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Performance of timely sown wheat (*Triticum aestivum* L.) genotypes under irrigated condition

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ABSTRACT

A field experiment was carried out during Rabi season, 2020 at Wheat Breeding Experimental Field, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj (U.P). The soil of experimental site was sandy loam in texture and nearly neutral in soil reaction with (pH 6.7). The experiment was laid out in Randomized Block Design and fourteen wheat genotypes were replicated fourfold. Study revealed that the genotype G_{12}, i.e., NERI-312 recorded significantly higher plant height (100.50 cm), number of tillers/hill (10/hill), plant dry weight (26.14 g), length of the spike (13.5 cm), number of grains per spike (42.95), test weight (40.05 g), grain yield (4.18 t/ha) and straw yield (6.04 t/ha). It was evident that the genotype NERI-312 was found to be productive.

Introduction

Wheat belongs to family poaceae and is very important crop as it contribute major portion of staple food for world's population. It provides more calories and protein within the world's diet than any other cereal (CIMMYT, 2002). Wheat acts as the staple food in more than 40 countries of the world (Sharma *et al.,* 2019). It is the world's most generally cultivated cereal crop. It has been described as the ''King of cereals'' due to the acreage it occupies, high productivity and prominent position it holds within the international food grain trade (Coasta *et al.,* 2013). Wheat is principally grown during *Rabi* season with wider adaptability and requires relatively low temperatures for their growth. The foremost favourable climatic condition for wheat cultivation is cool and moist weather during the vegetative phase, followed by dry warm weather for the grain to mature and ripening. In India, growing season for wheat is restricted by high temperature at maturation and moreover there is also concern for changing climate scenario. Time of sowing in wheat is the most significant factor that governs the crop development phenologically. It also plays a prominent role in conversion of biomass in to economic yield. Proper irrigation at the critical growth stages aids the wheat crop for withstanding unfavourable conditions. Providing irrigation at critical growth stage affects the yield in a positive way. Irrigation is such a vital and costly factor which influences the growth and yield of the wheat. So, the development of high yielding genotypes under limited water resources and limited environmental conditions are necessary in the

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current scenario. Improved varieties must be productive with higher yield and should be economical to the farmers. Therefore, with above facts to seek out the promising genotypes under prayagraj condition this present investigation was carried out.

Material and Methods

The experiment entitled ''Performance of Timely Sown Wheat (*Triticum aestivum* L.) Genotypes under Irrigated Condition'' was carried out during *Rabi* season of 2020, at the Wheat Breeding Experimental Field, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh. The Wheat Breeding Experimental Field is situated at 25°24'33" N latitude, 81°51'12" E longitude (Google, 2021) and 98 m altitude above the mean sea level. The experimental field soil texture was sandy loam. The experiment was laid out in a randomized block design and fourteen genotypes were replicated four times each. The wheat was sown on 25th November 2020 with plant geometry of 20 x 10 cm. The genotypes were G_1 - NERI-301, G_2 - NERI-302, G_3 - NERI-303, G_4 - NERI-304, G_5 - NERI-305, G_6 - NERI-306, G_7 - NERI-307, G_8 - NERI-308, G_9 - NERI-309, G_{10} - NERI-310, G_{11} - NERI-311, G_{12} - NERI-312, G_{13} - NERI-313, G_{14} - NERI-314 respectively. The experimental data recorded was subjected to statistical analysis by adopting the Fishers method of analysis of variance (ANOVA) as described by Gomez and Gomez (1984). The data collected from the experiment was subjected to statistical analysis using ICAR WASP software. Critical difference (CD) values were calculated by the 'F' test was found significantly at 5% level.

Results and Discussion

A. Growth parameters

Plant height (cm)

Data regarding the plant height (cm) of wheat is given in Table 1. The plant height increased significantly, at each crop stage up to crop harvest. Data pertaining the plant height of the wheat genotypes was recorded at 60, 90 DAS and at harvest shown significantly higher plant height (67.59 cm, 99.46 cm 100.50 cm) in the genotype G_{12}. The Genotypes G_{11}, G_8 and G_{13} were statistically at par with the genotype G_{12} at 60 DAS. The genotypes G_{11}, G_8, G_{13}, G_{10}, G_3 and G_1 were statistically at par with the genotype G_{12} at 90 DAS and at harvest. Each genotype has its own feature from the growth viewpoint. The variation in the plant height was recorded based on their genetic character. Larger leaf area, amount of chlorophyll pigments and other traits play an important role in the crop growth. These results were found close conformity with the results of Poudel *et al*. (2020) in wheat.

