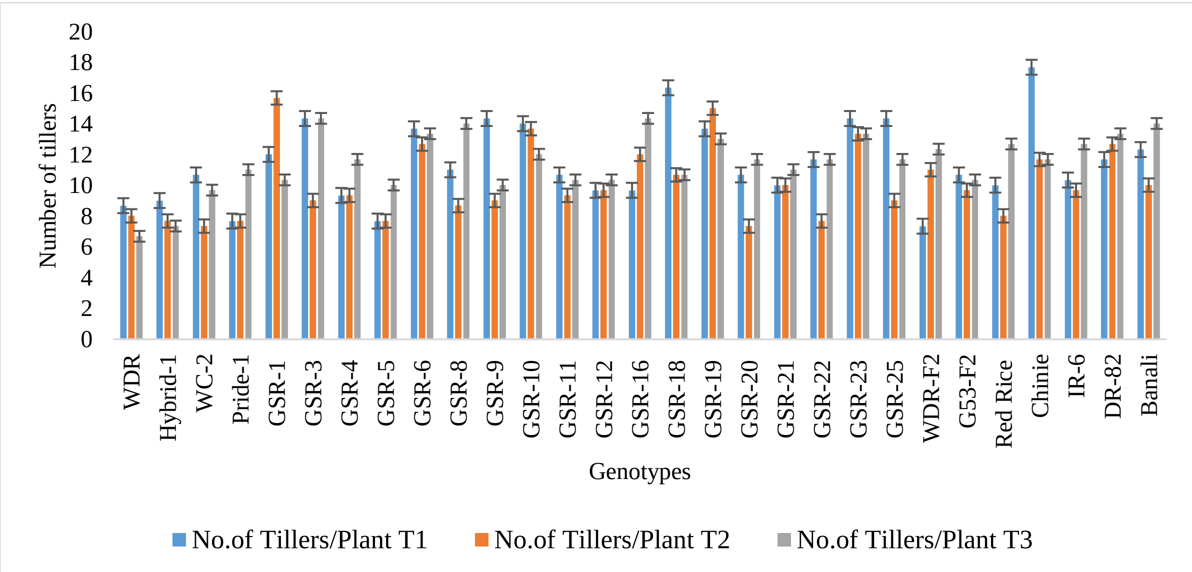

Fig. 4 Variation in number of tillers of various rice genotypes under different irrigation patterns

SPanicle length (cm)

Variation was not much higher for the hybrids and GSR lines across the treatments in case of panicle length while it was significantly higher for the landraces and verities. Within the treatments genotypes showed a range of 20-29 (cm), 21-27(cm) and 18-24(cm) for treatment 1, 2 and 3 respectively (Fig. 5). Overall, the maximum panicle length was observed in case of genotype red rice (29) while minimum in case of GSR 23 (18). Above average panicle length was noted mostly under treatment 2 as compare to 1 and 3. Under treatment 2, out of 29 genotypes 17 were portraying above average panicle length while in treatment 1 this number was 5 and in treatment 3, no genotype could over-pass the average performance.

