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Performance of new wheat genotypes under restricted irrigated conditions

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Abstract
Field experiment entitled "Performance of new wheat genotypes under restricted irrigated conditions" was conducted at Instructional-cum Research Farm of Barrister Thakur Chhedilal College of Agriculture and Research station, Bilaspur, Chhattisgarh during *rabi* 2021-22. The treatments were comprising of three irrigation levels I_0 (no irrigation), I_1 (irrigation at CRI stage), I_2 (irrigation at CRI and Boot leaf stage) in main plots and nine genotypes i.e., (V_1) MP3288(C), (V_2)HI1655, (V_3)DDW47(d), (V_4) HI8823(I), (V_5)CG1036, (V_6)DBW110(C), (V_7)HI8830(d), (V_8)DDW55(d) and (V_9) HI8627(d)in sub-plots, laid out in spilt plot design with three replications. The result showed that plant population, growth parameters i.e., plant height (cm), number of tillers (m^{-2}), dry matter accumulation (g $plant^{-1}$), crop growth rate (g $plant^{-1}$ day^{-1}), and relative growth rate (g g^{-1} day) and yield attributing characters like Ear length (cm), weight of grains ear^{-1}, number of grains ear^{-1} head and test weight (g) and biological yield (q ha^{-1}), grain yield (q ha^{-1}) and straw yield (q ha^{-1}) and harvest index (%) were recorded highest in irrigation level (Two irrigation at CRI and boot leaf stage) which was at par with I_1 (one irrigation at CRI) and lowest in I_0 (no irrigation). Among genotypes the plant population was recorded to be non-significant for all treatments and the highest plant height was recorded in genotype (V_2) HI1655 and lowest was recorded in genotype (V_5) CG1036 and highest number of tillers, dry matter production, crop growth rate, relative growth rate and yield attributing characters like ear length,number of grains ear^{-1} head, test weight, biological yield, grain yield, straw yield and harvest index were recorded highest in genotype (V_5) CG1036which at par with (V_6) DBW110(C)while the minimum was recordedin (V_4) HI8823(I), except of ear length and harvest index.The minimum ear length was recorded in genotype (V_8) DDW55(d) and harvest index in (V_2) HI1655.

Keywords: Restricted irrigation, wheat, genotypes, yeild, yeild attributes

Introduction
Wheat is one of the world's most important food grain crops. Wheat is a grain that originated in South Western Asia and expanded throughout Asia, Europe, Africa, and the Americas. It is the world's most important cereal crop, accounting for 30% of all cereal food produced globally, and is a staple food for nearly 10 billion people in 43 nations. It's a highly nutritious and useful grain that's grown all over the world. It has been cultivated in the Indian subcontinent since pre-historic times and is an important part of the economy and food security of the country. Worldwide, wheat provides nearly 55% of carbohydrates and 20% of the food calories consumed globally (Breiman and Graur, 1995)[3]. Wheat is grown in India on 31.61 m ha and produces of 109.52 m t with national average productivity of 3.46 t ha^{-1} during 2020-21 (Anonymous, 2021a) [1].

Chhattisgarh State is divided into 3 Agro-Climatic Zones with immense potential for Agricultural development. In Chhattisgarh, wheat is a major cereal crop of *rabi* season in rice based cropping system under irrigated condition and maximum farmers grow wheat crop after harvesting of rice in midland to low land condition. Wheat is one important crop of Chhattisgarh and the cropping system of the state is mainly rain dependent. In Chhattisgarh, wheat occupies an area 227 (000 ha) and average productivity of 1.6 t ha^{-1} (Anonymous, 2021b) [2].

Water is required at every developmental stage for the highest possible output of wheat, from seed germination to plant maturation to harvest. Due to regional heterogeneity in environment and agronomic techniques, the effect of restricted irrigation on crop yield and WUE is dependent on growth stage, which is fundamentally needed irrigation water and the most sensitive growth stage differs from area to region.

When compared to more irrigation schedules on wheat, restricted irrigation gets the highest yield and saves water (Khokhar *et al*., 2010) [13].