Number of Tillers per hill

Data pertaining to number of tillers per hill at 60, 90 DAS and at harvest was presented in Table 1. Number of tillers per hill was increased with the advancement of the crop growth up to 90 DAS and later on it was declined at harvest stage. The number of tillers per hill of wheat at 60, 90 DAS and at the time of harvest differed significantly in different genotypes. There was a significant increase in the number of tillers per hill (11.65/hill and 12.92/hill) and found maximum at 60 and 90 DAS in the genotype G_{12}. At harvest there was a slight decline in number of tillers per hill (10/hill) in the same genotype G_{12}, but found to be significant. However the genotypes G_{11}, G_8 and G_{13} were statistically at par with the genotype G_{12} at 60 DAS and at the harvest stage. At 90 DAS G_{11} and G_8 were found on par with the genotype G_{12}. Most of the economic yield of the grain crops is determined by number of tillers, number of tillers per hill affect the productive tillers respectively. This is in agreement with the findings of Shuaib *et al.* (2019) and Chopde *et al.* (2015).

Plant dry weight (g/hill)

Data on plant dry weight (g/hill) was given in Table 2. At 60, 90 DAS and at harvest showed that the maximum plant dry weight (8.5 g/hill, 20.86 g/hill and 26.14 g/hill) was recorded in the genotype G_{12} and was significantly superior over all the genotypes. The genotypes G_{11} and G_8 were statistically on par with the genotype G_{12} at both 60 DAS and at harvest. At 90 DAS only genotype G_{11} was at par to the genotype G_{12}. From 60 DAS the dry weight has shown significant increase. This is due to the formation of tillers and the occurrence of jointing which leads to dry matter accumulation in the genotypes.These results were in close onformity with Alam *et al.* (2013) and Shahzad *et al.* (2002).

Crop growth rate (g/m²/day)

Data pertaining to crop growth rate is presented in the Table 2. Maximum crop growth rate (13.528 g/m2/day and 20.603 g/m2/day) was recorded significantly higher in the genotype G_{12} during 30 - 60 DAS and 60 - 90 DAS intervals. The genotypes G_{11} and G_8 were at par with the genotype G_{12} during 30 - 60 DAS interval. But during the interval of 60 - 90 DAS, the genotypes G_{10}, G_{13}, G_8, G_{11}, G_3, G_1 and G_4 maintained the crop growth rate at par with the G_{12} genotype. The crop growth rate trend is depicted in the Figure 1. There was a significant increase in the crop growth rate of the wheat from 30, 60 and up to 90 DAS. Later on, there was a sudden decline in the crop growth rate after 90 DAS. This is due to the completion of the vegetative phase and maximum production of dry matter in the early growth stages of the plant. These results are similar to Alam (2013).

Relative growth rate (g/g/day)

Higher relative growth rate was recorded in initial growth stages during 30 - 60 DAS, in all the genotypes and is presented in Table 2. Relative growth rate curve is depicted in Figure 2. The genotype G_{11} recorded maximum relative growth rate (0.109 g/g/day) during 30 - 60 DAS. Later on, in the further intervals during 60 - 90 DAS, genotypes G_{10} and G_4 with relative growth rate (0.036) and during 90 - 120 DAS, genotypes G_7, G_6, G_9 and G_2 with relative growth rate (0.010) were found to be higher. There was a declining trend recorded in all the genotypes. Relative growth rate decreased steadily due to lower dry matter accumulation with the advancement of the crop growth stages. These results are in match up with those reported by Akhtar *et al*. (2018).

Yield and yield attributes

Observations regarding the yield and yield attributes viz., Length of the spike (cm), Number of grains per spike, Test weight (g), Grain yield (kg/ha) and Straw yield (kg/ha) of Wheat were depicted in Table 3.

Length of the spike (cm)

On perusal of data it is apparent that length of spike varied significantly due to different genotypes. The maximum spike length (13.5 cm) was recorded significantly higher in genotype G_{12}. However, the genotypes G_{11} and G_8 were statistically at par with the genotype G_{12}. Maximum spike length is a genetic trait and the variation in different spike lengths are due to the genetic variability among the genotypes which is in close conformity with results of Mushtaq *et al*. (2011).