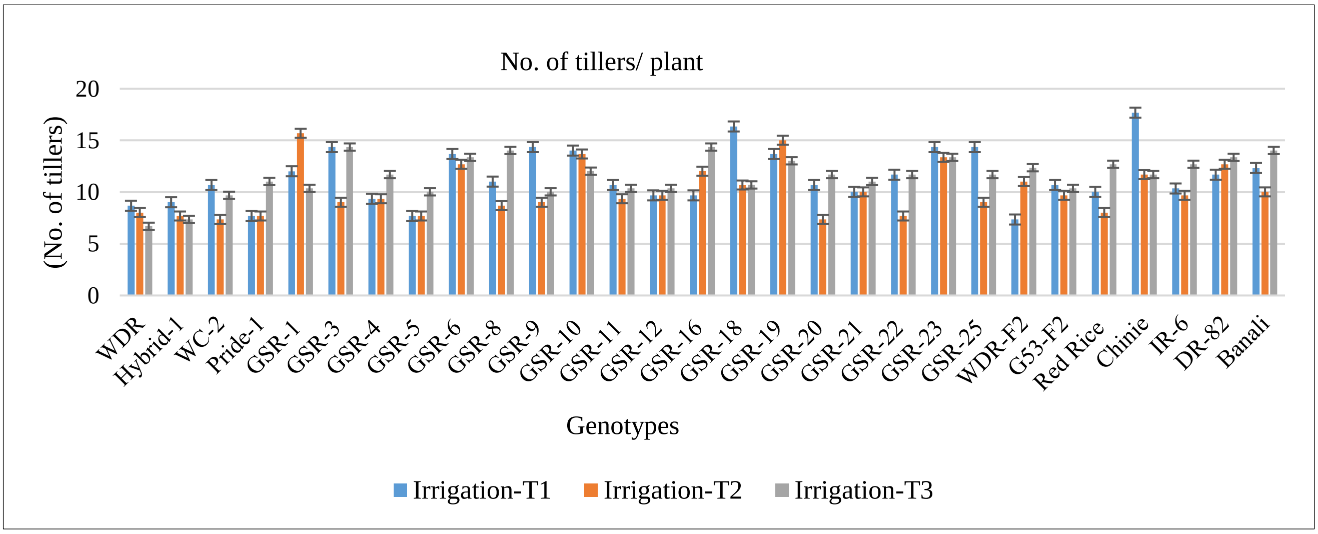

Fig. 5 Variation in Panicle Length of various rice genotypes under different irrigation patterns

Number of grains per panicle

Number of grains per panicle showed significant differences among all genotypes across all the treatments. Between hybrids WC2 produced maximum number of grains per panicle (323) under treatment 1 while pride-1 exhibited 314 grains under treatment 3. Across green super rice lines GSR 25 was found to have maximum number of grains per panicle (253) under treatment 3 whereas among landraces and varieties DR-82 was regarded as to have maximum number of grains per panicle (187) under treatment1. Overall grains were higher in hybrids as compared to GSR lines and verities. Considering the other extreme it was noted that minimum grains in was counted in G53 F-2 (125) hybrids and GSR 19 (79) in GSR lines. Among the land races 114 grains were counted in Chinie, Banali and red Rice under treatment 2 (Fig. 6). On average it was noted that landraces could not perform well in terms of grains per panicle as these were low achievers in all three treatments. Hybrids performed better in all the treatments and demonstrated above average position.

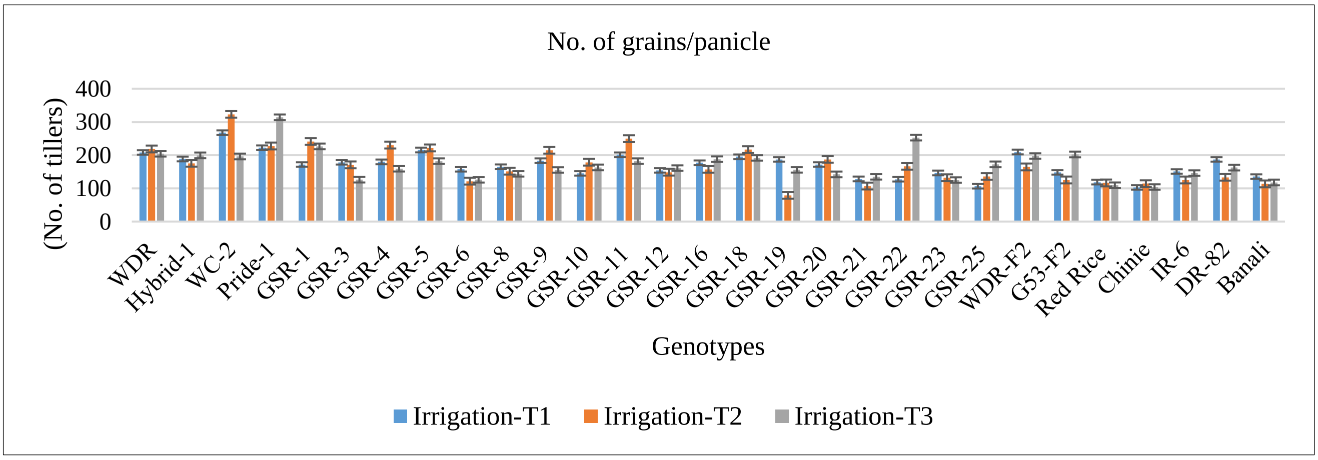

Fig. 6 Variation in number of grains per panicle of various rice genotypes under different irrigation patterns

Thousand grain weight (g)

