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Performance of wheat genotypes under different irrigational approaches in the Terai agro ecological condition

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Abstract
A field experiment was undertaken to study the Performance of wheat genotype under different irrigational approaches in the Terai agro ecological condition during *rabi* season of 2016. The experiment was conducted at experimental field of Uttar Banga Krishi Viswavidyalaya with six different wheat genotypes under two irrigation management practices i.e. irrigated and restricted irrigated condition, in Factorial Randomized Block Design comprising of three replications. The result of experiment revealed that highest economic yield found in HD 2967 under both the irrigated and restricted irrigation condition (47.1 q ha^{-1} & 26.8q ha^{-1} respectively). Significant differences were found in all the growth and yield attributing characters in two irrigational condition. Water stress was the key reason in the reduction of yield. By observing SPAD value HD 2967 and DBW 39 can maintain their greenness than other genotypes in later growth stages. It can be a very useful character for screening wheat genotypes for drought tolerance.

Keywords: SPAD, water stress, wheat genotype, yield

Introduction
Wheat is the third most important cereal crop in terms of total yield. At present, wheat productivity increases at 1.1% rate per annum globally (Dixon *et al*., 2009) [1] while the predicted demand is 1.7% increase per annum until 2050. Therefore, current yield gain per annum is not sufficient to meet the growing demand of wheat in future and new approaches to increase productivity are necessary to avoid future food crisis. Thus, continuous supply of wheat to exponentially increasing population is a major concern. India is second largest producer of wheat having 96 million tonnes in 2016, sharing 12% to the total production of the world. The targeted wheat production for the year 2020 is about 109 million tonnes. Highest increase in demand has been seen in Asia; increase is majorly due to increase in population with the per capita demand stable at ~66 kg. Current climate change is projected to have a significant impact on temperature and precipitation profiles, increasing the incidence and severity of drought. Water stress can also cause pollen sterility, grain loss, accumulation of abscisic acid in spikes of drought-susceptible wheat genotypes, and abscisic acid synthesis genes in the anthers (Ji *et al*. 2010) [2]. Drought led to shortened duration of maturation, grain filling duration and reduced grain yield, mean grain weight, grain number and thousand grain weight in wheat when imposed at different phenophases (Barbanas *et al*.2008) [3] and (Kaur and Behl, 2010) [4]. In rain fed areas wheat is ranked first as far as the area of cultivation is concerned and under irrigated conditions, it is ranked second after rice based on total cultivation area (Portmann *et al* 2000) [5]. Irrigation is such one important and costly input which influences the growth and yield of dwarf wheat and the productivity can be increased by providing copious water at the right time. A change in optimal temperature during its vegetative or reproductive growth adversely affects the rate and duration of growth and yield of wheat. It is not possible to modify the adverse environment during growth of wheat under field condition. However, favourable soil moisture regime can be created by timely scheduling of irrigation, which can take care of deleterious effect of low and high temperature during vegetative and reproductive growth phase respectively (Talukder, 1987) [6]. Wheat is one of the most important food crop grown in India under rainfed conditions and it is a challenging task to achieve the potential yield. So development of higher-yielding crops under water-limited environments is the most viable solution to stabilizing and increasing wheat production under current climatic conditions. Among the various factors, which contribute towards

productivity, the sowing condition and selection of suitable genotype is quite important. As the release of new genotypes is a continuous process and the behaviour of different genotypes varies under various growing condition i.e. irrigated or rainfed therefore there is a need to generate valuable information on these aspects. The present experiment was carried out to study the performances of different wheat genotypes under different irrigational approaches in Terai region of West Bengal.