Table 1: Evaluation of wheat genotypes on plant height and number of tillers per hill

Genotypes	Plant height (cm)			Number of tillers per hill		
	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest
NERI-301	60.36^{bcd}	95.46^{abcd}	96.30^{abcd}	8.05^{c}	9.05^{de}	7.65^{cde}
NERI-302	54.59^{e}	87.13^{f}	89.10^{f}	7.45^{c}	8.20^{e}	6.70^{e}
NERI-303	60.76^{bcd}	95.49^{abcd}	96.44^{abcd}	8.25^{c}	9.80^{cde}	7.85^{bcde}
NERI-304	59.81^{cd}	94.52^{bcd}	95.38^{bcd}	8.05^{c}	8.90^{de}	7.15^{de}
NERI-305	59.05^{cde}	91.74^{def}	92.98^{def}	7.45^{c}	8.50^{e}	6.80^{e}
NERI-306	59.64^{cde}	92.58^{cde}	94.38^{cde}	7.50^{c}	8.55^{e}	6.85^{e}
NERI-307	59.72^{cd}	94.18^{bcde}	94.85^{cde}	8.25^{c}	8.80^{de}	6.85^{e}
NERI-308	63.70^{abc}	98.48^{ab}	99.65^{ab}	9.65^{abc}	11.45^{abc}	8.80^{abc}
NERI-309	56.70^{de}	89.51^{ef}	90.49^{ef}	7.45^{c}	8.35^{e}	6.70^{e}
NERI-310	62.43^{bc}	96.01^{abcd}	97.09^{abcd}	9.10b^{c}	10.65^{bcd}	8.50^{bcd}
NERI-311	65.45^{ab}	98.84^{ab}	100.18^{a}	10.88^{ab}	12.00^{ab}	9.25^{ab}
NERI-312	67.59^{a}	99.46^{a}	100.50^{a}	11.65^{a}	12.92^{a}	10.00^{a}
NERI-313	63.26^{abc}	97.17^{abc}	98.48^{abc}	9.50^{abc}	10.85^{bcd}	8.70^{abc}
NERI-314	48.95^{f}	81.25^{g}	82.95^{g}	7.35^{c}	8.20^{e}	6.60^{e}
SEm (±)	1.79	1.68	1.67	0.84	0.72	0.50
CD (P = 0.05)	5.11	4.80	4.76	2.40	2.07	1.44

Table 2: Evaluation of wheat genotypes on dry weight, crop growth rate and relative growth rate

Genotypes	Dry weight (g/hill)			Crop growth rate (g/m2/day)			Relative growth rate (g/g/day)		
	60 DAS	90 DAS	At harvest	30 - 60 DAS	60 - 90 DAS	90 - At harvest	30 - 60 DAS	60 - 90 DAS	90 - At harvest
NERI-301	5.68[cd]	16.14[de]	20.44[de]	8.76[cd]	17.43[abc]	7.16	0.088	0.035	0.008
NERI-302	5.06[d]	13.02[gh]	17.25[h]	7.91[d]	13.27[d]	7.04	0.093	0.033	0.010
NERI-303	5.88[cd]	16.96[cd]	21.5[cd]	9.43[cd]	18.49[ab]	7.55	0.110	0.035	0.008
NERI-304	5.42[d]	15.78[def]	19.84[ef]	8.29[d]	17.27[abc]	6.78	0.083	0.036	0.008
NERI-305	5.17[d]	13.86[gh]	18.27[gh]	8.07[d]	14.49[cd]	7.37	0.093	0.034	0.009
NERI-306	5.22[d]	14.09[fg]	18.78[fgh]	8.17[d]	14.78[cd]	7.83	0.093	0.033	0.010
NERI-307	5.24[d]	14.49[efg]	19.5[efg]	8.20[d]	15.42[bcd]	8.35	0.093	0.034	0.010
NERI-308	7.50[ab]	19.02[b]	24.73[ab]	11.81[ab]	19.20[a]	9.52	0.097	0.031	0.009
NERI-309	5.09[d]	13.44[gh]	17.95[gh]	7.94[d]	13.92[cd]	7.52	0.092	0.033	0.010
NERI-310	6.03[cd]	17.96[bc]	22.16[c]	9.48[cd]	19.86[a]	7.02	0.095	0.036	0.007
NERI-311	8.05[ab]	19.29[ab]	25.18[ab]	12.88[ab]	18.73a[b]	10.05	0.109	0.029	0.009
NERI-312	8.50[a]	20.87[a]	26.14[a]	13.53[a]	20.60[a]	8.80	0.104	0.030	0.008
NERI-313	6.90[bc]	18.69[bc]	23.88[b]	10.87[bc]	19.64[a]	8.67	0.098	0.033	0.008
NERI-314	4.98[d]	12.07[h]	15.62[i]	7.86[d]	11.82[d]	5.92	0.100	0.030	0.009
SEm (±)	0.47	0.62	0.54	0.76	1.28	0.78	0.01	0.00	0.00
CD (P = 0.05)	1.33	1.79	1.55	2.17	3.66	NS	NS	NS	NS

