

Evaluation of Barley (*Hordeum vulgare* L.) genotypes for growth yield and yield attributing traits in north east region of Uttar Pradesh

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ABSTRACT

The study titled “Evaluation of Barley (*Hordeum vulgare* L.) Genotypes for growth Yield and Yield-Attributing Traits in the North East Plain Zone of Uttar Pradesh” was conducted during the *Rabi* season of 2023-24. The research aimed to identify the best-performing barley genotypes and estimate genetic variability, heritability, genetic advance and correlation coefficients. Twenty barley genotypes, including one check variety, were evaluated for 23 quantitative traits, such as Field emergence, plant height, lodging percentage, flag leaf length and Breadth, spike length, peduncle length, awn length, number of tillers, canopy temperature, days to heading and maturity, spikelets per spike, grains per spike, grain yield per plant and per plot, test weight biomass and grain yield per hectare. Significant variation was observed among the genotypes for all traits. Six-row barley genotypes outperformed two-row genotypes in yield. Notably, genotype IBT-13 achieved the highest yield per plot (191.20 g), surpassing the check variety IBT-17 (175.07 g per plot).

Key words: Genotypes, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PVC), Barley.

INTRODUCTION

Barley (*Hordeum vulgare* L.) is a key cereal crop in India, ranking just behind maize, wheat, and rice in acreage and production. Originating from Iraq and part of the Poaceae family, barley is primarily grown as a rabi season crop in temperate climates worldwide, except in snow-bound regions. It is believed to be one of the earliest domesticated grains, with possible origins in Egypt, Ethiopia, the Near East, or Tibet. Globally, barley is cultivated in countries like the United States, Canada, China, Russia, and many others. In India, it is mainly grown in Uttar Pradesh, Haryana, Rajasthan, Punjab, Madhya Pradesh, Himachal Pradesh, and Uttarakhand, with smaller cultiva-

tion areas in Bihar, Gujarat, Jammu and Kashmir, Chhattisgarh, West Bengal, Nagaland, Maharashtra, Sikkim, and Delhi. In 2022-23, India cultivated barley on 589.57 thousand hectares, yielding 1.37 million metric tons with a productivity of 2.920 MT/ha. Rajasthan led in both acreage (301.24 thousand ha) and production (979.33 MT). Other major states included UP (167.00 thousand ha, 523.04 MT), MP (30.00 thousand ha, 63.93 MT), and Haryana (46.50 MT). Haryana had the highest productivity at 3.837 MT/ha, followed by Punjab (3.644 MT/ha), Rajasthan (3.254 MT/ha), and UP (3.132 MT/ha). Evaluating genetic diversity in barley is crucial for plant breeding and genetic resource preservation. A systematic assessment helps characterize accessions, identify duplicates in germplasm collections, and guide parent selection for new hybrids. While much re-

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search exists on barley diversity, little is known about Indian varieties. Characterizing Indian barley genotypes is essential for breeding and high-quality seed production, especially in Uttar Pradesh's Northeast Plain Zone. This research will provide valuable insights for farmers in the region. This study focuses on evaluating barley genotypes for yield and yield-attributing traits, identifying high-yielding genotypes, and analyzing the correlation between yield traits. It aims to assist breeders in selecting the best component mix for superior results by estimating correlations among various qualities, particularly grain yield. (Malysheva-Otto *et al.*, 2006; Matus and Hayes, 2002), (Duke, 1983).

MATERIALS AND METHODS

The present study entitled "Evaluation of Barley (*Hordeum vulgare* L.) Genotypes for Growth Yield and Yield Attributing Traits in North East Plain Zone of Uttar Pradesh" was carried out at Field Experimentation Centre, Depart-

ment of Genetics and Plant Breeding, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (Uttar Pradesh), during Rabi 2023-2024. The study was conducted to evaluate 20 barley genotypes on DUS, Growth and Yield parameters. A factorial experiment was conducted based on Randomized Block design with three replications for field experiment. All the cultural operations were carried to grow the crop effectively. Five representative plants from each plot were randomly marked to record the data for 23 Characters viz., Field emergence, plant height @ 30, 60, 90 DAS, lodging Percentage, flag leaf length, flag leaf breadth, spike length, peduncle length, awns length, number of tillers per plant, canopy temperature at booting stage, canopy temperature at early grain filling stage, canopy temperature at late grain filling stage, days to heading, days to maturity, spikelets per spike, grains per spike, test weight, biomass, grain yield per plant, grain yield per plot and grain yield per hectare.