In case of overall trend of thousand grain weight among treatments it was observed that treatment 1 may be regarded as the case to have maximum thousand grain weight in most of the genotypes (21/29) under observation (Fig. 7). Under treatment 2 higher thousand grain weight was observed for 7 genotypes in contrast to treatment 1. No genotype was found to overpass for 1000 grain weight under treatment 3 compared to treatment 1 & 2. Highest 1000 grain weight was noted in genotype Red rice (44 g) under treatment 2 which could not be achieved by any genotype under any treatment. In case of treatment 1 variation was noted in a range of 24 g (GSR18) to 36 g (Red Rice). While considering treatment 2, the 1000 grain weight was found to be fluctuating in between 22 g (GSR18) to 44 g (Red Rice) whereas under treatment 3 it was variegating in between 20g (GSR 18) and 34g (Red rice). It was noted that genotypes occupying highest and lowest position in terms of 1000 grain weight was same in all the 3 treatments.

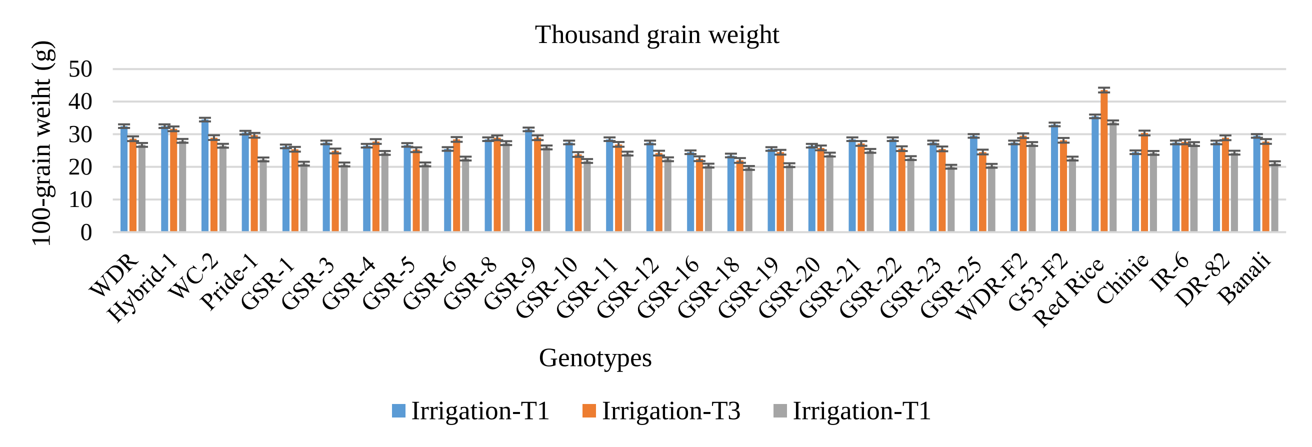

Fig. 7 Variation in Thousand grain weight of various rice genotypes under different irrigation patterns

Number of days to flowering and maturity

The number of days to flowering were highly significant across genotypes and non-significant among treatments. Variation in terms of days to flowering was not much higher among the GSR lines but it was significantly higher among the verities and hybrids. Minimum days to flowering were consumed by WDR hybrid which produced 50% flowers in just 71 days under treatment 2 while rest of the genotypes took days to flower in arrange of 83 to 103 days. Most of the genotypes were almost similar in performance for the days to flowering except for a hybrid (WDR) and a landrace (Chinie) which flowered a bit earlier. Whereas number of days to maturity exhibited significant differences across treatments and genotypes. Overall, across hybrids, GSR lines, land races and varieties WDR hybrid and Chinie landrace showed early flowering and early maturity under all treatments. All the GSR lines were examined to exhibit almost similar pattern in days to maturity except for GSR-16 & GSR-18 as no significant difference was obvious among the GSR genotypes and treatments as well (Fig. 8).