Materials and Methods

The present study was conducted during *rabi* season of 2016-2017 at the University Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar to study the performance of different wheat genotypes under different irrigated situation. The experimental site falls under sub Himalayan terai agro-climatic condition. During the experimentation period crop faced no rainfall during growth period of wheat. The rainfed crop was given single lifesaving irrigation at CRI stage of crop growth. The maximum temperature varied from 23.44 °C during January to 32.80 °C during November while minimum temperature varied from 7.44 °C during January to 18.97 °C during November. Humidity was high throughout the experimentation period. From November to March, the maximum humidity was 98.00 % and the minimum was 53.71 %. The local topography of the study area was almost flat with good drainage facilities. The soil of the experimental field was from Teesta alluvial plain group, which is sandy loam in texture with poor water holding capacity and moderate fertility status. The pH value was acidic in nature. The experiment was laid down in Factorial Randomized Block Design with three replications comprising of six number of genotypes and two environments. Six genotypes of wheat were used for this study i.e. UP 262, HD 2967, DBW 39, C 306, K 0307 and Sonalika. Also used two different type of environments i.e. (Irrigated and restricted irrigated). The size of individual plot was 5 m x 4 m. The wheat seed were sowing on 8th Nov 2016 in the field with a row spacing of 20cm. Dropping of seeds were done manually at a depth of 2-3 cm below the soil surface with the help of hand tynes and covered properly with soils. Recommended dose of fertilizer @ 140:60:40 (N: P: K) Kg/ha. [half nitrogen applied as basal rest half at the time of first irrigation]. It was applied through urea, SSP and MOP. The plant height (cm) was measured from the base to the tip of the panicle of the plant at maturity stage. Heights of five plants were taken from each replication and the mean values were computed and expressed in cm and also count the total number of tillers from each plant and the mean value were computed. Average days of heading of 75% plants of each line were recorded. The duration from date of sowing to date of heading was counted and recorded as days to heading. The physiological maturity of each line was recorded by judging the toughness of the grains. The duration from date of sowing to date of maturity was counted and recorded as days to maturity. Total number of grains was counted from each spike and then their average is calculated. Length of the spike (cm) was measured from neck node to the tip of the spike. Thousand grains were counted from harvested bulk grains of ten plants and their weight was recorded in grams by correct to two decimal points by an electric balance. The total weight of grain from a plot was taken after harvesting of wheat. Then it was expressed in quintal per hectare. Whole matured plants were uprooted from the plot. Then it was expressed in quintal per hectare. Konica Minolta SPAD - 502 Plus was used for recording the SPAD value which directly correlates with the chlorophyll content or greenness of the leaf. It is a non destructive field measurement. The SPAD 502 Plus determine the relative amount of chlorophyll present by measuring the absorbance on the leaf in two wavelength regions. It was seen that chlorophyll absorbance peaked in the blue (400 – 500 nm) and red (600 – 700 nm) regions, with no absorbance in the near-infrared region. To take advantage of this characteristic of chlorophyll, the SPAD 502 plus measures the absorbances of the leaf in the red and near-infrared regions. Using these two absorbances, the meter calculates a numerical SPAD value which is proportional to the amount of chlorophyll present in the leaf. Statistical analysis of the data was performed using GenStat version 11.1 analytical programme software. The mean values of each character were compared for each replication and then used for statistical analysis.

Results and Discussion

Studies on variability

Variability of the six genotypes under study was measured under irrigated and restricted irrigated condition (Table 1). Genotypes varied significantly for all the characters under study at both the conditions. Environmental variation was also found significant for all the traits under study except grains per spike and test weight. Genotype and environment interaction were significant for characters like plant height, days to maturity, tillers meter^{-2}, grains per spike, spike length, grain yield and biological yield whereas it was nonsignificant for days to heading and test weight. Singh *et al*. (2012)[7] and Awale *et al*. (2013)[8] also reported considerable genetic variability for grain yield and its component characters in studied bread wheat genotypes.

Growth parameters

Growth parameter (Table 2) in terms of plant height found differ significantly under two environmental conditions for all genotypes. Among the genotypes plant height was highest in C 306 under both irrigated and restricted irrigation condition (142 cm & 114 cm respectively). It was lowest in case of Sonalika under both the condition (86 cm & 77 cm respectively). Days to heading was also found to differ significantly under two environmental conditions for all the six genotypes. It was highest in HD 2967 under both irrigated and restricted irrigation condition (81 & 76 respectively). It was lowest in case of Sonalika under both the condition (69 & 66 respectively). Days to maturity, it was highest in HD 2967 under both irrigated and restricted irrigation condition (144 & 133 respectively). It was lowest in case of Sonalika under both the condition (115 & 108 respectively). The trait was also found to differ significantly for two environmental conditions for all the genotypes. It was found that all the growth parameters performed better in irrigated condition. Irrigation is a key measure in improving growth parameters in wheat. Because wheat is sensitive to water stress during the vegetative phase (e.g., tillering stage) also drought limits the development of the root system (Boonjung *et al*. 1996) [9].

