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STABILITY ANALYSIS OF YIELD AND ITS COMPONENT TRAITS OF BARLEY (*Hordeum vulgare* L.) GENOTYPES IN MULTI-ENVIRONMENT TRIALS IN THE NORTH EASTERN PLAINS OF INDIA

R.D. LODHI, L.C. PRASAD, S.S. BORNARE*, A.H. MADAKEMOHEKAR and R. PRASAD

Department of Genetics and Plant Breeding, Institute of Agricultural Sciences,
Banaras Hindu University, Varanasi, India
*Corresponding author's email: satish07bhu@gmail.com

SUMMARY

Stability performance of 105 barley genotypes including commercial cultivars and elite lines (indigenous and exotic) were compared by using regression on environmental means for grain yield and its components under 3 different environments during *Rabi* 2012-2014. Significant differences were observed among the genotypes for all the traits studied over all 3 individual environments. Genotype × environment interactions were highly significant for all the characters studied. The linear component of G × E interaction was preponderant for days to heading, days to maturity, effective tillers per plant, grains per ear and grain yield per plant. Most of the genotypes did not satisfy the stability criteria indicating the presence of non-linear component of G × E instead of the linear component for most of the traits studied. The genotypes RD-2618, PL-760 and NDB-1229 for days to heading; Lakhan, Clipper, JB-57, PL-760 and Maria for short duration; BH-688, BC-112, K-603, RD-2624 and BH-548 for dwarf stature; CIHO-3510 for tiller number; JB-16 for peduncle length, DL-88, BCU-IC-437851, Karan-15, RD-2660, Lakhan and JB-15 for spike length; BCU-550, EIBGN-04-14 and RS-6 for flag leaf length; Manjula and EIBGN-04-14 for grains per ear; EIBGN-2-1 and Jyoti for grain yield per plant were found to be comparatively stable by meeting all the 3 parameters of stability over the environments. These promising genotypes may be utilized as donors in barley improvement program for target ecosystems.

Key words: Barley, genotype x environment interaction, stability analysis, yield components

Key findings: The study of the interaction of genotype and environment and yield stability of promising barley lines is prerequisite for the development of improved cultivars. In order to achieve these goals promising lines should be cultivated in different climatic conditions and evaluated. High performance and high stability might transmit high means and increased phenotypic stability to the next progenies which may be considered as an ideal genotype for developing improved barley varieties.

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INTRODUCTION

Barley (*Hordeum vulgare* L.) is an ancient and important cereal grain crop (Babaiy *et al*., 2011). It was one of the first agricultural domesticates together with wheat, pea, lentil, goats, sheep and cattle dating from about 10,000 years ago in the Fertile Crescent of the Middle East (Smith, 1998). Barley was presumably first used as human food but evolved primarily into a feed, malting and brewing grain due in part to the rise in prominence of wheat and rice. In recent times, about two-thirds of the barley crop has been used for feed, one-third for malting and about 2% directly for food. In India, barley is important cereal crop cultivated in *rabi* season, after wheat in both area and production. It is widely used for different purposes such as, staple food for mankind, cheap ingredient in whisky and beer production industry and feed for animals (Bornare *et al*., 2013).

Being an important crop, the barley has been neglected in our country due to priority on wheat, rice and other cash crops. As a result the harvested area, production and productivity are falling down year by year (Singh *et al*., 2014). There is a need for the development of new barley cultivars that tolerate abiotic and biotic stresses for improving crop productivity. This will require good understanding of the available genetic variation in both wild and cultivated barley. The rate of progress, however, will depend on the occurrence of desirable genetic variation and the availability of precise methods of identification, selection and transfer of superior genes (Ellis *et al*., 2000).

Use of stable cultivars over several environments for high seed yield and quality characteristics is important for many crops. When cultivars are tested in terms of seed yield at the multi-environmental trials, great differences are commonly observed in yield performance over environments. This different yield response of cultivars from one environment to another is called genotype × environment (G × E) interaction (Allard 1960; Vargas *et al*., 1998). Raffi *et al*. (2004) reported that genotype x environment interaction is of much value in the selection of better genotypes. G × E interaction should be investigated so that the breeder can decide to restructure the program to minimize the interaction effect, or exploit it to produce varieties with specific adaptation to particular environments (Eisemann *et al*., 1990). The interaction indicates that genotypes react in different ways to variable environmental condition. A key concept in G x E analysis is genotype stability and by definition, genotypes exhibiting a high degree of G x E interaction are unstable across sites (Berger *et al*., 2007). The assessment of stability and wider adaptability of breeding lines against biotic and abiotic stresses is a prerequisite in any breeding program. Stability in performance of a genotype over a wide range of environment is a desirable attribute and depends on magnitude of genotype x environment interaction (Ahmad *et al*., 1996). The stability of seed yield in different crops has statistically evaluated through analysis of G × E interaction in cultivar adaptation traits conducted over several environments (Crossa 1990, Piepho 1998). Environmental factors such as soil moisture, sowing time, fertility, and temperature and day length have strong influence during various stages of plant growth (Bull *et al*., 1992). The environment changes constantly and it is highly important to evaluate crop genotypes at different location and its performances. Hence, this research was conducted to estimate phenotypic stability for yield and yield components under different environmental conditions.