Table 3.1. ANOVA for 22 characters of barley genotypes during Rabi- 2023-24

Mean sum of squares				
Sl. No.	Source Degrees of freedom	Replication 2	Genotypes 19	Error 38
1	Field emergence (%)	18.665	661.68*	18.568
2	Plant Height @30(cm)	4.398	20.35*	3.766
3	Plant Height @60(cm)	16.184	143.83*	14.276
4	Plant Height @90 (cm)	95.560	44.88*	11.798
5	Lodging Percentage (%)	21.950	856.43*	15.494
6	Flag Leaf Length (cm)	16.171	22.72*	4.759
7	Flag Leaf Breadth (cm)	0.109	0.12*	0.027
8	Spike Length (cm)	0.020	3.69*	0.169
9	Penducle length (cm)	5.180	44.57*	3.052
10	Awns Length (cm)	0.174	9.26*	0.915
11	No. of Tillers / plant	3.571	2.62*	0.960
12	Canopy Temperature Boating Stage	34.358	21.180	23.412
13	Canopy Temperature Early Grain Filling Stage	0.118	1.25*	0.491
14	Canopy Temperature late Grain Filling Stage	0.046	0.44*	0.180
15	Days to Heading	0.017	1.29*	0.403
16	Days To Maturity	0.150	5.22*	0.466
17	Spikelets / Spike	6.733	47.60*	5.882
18	Grains / spike	32.163	510.91*	14.201
19	Test Weight (g)	96.139	43.890	42.430
20	Biomass	2403.475	1097.310	1060.752
21	Grain Yield / plant (g)	5.142	118.10*	5.239
22	Grain Yield / plot (g)	425.312	226.07*	48.064
23	Grain yield/ha (t/ha)	0.002	0.13*	0.001

‘*’ and ‘***’ indicates level of significance at 5% and 1%.

RESULTS AND DISCUSSION

Growth and yield parameters

Field emergence: The mean performance of barley genotypes revealed significant variations in several traits. Field emergence ranged from 42.80% (IBT-32) to 90.33% (IBT-22), with a mean of 66.68%.

Plant height at 30 DAS ranged from 26.85 cm (IBT-22) to 35.88 cm (IBT-18), at 60 DAS from 52.74 cm (IBT-4) to 76.47 cm (IBT-39), and at 90 DAS from 105.39 cm (IBT-63) to 120.41 cm (IBT-39).

Lodging percentage varied from 28.00% (IBT-29) to 89.67% (IBT-4).

Canopy Temperature: Booting Stage: 8.45°C to 19.21°C, with the mean of 22.64°C, Grain Filling Stage: 20.33°C to 22.64°C, with the mean of 21.28°C. Grain Filling Stage: 13.91°C to 15.35°C as shown in the mean of 14.55°C.

Days to Heading: The shortest duration of 75.33 days to heading was taken by the genotype IBT-22 followed by IBT-13 (75.67 days), IBT-32 (76 days), IBT-36 (76 days). On the contrary, the plants of genotype IBT-4 took the longest duration of 78 days for heading followed by the genotype IBT-63 (77.67 days), IBT-58 (77.33 days), IBT-46 (77.33 days).

Spikelets per Spike: Ranged from 12.93 to 28.87, and maximum number of spikelets was observed in the genotype IBT-10 (28.87), followed by IBT-3 (25.73), IBT-58 (24.20), IBT-34 (22.67). The genotypes with the minimum number of spikelets were 12.93 for genotype IBT-39 followed by IBT-46 (14.47), IBT-63 (15.40), IBT-22 (16.13).

Grains per Spike: ranged from 73.80 to 32.00

Days to Maturity: The mean performance for number of days for days to maturity among 20 barley genotypes ranged from 118.67 days to 123.67 days,

Flag leaf length ranged from 15.82 cm (IBT-22) to 25.83 cm (IBT-8), and

flag leaf breadth from 1.30 cm (IBT-67) to 2.03 cm (IBT-39).

Spike length ranged from 6.65 cm (IBT-8) to 10.93 cm (IBT-18),

peduncle length from 24.95 cm (IBT-34) to 36.71 cm (IBT-10).

Awn length varied from 8.93 cm (IBT-32) to 15.66 cm (IBT-63).

The number of tillers ranged from 8.07 (IBT-17) to 11.93 (IBT-78).