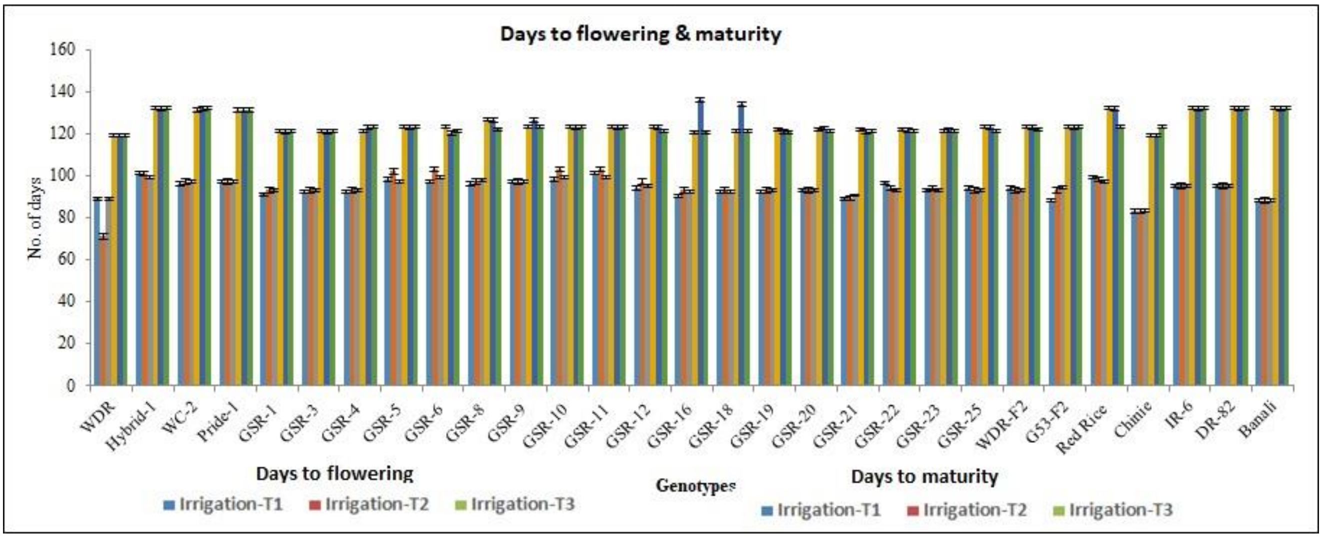

Fig. 8 Variation in days to flowering and maturity of various rice genotypes under different irrigation patterns

Paddy yield

The yield was found to exhibit highly significant difference across treatments and genotypes. In case of yield huge variation was observed among hybrids and GSR lines with varieties as hybrids ranged in between 6.5 to 9.5kg/plot while others fluctuating around 0.05 kg to 2.25 kg/plot (Fig. 9). Yield was 5-8 folds higher in hybrids as compared to the GSR lines while the varieties were yielding 2-3 times higher than GSR lines. Among hybrids, Pride-1 hybrid showed maximum yield (9.44 kg) under treatment 2 whereas across green super rice lines GSR 25 showed maximum yield of (1.67 kg) and among land races and varieties DR-82 shows maximum yield of (2.27kg) under treatment 2 followed by treatment 1 and treatment 3 (Fig. 9).

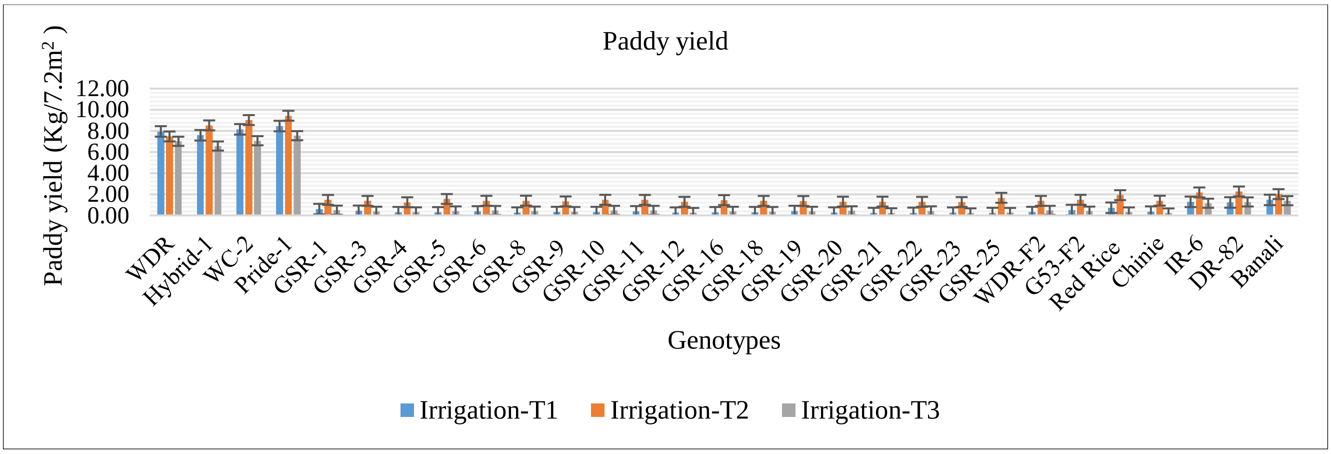

Fig. 9 Variation in paddy yield of various rice genotypes under different irrigation patterns