Table 3: Evaluation of wheat genotypes on yield and yield attributes

Genotypes	Length of the spike (cm)	Number of grains per spike	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)
NERI-301	12.20[bcd]	40.75[de]	37.65[cd]	3.73[abc]	5.70[abcd]
NERI-302	11.89[cd]	37.97[hi]	34.95[gh]	2.97[ef]	4.94[fg]
NERI-303	12.25[bcd]	40.85[de]	38.35[bc]	3.79[abc]	5.79[abc]
NERI-304	12.17[cd]	40.65[de]	37.30[cde]	3.51[bcd]	5.59[abcde]
NERI-305	12.03[cd]	38.95[fg]	35.82[fg]	3.24[de]	5.33[def]
NERI-306	12.10[cd]	39.5[f]	36.22[ef]	3.26[de]	5.34cdef
NERI-307	12.12[cd]	40.40[e]	36.52[def]	3.37[cde]	5.44[bcde]
NERI-308	12.70[abc]	41.70[bc]	39.37[ab]	3.92[ab]	5.94[a]
NERI-309	11.98[cd]	38.70[gh]	35.77[fg]	3.16[de]	5.24[efg]
NERI-310	12.36[bcd]	41.25[cde]	38.90[ab]	3.83[ab]	5.82[ab]
NERI-311	13.00[ab]	42.35[ab]	39.55[ab]	3.94[ab]	5.96[a]
NERI-312	13.50[a]	42.95[a]	40.05[a]	4.18[a]	6.04[a]
NERI-313	12.55[bc]	41.40[cd]	39.15[ab]	3.86[ab]	5.87[ab]
NERI-314	11.72[d]	37.80[i]	34.15[h]	2.71[f]	4.85[g]
SEm (±)	0.29	0.25	0.42	0.16	0.16
CD (P = 0.05)	0.83	0.71	1.21	0.45	0.46

Number of grains per spike

Maximum number of grains per spike (42.95) was recorded significantly higher in the genotype G_{12} and the genotype G_{11} was statistically at par with the genotype G_{12}. Number of grains per spike mainly depends on the genetic variability. Each genotype exhibits its own hereditary characters and genetic traits. These results were found similar with the results of Kilic and Gursoy (2010).

Test weight (1000 seed weight in g)

Genotype G_{12} recorded significantly higher 1000 seed weight of (40.05 g). The genotypes G_{11}, G_8, G_{13} and G_{10} were statistically at par with the genotype G_{12}. Test weight is influenced by both environmental and genetic factors. Genetic characters include both the hereditary and variability traits that are directly responsible for the