Test weight ranged from 30.13 g (IBT-36) to 54.78 g (IBT-78),

Biomass yield from 92.33 g (IBT-13) to 122.13 g (IBT-32).

Grain yield per plant for six-row barley ranged from 25.93 g (IBT-14) to 38.24 g (IBT-13), and for two-row barley from 25.11 g (IBT-63) to 33.48 g (IBT-46).

Grain yield per plot for six-row barley ranged from 125.57 g (IBT-63) to 191.20 g (IBT-13), and for two-row barley from 125.57 g (IBT-63) to 167.40 g (IBT-46).

Grain Yield Per Hectare: The maximum yield of grain yield per hectare was obtained in genotype IBT-13 with 2.11 t/ha, followed by IBT-39 (2.06 t/ha), IBT-36 (2.00 t/ha), IBT-17 (1.93 t/ha) in case of six row barley, whereas in two row barley the highest grain yield/plot was 1.85 t/ha in genotype IBT-46, followed by IBT-67 (1.82 t/ha), IBT-78 (1.66 t/ha), IBT-3 (1.60 t/ha). The minimum yield of grain per hectare was about 1.38 t/ha obtained from the genotype IBT-63, followed by IBT-10 (1.41 t/ha), IBT-14 (1.43 t/ha), IBT-19 (1.54 t/ha). The results concluded that the yield of six row barley is more compared to two row barley among 20 genotypes, where the genotype IBT-13 (2.11 t/ha) yielded more compared to IBT-17 (CHECK) which yielded 1.93 t/ha. These variations highlight the genetic diversity among the barley genotypes, providing valuable insights for breeding programs aimed at improving yield and other agronomic traits by Kaur *et al.*, (2022), and Ahmad *et al.*, (2008).

Estimation of Genetic parameters

The study observed significant variations in phenotypic and genotypic coefficients of variation among barley genotypes. Phenotypic coefficients ranged from 1.092 (days to heading) to 45.617 (canopy temperature at booting stage), while genotypic coefficients ranged from 0.7112 (days to heading) to 25.78 (lodging percentage). High heritability (>60%) was recorded for traits like lodging percentage (94.80%), grains per spike (92.10%), and Field emergence (92.00%), while moderate heritability (30-60%) was found in traits such as plant height at 30 DAS (59.50%) and flag leaf

Table 3.2. Mean performance of 20 barley genotypes for 22 quantitative characters evaluated during Rabi-2023-24.