Varied wheat genotypes require different amounts of water in different habitats. For past two decades, the rainfall pattern and environmental circumstances have been shifting under the new scenario of the total rainfall and its distribution; there is insufficient irrigation water to meet the wheat crops need. Wheat crop is highly susceptible to water stress, so identifying and growing such varieties of wheat which could thrive under restricted irrigation could solve the problem. Under limited supply of water, irrigation should be planned to maximize the utilization of the amount of water that is available. When only one irrigation is available, it should be applied at the crown root initiation stage (20-25 days after sowing); when two irrigations are available, the first should be applied at the crown root initiation stage and the second at the flowering stage; and when three irrigations are available, the first should be applied at the crown root initiation stage, the second at the late jointing stage and the third at the milking stage. These suggestions emphasize the importance of irrigation during the crown root initiation stage.

Materials and Methods

Field experiment entitled "Performance of new wheat genotypes under restricted irrigated conditions" was conducted at Instructional-cum Research Farm of Barrister Thakur Chhedilal College of Agriculture and Research station, Bilaspur, Chhattisgarh during *rabi* 2021-22. The soil of experimental field was clay loam in texture withPH 6.9 and EC dsm^{-1} 0.24 in the top 0-30 cm of soil. The soil was low in available N medium in available P, organic carbon, and available K. Fertilizer dose recommended for this experimental was 90:60:40 NPK kg ha^{-1}. The treatments were comprising of three irrigation levels I_0 (no irrigation), I_1 (irrigation at CRI stage), I_2 (irrigation at CRI and Boot leaf stage) in main plots and nine genotypes i.e., (V_1) MP3288(C), (V_2)HI1655, (V_3)DDW47(d), (V_4) HI8823(I), (V_5)CG1036, (V_6)DBW110(C), (V_7)HI8830(d), (V_8)DDW55(d) and (V_9) HI8627(d)in sub-plots, laid out in spilt plot design with three replications. The crop was sown on 30th November, 2021 and harvesting was done on 10th march, 2022.

To evaluate the different irrigation level on different wheat genotypes, the various morphological observations, growth analysis and yields were recorded in the experiment at 30, 60, 90 days after sowing and at harvest stage. The recommended dose of fertilizers for wheat are 120:60:40 kg of N, P_2O_5, K_2O ha^{-1} respectively. Full dose of P_2O_5, K_2O and 50% of Nitrogen were applied at the time of sowing in I_1 (One irrigationat CRI (20-25DAS)) I_2 (Two irrigations at CRI and Boot leaf stage (80-85 DAS)) and remaining Nitrogen were applied at first irrigation (20-25 DAS) and Full dose of P_2O_5, K_2O, and Nitrogen were applied in I_0. Growth parameters were recorded before harvesting of crop. Harvesting was done when the spikelet matured and plant was dried up. The threshing of the crop was done by manually by plot wise and grain and straw where collected separately.

Results and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads:

Plant height (cm)

The highest plant height was recorded under I_2 (Two irrigation) at CRI & boot leaf which at par with I_1 (One irrigation at CRI), while the lowest was recorded under without irrigated plot at 30 DAS Similar trends were recorded under 60, 90 DAS after sowing and at harvest (Table 1.). Among genotypes the highest plant height was recorded in genotype (V_2) HI1655 which at par with genotype (V_6) DBW110 (C), (V_7) HI8830 (d), (V_8) DDW33 (d) and (V_1) MP2288 (C) at 30 DAS after sowing, while lowest was recorded in genotype (V_5) CG1036, and in 60 DAS after sowing the highest plant height was recorded in genotype (V_2) HI1655 while the lowest was recorded in genotype (V_5) CG1036. Similar trends were recorded by 90 DAS after sowing and at harvest. Interaction effect between irrigation levels and genotypes was recorded Non-significant.

All genotypes increased plant height by applying irrigation at all critical growth stages which might be due to the variation in genetic characters among different cultivars as well as with healthier plant growth with sufficient availability of nutrients having no moisture stress. These results are in line with those of Wang *et al.,* (2009) who reported that irrigation treatments significantly influenced plant height.

Number of tillers (m^{-2})

The highest number of tillers were recorded under I_2 (two irrigation level) which at par with I_1 (one irrigation level) while the lowest was recorded under I_0: (without irrigated plot). Similar trends were recorded at 60th, 90th DAS after sowing and at harvest (Table 2.). Data revealed that (V_5) CG1036 recorded highest number of tillers which at par with (V_6) DBW110(d), while minimum was recorded under genotype (V_4) HI8823(I) at 30 DAS after sowing. Similar trend was recorded at 60th, 90th DAS after sowing and at harvest. Interaction effect between irrigation levels and genotypes was recorded Non-significant.