Leaf folder and stem borer

Among hybrids, green super rice lines, land races and varieties, high infestation of leaf folder was noted in GSR-12, Banali and red rice whereas WDR hybrid showed some resistance against leaf folder in all the treatments. It was noted that disease incidence was not the feature related to treatment as variation among the treatments was not significant for respective genotypes but significant variation was observed among the genotypes (Fig. 10). Incidence of stem borer was not observed to be in damaging range as it only can proliferate in limited number of genotypes. Most of the GSR lines showed resistant reaction towards stem borer however in case of hybrids and varieties the population was significantly higher similar to the leaf folder the variation among the treatments was not significant but among the genotypes it was depicting significant difference (Fig. 11).

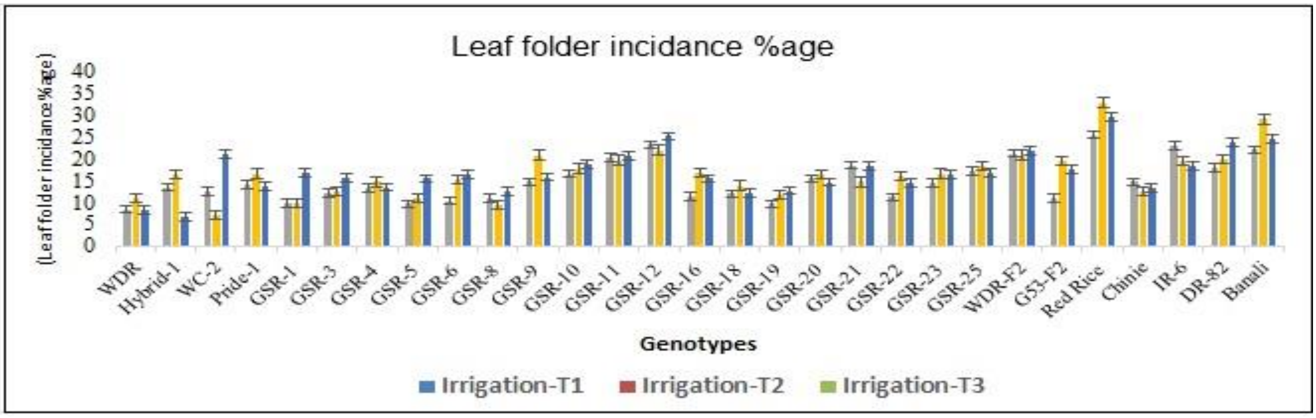

Fig. 10 Incidence of leaf folder on various rice genotypes under different irrigation patterns

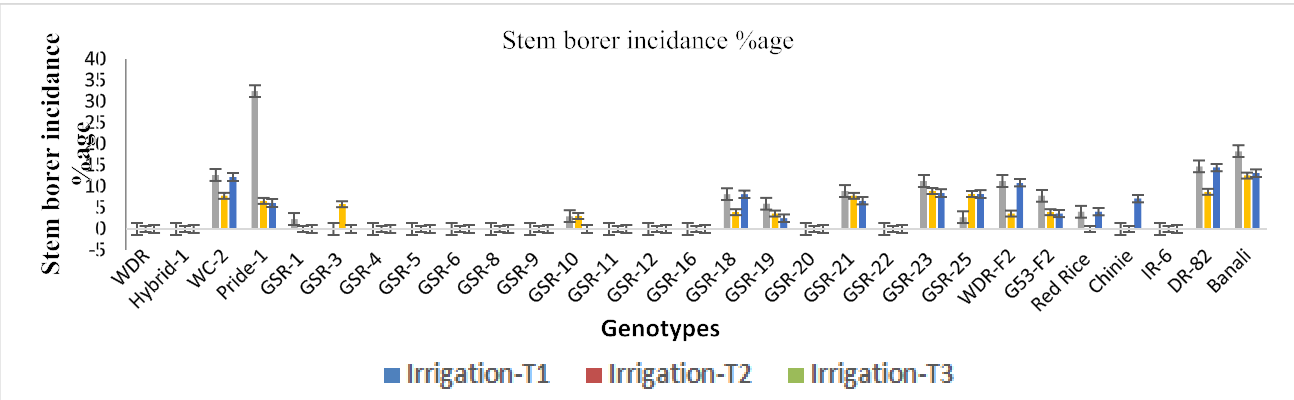

Fig. 11 Incidence of stem borer on various rice genotypes under different irrigation patterns