Sl. No.	Genotypes	FE(%)	PH @30	PH @60	PH @90	Lo (%)	FLL (cm)	FLB (cm)	SL (cm)	PL (cm)	AL (cm)	NT/P
G1	IBT 39/ASA2201100	80.10	34.09	76.47	120.41	79.33	23.22	2.03	8.97	32.47	9.43	9.40
G2	IBT 14/ASA2200863	81.92	31.57	53.60	110.67	70.67	21.32	1.77	8.82	29.39	10.41	8.73
G3	IBT 29/ASA2200353	63.94	29.95	65.45	117.53	28.00	18.71	1.55	9.63	25.36	13.79	9.67
G4	IBT 63/FFM220618	70.45	31.29	69.61	105.39	79.00	21.36	1.43	9.44	33.75	15.66	9.00
5	IBT 8/ASA2200267	67.96	27.36	56.17	117.02	66.00	25.83	1.81	6.65	31.35	13.02	9.60
G6	IBT 19/ASA2200761	54.06	28.73	58.65	111.96	89.33	21.83	1.65	9.77	27.98	13.05	8.47
G7	IBT 78/FFM221165	87.93	30.52	61.24	111.77	62.00	16.56	1.46	9.64	26.41	11.85	11.93
G8	IBT 4/ASA2200740	77.54	26.97	52.74	110.09	89.67	20.34	1.48	8.42	33.96	11.04	8.73
G9	IBT 10/ASA2200812	89.24	31.89	64.43	118.70	74.67	17.89	1.85	9.46	36.71	13.53	8.27
G10	IBT 13/ASA2201089	63.34	32.18	70.41	118.75	65.67	22.95	1.82	9.39	36.52	11.67	9.27
G11	IBT 58/FFM221028	50.01	29.49	63.91	117.95	73.67	21.66	1.81	8.71	31.87	13.15	9.20
G12	IBT 3/ASA2200760	55.03	29.35	63.84	115.11	56.33	22.33	1.62	9.99	25.83	11.59	8.40
G13	IBT 46/FFM221177	64.62	32.21	66.55	109.31	44.67	16.47	1.36	6.81	31.20	12.79	8.93
G14	IBT 36/ASA2200348	44.82	33.13	64.42	109.76	73.33	20.86	1.73	10.13	36.69	9.65	10.13
G15	IBT 18/ASA2200955	52.42	35.88	75.75	111.81	70.67	18.53	1.71	10.93	30.25	11.22	8.20
G16	IBT 22/ASA2200626	90.33	26.85	55.51	112.59	84.67	15.82	1.43	9.35	25.29	14.67	9.67
G17	IBT 34/ASA2200349	67.93	31.31	72.34	114.27	50.33	20.23	1.85	8.15	24.95	10.61	10.13
G18	IBT 32/ASA2200735	42.80	35.41	71.81	113.32	54.00	22.80	1.66	8.18	28.11	8.93	10.53
G19	IBT 67/FFM220729	53.04	28.14	67.31	115.86	45.00	21.78	1.30	10.16	29.25	12.78	9.80
CHECK	IBT 17/DWRB92	76.16	32.09	65.54	114.53	42.00	16.03	1.38	7.63	31.89	11.64	8.07
Mean		66.68	30.92	64.79	113.84	64.95	20.33	1.63	9.01	30.46	12.02	9.31
Min		42.80	26.85	52.74	105.39	28.00	15.82	1.30	6.65	24.95	8.93	8.07
Max		90.33	35.88	76.47	120.41	89.67	25.83	2.03	10.93	36.71	15.66	11.93
Std.D		14.85	2.60	6.92	3.87	16.90	2.75	0.20	1.11	3.85	1.76	0.94
CV (%)		22.27	8.42	10.69	3.40	26.01	13.54	12.38	12.32	12.66	14.62	10.06
CD at 5%		2.39	0.42	1.12	0.62	2.72	0.44	0.03	0.18	0.62	0.28	0.15
Std.E		3.32	0.58	1.55	0.86	3.78	0.62	0.05	0.25	0.86	0.39	0.21

length (55.70%). Low heritability (<30%) was noted for grain yield per plant (1.10%) and grain yield per plot (1.10%). The highest genetic advance was observed for lodging percentage (33.59), followed by Field emergence (28.93) and grains per spike (25.44). High genetic advance mean was noted for lodging percentage (51.71) and grains per spike (48.3), while moderate genetic advance mean (10-20%) was found in traits like flag leaf length (18.50) and plant height at 60 DAS (18.13). Low genetic advance mean was observed in traits such as plant height at 90 DAS (4.18) and canopy temperature at early grain filling stage (2.85). High heritability coupled with high genetic advance as percent mean was observed for lodging percentage (94.80%, 51.71%), grains per spike (92.10%, 43.3), and Field emergence (92.00%, 43.38%). These findings highlight the genetic diversity among barley genotypes, providing valuable insights for breeding programs aimed at improving yield and other agronomic traits by Jalata *et al.*, (2011), and Matin *et al.*, (2019).

DISCUSSION

The average grain yield per plant for the 20 barley genotypes was 31.90 grams, with the highest yields in six-row barley from IBT-13 (38.24 gm), IBT-39 (37.43 gm), IBT-36 (36.27 gm), IBT-

Table 3.3. Mean performance of 20 barley genotypes for 22 quantitative characters evaluated during Rabi-2023-24.