It might be due to timely supply of irrigation at the critical stages i.e., CRI and Boot leaf stage: Thus, maximum moisture level (Two irrigations) was most favorable for vegetative growth and development resulted into higher number of effective tillers m^{-2} the findings are in support to those of Ali *et al.,* (2010) [2].

Dry Matter Accumulation (G $plant^{-1}$)

Maximum total dry matter accumulation $plant^{-1}$ was recorded under I_2 (Two irrigation at CRI & boot leaf stage) which at par with I_1 while the lowest was recorded under I_0 (no irrigation) at 30th DAS. Similar trends were observed at 60th, 90th DAS after sowing and at harvest (Table 3.). Among genotypes the highest dry matter production was recorded in genotype (V_2) HI1655 which at par with (V_5) CG1036, (V_6) DBW110(C) and (V_7) HI8830(d) while the minimum was recorded under the genotype (V_4) HI8823(I). Similar trends were noticed at 60th, 90th DAS after sowing and at harvest. Interaction effect between irrigation levels and genotypes was recorded Non-significant.

Irrigation during critical growing stage of wheat can enhance wheat photosynthetic rate, dry matter accumulation and transportation. Similar finding were reported by Boughdiri *et al.,* (2014) [8].

Ear length (cm)

The highest ear length (cm) was recorded in I_2 (Two irrigation at CRI & boot leaf) which found to be at par with I_1 (One irrigation at CRI stage) while the minimum ear length was found in I_0 (No irrigation). Among different genotypes (V_5) CG1036 produced maximum ear length followed by (V_6) DBW110(C) and lowest was recorded in genotype (V_8)

DDW55(d) at harvest (Table 4.). Interaction effect between irrigation levels and genotypes in ear length (cm) was recorded non-significant at harvest.

Increase in length of ear (cm) at higher level of irrigation could be possible due to maintenance of constant water supply to the plants, which maintained various metabolic processes and increases the photosynthetic activity of plants. Increase in length of ear (cm) dueto increased irrigation levels was also reported by Atikullah *et al*., (2014) and Ahmad and Kumar (2015) [6, 1].

Number of grains ear head^{-1}

The highest number of grains ear^{-1} head was recorded in irrigation level I_2 (Two irrigations at CRI & boot leaf) followed by I_1 (One irrigation at CRI) while lowest number of grains ear^{-1} head was recorded in I_0 (No irrigation) plot. As per data regarding different genotypes also indicated that genotypes had significant difference in number of grains per ear head. Amongst different genotype maximum number of grains ear^{-1} head was recorded in (V_5) CG1036 which at par with (V_6) DBW110(C) while the minimum was found in (V_4) HI8823(I) (Table 4.). Interaction effect between irrigation levels and genotypes for the number of grains ear head^{-1} was recorded Non-significant at harvest.

With adequate moisture, the plant height, LAI and dry matter accumulation was highest which might be contributed to highest yield attributes due to increased photosynthesis activity of leaves. Besides, translocation of photosynthates from source to sink, higher uptake of potassium under optimum moisture condition also leads to better yield attributes. Due to this maximum number of grains ear head^{-1} was recorded under I_2 (Two irrigations, first at CRI and second at Boot leaf stage). The increase in number of grains ear head^{-1} due to increase in irrigation levels was also reported by Khokhar *et al.,* (2010) [13].

Test weight (g)

The crop was given with I_2 (Two irrigation at CRI & boot leaf) had the higher Test weight which was at par with I_1 (One irrigation at CRI) while lowest Test weight was I_0 (no irrigation) irrigated plot. As per data regarding different genotypes also indicated that genotypes had significant difference in seed weight. Among different genotypes the highest Test weight was recorded in (V_5) CG1036 which at par with (V_6) DBW110(C) and (V_7) HI8830(d) while the minimum was recoded in (V_4) HI8823(I) (Table 4.). Interaction effect between irrigation levels and genotypes atharvest was recorded as non-significant.

A regular supply of water or irrigation throughout the growing season results in an increase in dry matter accumulation in the grain, and the plumpness of the grain will increase.Test weight depends on the plumpness of the grain. The results are in agreement with the findings of Karam *et al.,* (2009) and Ahmad and Kumar (2015) [12, 1].