Discussion

Different irrigation regimes did not influence the initial crop stand because during nursery germination and growth, equal irrigation was supplied across all treatments (Zulfiqar et al., 2021). In alternate wetting and drying technique of irrigation, rice field were under periodic irrigation and cyclic water deficits. The duration of watering the paddy field can vary from 1 day to more than 10 days (Bouman, 2007). Number of tillers per plant, number of grains per panicle, and grain yield was significantly affected by the number of days before re-watering to a ponded depth of 5 cm, 10 cm and 15 cm. The paddy yield decreased with increase in number of days lapsing (under treatment 3, 15 cm depth) before re irrigation. There is no need of continuous standing water as rice crop had adapted to alternate irrigation pattern and possessed a semi aquatic nature (Kato & Okami, 2010).

A study was executed by Midya et al. (2021) to analyze the water saving production technologies in rice together with economic profitability of rice farmer under different production methods as conventional flooded, aerobic culture and SRI to determine the sustainability of rice production. Significant difference was observed in case of yield under all the methods and yield was significantly higher in SRI system but the water productivity was better in case of reduced irrigation setup. Yield reduction was attributed to conventional and aerobic production system but not to the SRI system. It has been concluded that SRI system is more efficient when concerned with the value cost ratio, economic profitability and partial factor productivity of nutrients.

In an experiment conducted by Malumpong et al. (2021) at Thailand different treatments were examined to affect the rice productivity. Alternate wetting and drying method was executed at three levels 10/-10, 10/-15, and 10/-20) and conventional flooding as a comparative analysis. It was observed that grain yield was negatively affected by the AWD method but milling quality was not halted at all across the treatments. Among different treatments it was recommended to adopt AWD10/-10 irrigation system to harvest maximum water productivity without much losing the yield. In addition to crop production, it also posed significant impact on the methane emission as AWD resulted in the lower emission of CH4 as compared to conventional flooding (Haque et al., 2021). In terms of N2O the emission was not attributed to irrigation patterns as same in almost all the treatments of AWD and CF as well (Malumpong et al., 2021).

The physiological demand of water for rice cultivation rationally controlled by supplying water during critical growth stages of rice so that irrigation water was cut down. (Carrijo et al., 2017) reported 15-40% water input reduced in transplanting rice with AWD irrigation method. It was reported in previous studies that water losses by deep drainage could be considerably reduced when rice was cultivated with AWD irrigation technique, (Bouman, 2007). Our results are consistent with the findings of (Norton et al., 2017; Pascual and Wang, 2017) previous studies which showed that productive tillers per plant increased by using AWD method of irrigation in rice cultivation.

AWD technique of irrigating the paddy fields may increase or else maintain the grain yield (Chu et al., 2014; Liang et al., 2016) as compared to flooding irrigation method. Previous studies reported that by adapting AWD method of irrigation, 20% to 70% irrigated water saved, without any major decrease in the yield (Bouman and Tuong, 2001; Uphoff, 2001). The soil environment and paddy yield along water saving improved by using AWD water saving or resource conserving technique (ACIAR, 2013). A significant correlation was observed among yield and yield related traits. AWD not only conserve water resources also helped in to avoid crop lodging, insect pest attack salinity issues which were caused by excessive use of water (flooded irrigation). Similar findings were also observed by (Cabangon et al., 2012). The AWD method of irrigation in rice production proved an efficient and effective technique for water saving.