Sl. No.	Genotypes	CTABS	CTAEGF	CTALGF	D2H	DM	Sp/S	G/S	TW (g)	BM(g)	GYP (gm)	GYP/PI (gm)	GY/Ph (t/ha)
G1	IBT 39/ASA2201100	8.84	21.05	14.91	76.33	118.67	12.93	40.27	33.53	99.20	37.43	187.13	2.06
G2	IBT 14/ASA2200863	10.34	20.94	14.19	76.67	120.33	20.00	58.27	37.33	106.13	25.93	129.67	1.43
G3	IBT 29/ASA2200353	9.50	20.47	14.57	76.67	120.00	22.27	71.87	32.53	102.20	31.65	158.23	1.74
G4	IBT 63/FFM220618	9.13	20.88	14.09	77.67	121.67	15.40	32.07	39.07	106.53	25.11	125.57	1.38
G5	IBT 8/ASA2200267	9.97	20.90	14.30	76.00	120.00	19.80	64.93	37.47	107.67	31.18	155.90	1.72
G6	IBT 19/ASA2200761	10.13	20.67	13.91	76.67	121.67	16.87	32.00	44.07	94.67	28.03	140.13	1.54
G7	IBT 78/FFM221165	8.81	20.88	14.60	76.67	119.67	17.80	36.93	54.87	120.67	30.21	151.03	1.66
G8	IBT 4/ASA2200740	10.20	21.85	14.56	78.00	122.33	16.67	43.00	37.47	99.40	29.35	146.73	1.62
G9	IBT 10/ASA2200812	10.62	21.05	13.97	77.00	121.67	28.87	59.33	32.57	102.13	25.55	127.73	1.41
G10	IBT 13/ASA2201089	16.43	21.83	14.87	75.67	119.00	21.80	67.07	36.33	92.33	38.24	191.20	2.11
G11	IBT 58/FFM221028	10.14	22.39	14.46	77.33	122.67	24.20	73.80	42.50	106.47	34.62	173.10	1.91
G12	IBT 3/ASA2200760	10.40	21.49	14.51	76.67	120.67	25.73	53.47	37.10	98.07	29.10	145.50	1.60
G13	IBT 46/FFM221177	8.86	21.33	14.15	77.33	122.00	14.47	32.13	46.47	114.53	33.48	167.40	1.85
G14	IBT 36/ASA2200348	9.25	20.71	14.29	76.00	121.00	18.47	59.53	30.13	97.13	36.27	181.33	2.00
G15	IBT 18/ASA2200955	9.36	21.14	14.75	77.00	120.00	18.13	58.27	39.20	98.67	32.08	160.40	1.77
G16	IBT 22/ASA2200626	8.45	20.33	14.83	75.33	119.00	16.13	51.27	32.80	106.33	33.74	168.70	1.86
G17	IBT 34/ASA2200349	19.21	22.39	14.70	76.67	120.33	22.67	63.80	37.13	116.33	34.29	171.47	1.89
G18	IBT 32/ASA2200735	10.67	22.64	15.35	76.00	120.00	16.80	50.07	30.43	122.13	33.71	168.53	1.93
G19	IBT 67/FFM220729	8.53	21.39	15.00	76.67	123.67	20.33	50.73	43.97	115.00	33.06	165.30	1.86
CHECK	IBT 17/DWRB92	8.53	21.25	15.01	76.33	120.67	17.33	54.53	46.50	97.20	35.01	175.07	1.82
Mean		10.44	21.28	14.55	76.63	120.75	19.33	52.67	38.57	105.14	31.90	159.51	1.76
Min		8.45	20.33	13.91	75.33	118.67	12.93	32.00	30.13	92.33	25.11	125.57	1.38
Max		19.21	22.64	15.35	78.00	123.67	28.87	73.80	54.87	122.13	38.24	191.20	2.11
Std.D		2.66	0.65	0.38	0.66	1.32	3.98	13.05	6.27	8.68	3.83	19.13	0.03
CV (%)		25.46	3.04	2.64	0.86	1.09	20.60	24.78	16.27	8.26	11.99	11.99	2.34
CD at 5%		0.43	0.10	0.06	0.11	0.21	0.64	2.10	1.01	1.40	0.62	3.08	0.07
Std.E		0.59	0.14	0.09	0.15	0.30	0.89	2.92	1.40	1.94	0.86	4.28	0.03

17 (35.01 gm), and IBT-58 (34.62 gm), and in two-row barley from IBT-46 (33.48 gm), IBT-67 (33.06 gm), IBT-78 (30.21 gm), and IBT-3 (29.10 gm); the lowest yields in six-row barley were from IBT-14 (25.93 gm), IBT-10 (25.55 gm), and IBT-19 (28.03 gm); Kaur *et al.* (2022) reported wide variability in plant height (45.96–171.32 cm), spike length (3.44–13.73 cm), grain number/spike (10.48–82.35), days to spike emergence (51–139 days), and 100-grain weight (1.20–6.86 g), while Ahmad *et al.* (2008) found significant genetic diversity in 14 quantitative traits among 133 barley accessions from Pakistan.