Table 1: Analysis of variance for growth, yield attributes and yield of wheat genotypes under two different environments

Sources of Variation	df	Mean Square Values								
		Plant height (cm)	Days to heading	Days to maturity	Tillers m^{-2}	Grains per spike	Test Weight (g)	Spike length (cm)	Grain yield (q ha^{-1})	Biological yield (q ha^{-1})
Genotype (G)	5	1589.76**	95.71**	648.86**	16672.0**	402.27**	56.69**	4.76**	323.53**	6905.6**
Environment(E)	1	1872.00**	191.36**	676.00**	145415.1**	14.69	0.16	2.61**	2089.70**	61083.1**
G×E	5	85.06**	0.56	9.46**	3122.9**	54.72**	4.73	0.65**	23.33*	740.0**
Error	22	3.20	1.84	1.00	149.9	3.750	1.88	0.086	6.91	175.7
Grand mean		98.82	74.92	122.50	251.78	49.22	40.79	10.90	26.49	132.99

*,** Significant at 5% & 1% level of significance respectively

Table 2: Mean performance of different growth attributes of wheat genotypes under two environmental conditions

Genotypes	Plant height(cm)		Days to heading		Days to maturity	
	IR	RI	IR	RI	IR	RI
UP 262	106.5	92.9	80	75	122	115
HD 2967	103.6	92	81	76	144	133
DBW 39	94.1	77.5	78	73	121	115
C 306	142.3	114.0	79	74	136	128
K 0307	103.2	95.8	76	72	123	111
SONALIKA	86.2	77.2	69	66	115	108
Mean	106.0	91.6	77	73	127	118
CD (Gen.)	2.14		1.62		1.20	
CD (Env.)	1.24		0.94		0.69	

Yield attributes and Yield

Data pertaining to yield attributes and yield of wheat is presented in (Table 3). Highest number of tillers m^{-2} was shown by K 0307 and C 306 under irrigated and restricted irrigation condition respectively (386.6 & 244). It was lowest in case of DBW 39 under both the condition (229.67 & 111 respectively). The trait was also found to differ significantly under two environmental conditions for all genotypes. Grains per spike was highest in DBW 39 and HD 2967 under irrigated condition and restricted irrigation condition respectively (63 & 56). It was lowest in case of C 306 under both the condition (40 & 35 respectively). Environmental difference was significant for this trait too. For all the genotypes except HD 2967 which showed no significant variation under two environments. The plumpness or boldness of seed in terms of test weight (1000 grain weight) of wheat found to differ significantly under two environmental conditions for all the genotypes. It was highest in DBW 39 and UP 262 under irrigated and restricted irrigation condition respectively (42.75 g & 44.07 g). It was lowest in case of K 0307 under both the condition (34.13g & 35.7g respectively). Spike length was highest in case of UP 262 and DBW 39 under irrigated and restricted irrigation condition respectively (12.6 cm & 11.2 cm). It was lowest in case of Sonalika under both the condition (9.97 cm & 9.63 cm respectively). The trait was found to differ significantly under two environmental conditions for all genotypes except HD 2967 showed no significant variation under two environments for this trait. The land productivity in terms of seed yield of wheat was found to differ significantly under two environmental conditions for all genotypes. The highest seed yield was found in HD 2967 under both the irrigated and restricted irrigation condition (47.1 q ha^{-1} & 26.8q ha^{-1} respectively). It was lowest in case of C 306 and DBW 39 in irrigated and restricted irrigation condition respectively (26.1 q ha^{-1} & 11.2 q ha^{-1}). The biological yield of wheat varied significantly under two environmental conditions for all genotypes. It was highest in C 306 under both the conditions (215 q ha^{-1} & 111.1q ha^{-1} respectively). Lowest biological yield was observed in Sonalika and DBW 39 under irrigated and restricted irrigation condition respectively (117.9 q ha^{-1} & 41.6 q ha^{-1}). With an increase in irrigation level, wheat grain yield is significantly improved (Sissons *et al.* 2014) [10]. Drought was shown to have a greater influence on grain number, which largely accounts for the decline in wheat yield Dolferus *et al*. (2011) [11]. It might be due to water stress has an extremely adverse effect on meiosis and anthesis, which directly affects grain number. This causes substantial reduction in grain yield (Cattivelli *et al*. 2008) [12].