It has been reported that AWD method causes a reduction in the requirement of irrigation water by 26-52% but alongside it poses a diminishing impact over the yield which may range 3-14%. Water use efficiency could efficiently be enhanced by their application of AWD tubes when cultivating early maturity varieties or hybrids. It has been found that by modifying just the management practices one can reduce the irrigation water by 18% facing some compromise over the yield but enhancing the water productivity by 21%. Yield reduction may be controlled to some extent by managing the depth of water by AWD tube and nominal reduction is reported while observing 10cm depth only. The tubes being a novel tool are regarded as to pose a significant positive impact towards the profitability of the farming community (Chaurasiya et al., 2022).

Owing to water shortage problems over the years its dire need of time to consider the water efficient mechanisms for crop production and AWD has been reported to be the more efficient way to fulfill plant water requirement in case of rice being an intensive water requiring crop. It has been reported that AWD irrigation system saves irrigation water and causes a diminishing effect over the grain yield. Nutritional factors of rice were also examined if being affected by changing the irrigation patterns or not. It has been concluded that AWD may improve the nutritional aspects of rice as milling performance was more efficient in AWD rice rather than the CF methodology. Rice produced by AWD methods was found to have enhanced amino acids and phenolics compounds while decreasing the contents of lipids and alkaloids (Song et al., 2021).

It has been explained that water productivity increased by 2 folds when rice was grown on raised beds thus conserving the water up to 40-45% in contrast to conventional flooding. In terms of water conservation and improving water productivity. Raised sunken bed rice has been referred to as the most efficient rice production system if irrigation is to be provided by tube well method. Growing of higher water requiring crops on raised beds ultimately lead to the conservation of underground water which other way be used for some more important ways. So, it was tried to Figure out the more efficient irrigation pattern as per diversified crop type to improve the water use efficiency as “higher crop per drop” or “increased food with decreased water”. It was concluded that sunken rice bed of 3m depth following alternate wetting and dry method is best system for rice productivity (Das et al., 2021).

Potential of different irrigation regimes (alternate wetting and drying (AWD), aerobic rice (AR), and (CF) continuous flooding) in rice cultivation was examined on two rice cultivars (Pride-1, hybrid) and (NB-1, inbred line). These were examined for crop growth, yield traits, paddy yield, water productivity and end profitability. It was found that AWD saved 5.72 and 32.98% while AR saved 11.22 and 28.40% water compared to CF during 2018 and 2020, respectively. A significant difference was observed for grain yield both in treatments and cultivars. In terms total dry weight and grain yield, AR found to decrease the grain yield by 34.82% and 38.16% and total dry weight by 31.34% and 38.04% while AWD and CF produced statistically same across the years. All the yield contributing parameters were found to be positively linked to grain yield and biomass accumulation except for the 1000 grain weight and harvest index. It was concluded that AWD had maximum water productivity and conventional flooding was having maximum grain yield. So, keeping in view the water scarcity issue, AWD should be promoted to potential rice growing areas (Hussain et al., 2021).

Conclusion

Rice is a major crop of most of the Asian countries but it requires a lot of fresh water for irrigation purposes to grow to its full potential. Irrigation must be carefully controlled in locations where water is scarce to maintain good agricultural production. Water scarcity is becoming more common, requiring sustainable irrigation strategies to boost crop yield while conserving resources. As a result, crop irrigation research has been carried out in order to enhance performance, efficiency, and profitability. The prime objective of the study was to compare the growth and yield of irrigated rice farmed with various amounts of water supplied following AWD technology. It will also help to observe that how the AWD interventions affect irrigation pattern (e.g., number of hours and frequency), labor, yields, and profitability. In present study comprising of 29 genotypes, 2 replications and 3 treatments polled analysis of variance showed significant difference for all the traits as plant height, number of tillers, number of grains per panicle, panicle length, thousand grain weight, days to flowering, days to maturity and for yield. The yield was found to exhibit highly significant difference across treatments and genotypes. In case of yield huge variation was observed among hybrids and GSR lines with varieties as hybrids ranged in between 6.5 to 9.5kg/plot while others fluctuating around 0.05kg to 2.25 kg/plot. Yield was 5-8 folds higher in hybrids as compared to the GSR lines while the varieties were yielding 2-3 times higher than GSR lines. Paddy yield was significantly increased with reduced input cost of paddy production by implementing the AWD technique. As compared to conventional method of irrigation (flood), AWD method of irrigation not only conserves the resources but also increases the paddy yield. Maximum yield was reported at 50% reduced irrigation than normal flood irrigation. It was evident from the results of this study that by using AWD tube farmers can increase their paddy yield while reducing irrigation.

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