PCV, GCV, heritability, and genetic advance estimations are crucial for selecting traits to enhance populations, with PCV generally higher than GCV, indicating environmental influence; the highest variation was in grains per spike, and significant variation was also noted in traits like harvest index and grain yield per plot; Matin *et al.* (2019) found high GCV in grain/spike (29.89%), yield/plant (28.72%), effective tiller/plant (21.86%), and spike length (13.56%), with the highest heritability in 1000 seed weight (95.09), yield/plant (93.98), and grain/spike (92.09), suggesting these traits have high selection potential.

CONCLUSION

In conclusion, by the analysis of obtained results, the current study provides a comprehensive analysis of twenty barley genotypes, revealing significant variations in performance across different genotypic categories. Among the six-row barley genotypes evaluated, IBT-13 and IBT-39 demonstrated exceptional performance in terms of growth parameters and seed yield, surpassing the check variety IBT-17. Specifically, these genotypes exhibited superior characteristics, making them highly favourable for cultivation. Similarly, IBT-36 also showed commendable results, though slightly less impressive compared to IBT-13 and IBT-39. On the other hand, the two-row barley genotypes IBT-46 and IBT-67, while still demonstrating strong performance, were not as competitive as their six-row counterparts and the check variety. Despite their comparatively lower yield and growth metrics, these two-row genotypes still performed better than the check variety in some aspects. Consequently, based on these findings, it is recommended that the six-row barley geno-

types IBT-13, IBT-39, and IBT-36 be considered for commercial cultivation in the North east region of Uttar Pradesh due to their superior growth and yield attributes. Furthermore, IBT-46 and IBT-67 may also be considered for cultivation, albeit with a more cautious approach, given their relative performance compared to the six-row varieties and the check. Also, the character with high GCV, PCV, Heritability can be considered for further hybridization and breeding programme.

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Conflict of interest

The authors have no competing interests.

Table 3.4. Estimates of components of variance and genetic parameters for 22 quantitative parameters in 20 barley genotypes evaluated during Rabi-2023-24.

Sl. No.	Trait	GCV	PCV	Heritability	Genetic Advance	GA as % of Mean
1	FE (%)	21.96	22.89	92.00	28.93	43.38
2	PH @30	7.61	9.86	59.50	3.74	12.09
3	PH @60	10.14	11.70	75.20	11.74	18.13
4	PH @90	2.92	4.20	48.30	4.75	4.18
5	Lo (%)	25.78	26.48	94.80	33.59	51.71
6	FLL (cm)	12.04	16.13	55.70	3.76	18.50
7	FLB (cm)	10.95	14.87	53.80	0.27	16.46
8	SL (cm)	12.03	12.87	87.50	2.09	23.19
9	PL (cm)	12.21	13.49	81.90	6.94	22.77
10	AL (cm)	13.88	16.00	75.30	2.98	24.81
11	NT/P	8.01	13.23	36.70	0.93	10.00
12	CTABS	-1.00	45.62	-3.30	-0.32	-3.10
13	CTAEGF	2.37	4.06	34.10	0.61	2.85
14	CTALGF	2.03	3.55	32.70	0.35	2.39
15	DH	0.71	1.09	42.50	0.73	0.96
16	DM	1.04	1.19	77.30	2.28	1.89
17	Sp/S	19.29	23.01	70.30	6.44	33.32
18	G/S	24.43	25.46	92.10	25.44	48.30
19	TW (g)	15.90	16.97	87.80	11.84	30.70
20	BM(g)	7.33	9.86	55.20	11.78	11.21
21	GY/P (gm)	2.19	20.54	1.10	0.15	0.46
22	GY/Pl (gm)	2.19	20.54	1.10	0.77	0.48
23	GY/Ph (t/ha)	11.92	12.15	9.6	0.42	24.17

Legends: **FE%- Field emergence, PH@30 - Plant height at 30DAS, PH@60 - Plant height at 60DAS, PH@90 - Plant height at 90DAS, Lo(%) - Lodging percentage, FLL- flag leaf length, FLB- Flag leaf length, FLB- Flag leaf breadth, SL- Spike length, PL- Penduncle length, AL- awn length, NT/ P- No. of tillers/plant, CT@BS - Canopy tempera-

ture at booting stage, CT@EGF - Canopy temperature at Early grain filling stage, CT@LGF - Canopy temperature at Late grain filling stage, DH- days to heading, DM- days to maturity, SP/S- spikelets per spike, G/S- grains per spike, TW - Test weight, BM- Biomass yield, GY/P- grain yield per plant, GY/PL- grain yield per plot.

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