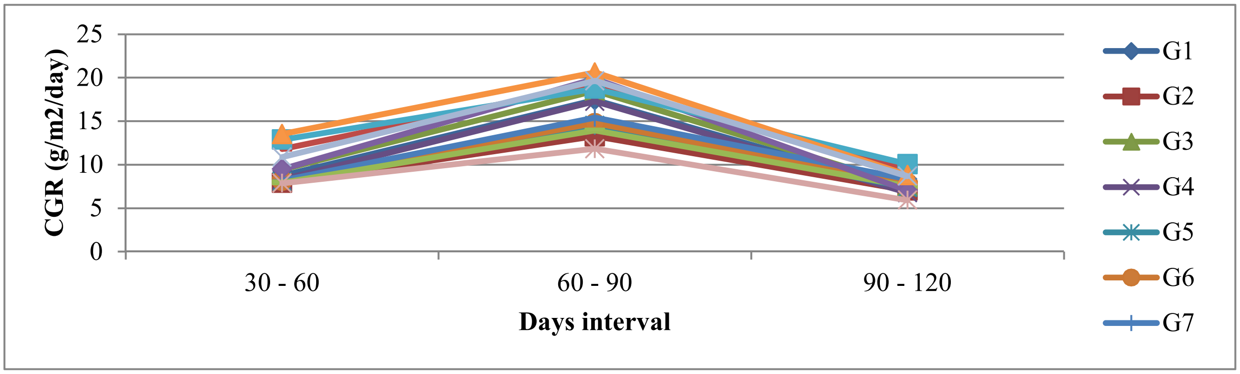

Figure 1: Crop growth rate (g/m2/day) of wheat in different genotypes

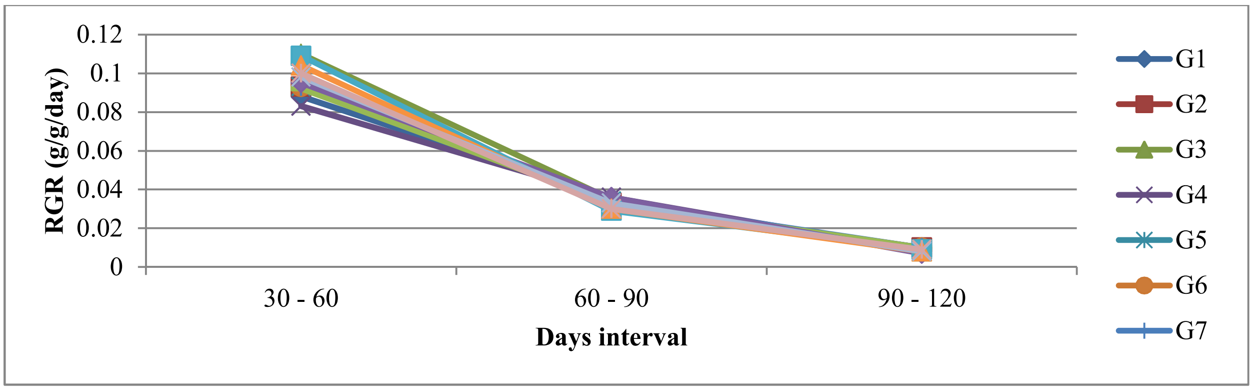

Figure 2: Relative growth rate (g/g/day) of wheat in different genotypes

1000 seed weight. Environmental factors like nutrient uptake, irrigation and etc., influence the test weight of the genotypes. Grain filling pattern and the other factors also influence the test weight of seeds in wheat crop (Banker *et al*., 2018).

Yield

Grain yield (t/ha)

Data pertaining to grain yield of wheat depicted in Table 3. It was specified that significant differences were due to variability in the genotypes. The maximum grain yield (4.18 t/ha) in the genotype G_{12} was found to be significantly superior over all the other genotypes. Genotypes G_{11}, G_8, G_{13} and G_{10} were at par with the genotype G_{12}. The maximum yield in genotype G_{12} is due to the yield attributes like higher number of grains per spike, maximum spike length and maximum thousand grain weight of the seeds which were significantly higher. These findings are similar with Sar *et al.* (2020). The higher grain yield was correlated with longer spike, growth duration and grain spike weight ratio at anthesis phase Gill (2009).

Straw yield (t/ha)

Data related to straw yield was recorded after harvesting of crop and tabulated in Table 3. It revealed that the genotype G_{12} recorded significantly higher straw yield (6.04 t/ha). However, the genotypes G_{11}, G_8, G_{13}, G_{10} and G_3 were statistically at par with the genotype G_{12}. Higher straw yield in G_{12} genotype is due to the achievement of the significantly higher growth attributes like plant height, dry weight and number of tillers. Nutrient uptake, irrigation at the critical growth stages and some environmental factors affect the straw yield of the wheat. These findings were in close conformity with Donaldson *et al.* (2001).

Conclusion

This study concluded that the wheat genotype NERI-312 was found more productive with maximum plant height, maximum number of tillers per hill, higher plant dry weight, higher number of grains per spike, maximum Test weight, higher grain yield and biological yield.

As the cost of cultivation is same for all the wheat genotypes, among them NERI-312 genotype will be economically viable due to the achievement of higher yield by that genotype.

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Conflict of interest
The authors declare that they have no conflict of interest.

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