SPAD values of different genotypes at pre and post anthesis stages

SPAD value was measured for all the six genotypes under irrigated and restricted irrigation condition. Variation for SPAD value was found significant for genotypes, environments and flowering stages i.e., pre anthesis and post anthesis. Genotype × environment interaction and genotype × flowering stage interaction were also found significant for SPAD values whereas environment × flowering stage interaction was nonsignificant (Table 4). The mean SPAD values presented in (Table 5) which showed higher SPAD values in irrigated condition except in one case where DBW 39 showed higher SPAD value in restricted irrigated condition at pre anthesis stage. Water deficits enhanced the senescence by accelerating loss of leaf chlorophyll and soluble proteins and the loss was more in sensitive one than tolerant one (Saeedipour, 2012) [13]. Chloroplasts need nitrogen to accumulate chlorophyll through proteins (Paknejad *et al*., 2007) [14] and decrease of SPAD values in stress conditions may be related to a reduction of nitrogen uptake. Photosystem II (PSII) is one of the main components in photosynthesis, and PSII reaction centers and its biochemical processes are sensitive to drought stress (Guo et al., 2008) [15]. Highest SPAD value (46.3) was recorded in HD 2967 under irrigated condition and lowest value (35.5) was observed in C 306 under restricted irrigation condition at pre anthesis stage. DBW 39 showed maximum SPAD value (46.0) and C 306 showed minimum value (31.8) under irrigated and restricted irrigation condition respectively at post anthesis stage. SPAD values were always higher in pre anthesis stage than post anthesis in all the genotypes under both the environments except DBW 39. This might be due to senescence of leaf irrespective of varieties.

Table 3: Mean performance of different yield attributes and yield of wheat genotypes under two environmental conditions

Genotypes	Tillers m^{-2}		Grains per spike		1000 grain Weight(g)		Spike length(cm)		Grain yield (q ha^{-1})		Biological yield (q ha^{-1})	
	IR	RI	IR	RI	IR	RI	IR	RI	IR	RI	IR	RI
UP 262	355.33	153.67	56	49.1	42.6	44	12.6	11	33.7	17.11	165.27	96
HD 2967	337.67	235	55.7	56.8	41.2	39.6	10.9	11	47.1	26.81	193.33	132

DBW 39	229.67	111	63.1	55.7	42.7	41.3	12.4	11.2	29	11.25	148.1	41.67
C 306	328.67	244	40.8	35.3	41.7	40.4	10.1	9.8	26.15	13.82	215	111.17
K 0307	386.67	224.67	42.1	47.2	41.7	43.9	11.1	10.9	41.75	26.57	205.47	109.4
SONALIKA	254	161	41.2	47	34.1	35.7	9.9	9.6	26.97	17.7	117.93	60.57
Mean	315.33	188.22	49.8	48.5	40.7	40.8	11.1	10.6	34.11	18.87	174.18	91.8
CD(Gen.)	14.66		2.31		1.64		0.35		3.14		15.87	
CD(Env.)	8.46		1.34		0.95		0.2		1.81		9.16	

Table 4: ANOVA of SPAD value at pre and post anthesis stage under two environmental conditions

Source of variation	df	SPAD values
		Mean Squares
Genotype (Gen)	5	100.851**
Environment (Env)	1	121.92**
Flowering stage (Fs)	5	7.378**
Gen × Env	1	129.297**
Gen × Fs	5	26.899**
Env × Fs	1	2.571
Gen × Env × Fs	5	3.306**
Error	46	0.69
Grand mean		40.94

Table 5: Mean SPAD values of different genotypes at pre and post anthesis stages under two environmental conditions

Genotypes	Environment	Pre anthesis stage	Post anthesis stage
UP 262	IR	44.3	37.6
	RI	41.8	38.2
HD 2967	IR	46.3	45.3
	RI	42.1	40.6
DBW 39	IR	41.6	46.0
	RI	42.5	43.6
C 306	IR	39.1	36.0
	RI	35.5	31.8
K 0307	IR	44.3	40.9
	RI	43.1	38.0
SONALIKA	IR	44.8	40.7
	RI	41.9	36.6
CD (Gen.)	0.683		
CD (Env.)	0.394		
CD (Fs)	0.394		

Conclusion

For the experiment it was concluded that all the growth, yield attributes and yield were varied significantly in two irrigational approaches. HD 2967 and K 0307 showed better performance in respect to yield attributes and yield. By observing SPAD value, HD 2967 and DBW 39 can maintain their greenness which is a indicator of water stress tolerance. Good growth and development of plants reflect the final production and productivity of crop therefore, proper selection of genotype and good irrigation approach be more effective in augmenting yield of wheat in the Terai region of West Bengal. Overall HD 2967 is the best variety for this region to satisfy the yield requirements.

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