Grain yield (q ha^{-1})

The irrigation levels and genotypes were significantly affected the grain yield at harvest of the crop. I_2 (Two irrigation at CRI & boot leaf) had the higher grain yield which was at par with I_1(One irrigation at CRI) while lower grain yield was recorded for I_0 (no irrigation) plot. As per data regarding different genotypes also indicated that Genotypes had significant variation in grains yield. Amongst different genotype the highest grain yield was recorded in genotype (V_5) CG1036 which at par with (V_6) DBW110(C) while the minimum was found in (V_4) HI8823(I). Non-significant interaction effect between irrigation levels and genotypes was observed at harvest.

The higher grain yield was certainly due to adequate moisture availability, which contributed to better growth parameters and yield attributes which resulted in higher grain yield. The increase in grain yield (q ha^{-1}) due to increase in irrigation levels was also reported by Kumar and Pannu (2012) [14]. Ngwako and Mashiqa (2013). Aslam *et al.,* (2014) and Bedarkar *et al.,* (2017) [5, 7].

Straw yield (q ha^{-1})

Table 1: Plant height (cm) at successive stages of wheat as influenced by different irrigation levels and genotypes

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	AT Harvest
A. Irrigation Levels				
I_0 (no irrigation)	27.29	67.00	78.61	74.69
I_1 (One Irrigation) at CRI stage	29.24	69.81	80.02	76.79
I_2 (Two Irrigation) at CRI and boot leaf	30.14	70.65	80.80	78.29
S.Em±	0.54	0.71	0.40	0.69
C.D. (P=0.05)	2.13	2.79	1.57	2.69
B. Genotypes				
MP3288(C)	28.92	70.44	81.72	78.54
HI1655	31.51	81.41	92.87	89.32
DDW47(d)	28.30	63.42	74.57	71.67
HI8823(I)	27.24	63.63	74.39	70.60
CG1036	27.20	61.31	72.30	69.07
DBW110(C)	30.57	74.40	85.39	82.44
HI8830(d)	30.04	73.83	85.08	81.93
DDW55(d)	28.68	70.16	80.80	77.79
HI8627(d)	27.56	63.78	71.18	67.96
S.Em±	0.91	1.70	0.77	0.55
C.D. (P=0.05)	2.60	4.85	2.20	1.56
Interaction				
S.Em±	1.58	2.95	1.34	0.95
C.D. (P=0.05)	NS	NS	NS	NS

Table 2: Number of tillers m^{-2}at successive stages of wheat as influenced by different irrigation levels and genotypes

Treatments	Number of tillers (m^{-2})			
	30 DAS	60 DAS	90 DAS	AT Harvest
A. Irrigation Levels				
I_0 (no irrigation)	181.17	293.67	320.47	312.06
I_1 (One Irrigation) at CRI stage	184.78	300.90	330.86	324.48
I_2 (Two Irrigation) at CRI and boot leaf	189.92	307.26	339.21	334.58
S.Em±	1.55	1.38	2.05	4.18
C.D. (P=0.05)	6.11	5.43	8.06	16.44
B. Genotypes				
MP3288(C)	185.89	300.15	331.61	323.94
HI1655	183.67	298.79	328.17	321.28
DDW47(d)	180.65	296.43	325.15	317.48
HI8823(I)	177.38	292.46	321.99	314.32
CG1036	195.63	310.81	340.12	338.01
DBW110(C)	192.06	307.22	336.55	333.33
HI8830(d)	186.64	304.11	333.36	325.69
DDW55(d)	185.57	300.36	330.06	323.51
HI8627(d)	180.11	295.18	324.60	315.83
S.Em±	3.07	2.24	2.16	4.26
C.D. (P=0.05)	8.74	6.37	6.16	12.13
Interaction				
S.Em±	5.32	3.88	3.75	7.38
C.D.(P=0.05)	NS	NS	NS	NS

Table 3: Dry matter accumulation (g plant^{-1}) of wheat as influenced by different irrigation levels and genotypes

Treatments	Dry matter accumulation (g plant$^{-1)}$			
	30 DAS	60 DAS	90 DAS	AT Harvest
A. Irrigation Levels				
I_0 (no irrigation)	0.640	6.43	16.04	21.96
I_1 (One Irrigation) at CRI stage	0.670	8.51	21.55	30.06
I_2 (Two Irrigation) at CRI and boot leaf	0.680	9.02	22.99	32.12
S.Em±	0.003	0.18	0.45	0.62
C.D. (P=0.05)	0.011	0.71	1.77	2.47
B. Genotypes				
MP3288 (C)	0.674	8.17	20.41	28.32
HI1655	0.698	8.63	21.27	29.29
DDW47 (d)	0.633	7.60	19.56	27.35
HI8823 (I)	0.632	6.79	16.45	22.60
CG1036	0.682	8.50	22.60	31.73
DBW110 (C)	0.691	8.87	21.57	29.64
HI8830 (d)	0.680	8.26	20.93	28.87
DDW55 (d)	0.658	7.97	20.06	28.03
HI8627 (d)	0.640	7.12	18.91	26.59
S.Em ±	0.011	0.20	0.49	0.89
C.D. (P=0.05)	0.030	0.59	1.40	2.53
Interaction				
S.Em±	0.018	0.36	0.85	1.53
C.D. (P=0.05)	NS	NS	NS	NS

Table 4: Ear length (cm), grains ear^{-1} head, test weight (g), grain yield (q ha^{-1}), straw yield (q ha^{-1}) of wheat as influenced by different irrigation levels and genotypes

Treatments	Ear length (cm)	No. of grains ear $^{-1}$head	test weigth (g)	Grain yield (q ha^{-1})	Straw yield (q ha-1)
A. Irrigation Levels					
I_0 (no irrigation)	7.53	24.15	39.32	29.63	35.20
I_1 (One Irrigation) at CRI stage	7.71	26.52	40.76	35.07	38.80
I_2 (Two Irrigation) at CRI and boot leaf	8.01	26.70	41.00	36.62	39.17
S.Em±	0.09	0.51	0.32	0.96	0.80
C.D. (P=0.05)	0.35	2.03	1.28	3.77	3.14
B. Genotypes					
MP3288 (C)	9.31	25.63	40.89	34.16	36.97
HI1655	8.06	25.02	40.07	32.34	43.57
DDW47 (d)	6.01	24.75	39.82	31.60	35.30
HI8823 (I)	7.07	24.17	38.33	29.24	33.60
CG1036	9.66	28.73	42.05	39.35	40.55
DBW110 (C)	9.27	27.29	41.88	38.06	40.87
HI8830 (d)	7.47	26.34	41.28	35.54	38.65
DDW55 (d)	5.59	25.43	40.46	33.33	36.66
HI8627 (d)	7.34	24.78	38.48	30.35	34.66
S.Em±	0.11	0.80	0.70	0.97	1.22
C.D. (P=0.05)	0.32	2.27	1.99	2.74	3.48
Interaction					
S.Em±	0.19	1.38	1.21	1.67	2.12
C.D. (P=0.05)	NS	NS	NS	NS	NS

The irrigation levels and genotypes were significantly affected the straw yield ofter thresing of the crop. The crop was given with I_2, (Two irrigation at CRI & boot leaf) had the higher straw yield which was at par with I_1(One irrigation at CRI) while lower straw yield was for I_0 (no irrigation) plot. As per data regarding different genotypes also indicated that genotypes had significant variation in straw yield. Amongst different genotype thehigheststraw yield was recordedin (V_2) HI1655 followed by (V_5) CG1036, (V_6) DBW110(C)while the minimum was recorded in (V_4) HI8823(I). (Table 4.).
Interaction effect between irrigation levels and genotypes was observed ofter thresing.
Poor moisture supply during critical stages reduced the yield attributes and resulted in poor straw yield. Similar findings were reported by Mitra *et al.,* (2006) and Idnani and Kumar (2012).

Conclusion

It can be concluded that The irrigation levels I_2 (Two irrigation at CRI & boot leaf) was given highest performance which at par with I_1 (One irrigation at CRI). among the genotypes, CG1036reflected the maximum grain yield (39.35 q ha^{-1}) which at par with DBW110(C) (38.06 q ha^{-1}) under restricted irrigation. This genotype can be a good option for the wheat farmers of the chhattisgarh under restricted irrigation in terms of productivity as well as various growth parameters.

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