MATERIALS AND METHODS

The experimental materials consisted of 105 genotypes/varieties of barley (*Hordeum vulgare* L.) involving commercial cultivars and elite lines (indigenous and exotic) selected from the entries of All India Co-ordinated Barley Improvement Project conducted at Department of Genetics and Plant Breeding, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. Experiment was carried out in Randomized Block Design with 3 replications. These selected 105 genotypes were sown under 3 different environments (2 consecutive year *rabi* 2012-13 and *rabi* 2013-14) at Agriculture Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi and at Farmers field Village-Chhitipur, District-Shivpuri, 38 km from Jhansi in Madhya Pradesh during *rabi* 2013-14). Varanasi is situated at 25^{o} 18′ North latitude and 83^{o} 03′ East longitude and at altitude of 123.23 m from sea level while Jhansi is situated at 25^{0} 27’ North latitude and 78^{o} 37’ East longitude and at altitude of 284 m above sea level. These selected 2 locations were diverse geographically, as Jhansi is located North-west and Varanasi is at North-east. The stability was evaluated over these diverse ranges of climatic region.

Each entry were grown in 3 replications comprising 2 row of 1.5 m length with row to row spacing of 30 cm and plant to plant spacing of 10 cm following Randomized Block Design. The recommended cultural practices were carried out to raise good crop. The data were recorded for plant height (cm), effective tillers per plant, peduncle length (cm), spike length with awn (cm), spike length without awn (cm), flag leaf length (cm), grains per ear, 1000-grain weight (g), grain yield per plant (g). The days to maturity, days to heading and grain yield were recorded on plot basis, whereas the rest of the characters were recorded on 5 random competitive plants. The days to heading were recorded from the date of sowing to the date on which 75% plants. Randomly selected 5 plants of each genotype from both rows in each replication were harvested and threshed separately and weighed after threshing grain yield per plant in grams using electronic balance.

The means of 10 plants were subjected to statistical analysis as per Fisher (1954). The stability performance of the genotypes for yield and yield components was assessed following Eberhart and Russell (1966). The statistical analysis was performed by statistical software INDOSTAT version 8.2. A genotype with unit regression coefficient (b = 1) and the deviation not significantly differing from zero ($S^2d_i = 0$) was taken to be stable genotype with unit response.

RESULTS AND DISCUSSION

The pooled analysis of variance for stability parameters (Table 1) clearly indicated that G × E interactions played an important role in the expression of all the characters studied. The significant estimates of G × E interaction indicated that the characters are unstable and may considerably fluctuate with change in environments. According to this model the genotype × environment interaction was further partitioned into linear and non-linear components. The pooled analysis of variance revealed that variances due to pooled deviations were found to be highly significant. Thus, it showed the significant role of non-linear component of genotype × environment interaction in determining the stability of performance for all the characters.

The variances due to genotypes were found to be significant for all the characters against pooled deviation which indicated the presence of sufficient genetic variability among the genotypes. The environments (linear) were significant against pooled deviations for all the characters, whereas genotype x environment (linear) was found to be non-significant against pooled deviation for almost all the characters, except days to heading, days to maturity, effective tillers per plant, grains per ear, grain yield per plant. These results indicated that variation in performance of genotypes when grown over these environments is predictable for only above said significant characters *viz.* days to heading, days to maturity, effective tillers per plant, grains per ear, grain yield per plant. The variation due to pooled deviation was significant for all the characters, which indicated that genotypes differed with respect to their stability for these characters. These findings are in close agreement for days to heading, plant height, days to maturity and 1000-kernel weight (McGuire *et al*., 1979; Shah *et al.,* 2009; Nurminiemi *et al*., 2002; Turuspekov *et al*., 2013), for grains per ear, effective tillers per plant (Birch and Long, 1990; Pilania and Dhaka, 2007), for spike length (Amini *et al*., 2012), for flag leaf length, peduncle length (Shah *et al.,* 2009) and for grain yield (McGuire *et al*., 1979; Sainio and Peltonen, 1993; Costa and Bollero, 2001; Tamm, 2003).

Environmental indices (Table 2) for all the characters with the exception of peduncle length were high at farmer's Field, Chhitipur 2014 environment while it was low for all characters in Agriculture Research Farm, Varanasi 2013. Whereas, the environmental index values were also low in Agriculture Research Farm, Varanasi 2013 environment for all the characters except for the peduncle length, flag leaf length and 1000-grain weight.

It is well known that phenotype is the product of interaction between genotype and environment. A particular genotype may express its full genetic potential only under optimum environmental conditions.

Table 1. Stability analysis of variance for yield contributing characters in 105 barley genotypes.

Source of variation	d. f.	Days to Heading	Days to Maturity	Plant Height cm	Effective tiller s/plant	Peduncle length	Spike length With awn	Spike length Without awn	Flag leaf length	Grains/ ear	1000-grain weight g	Grain yield/ plant g
Genotypes	104	43.48**	37.82**	250.35**	5.50**	22.28**	11.10**	2.63**	17.95**	318.55**	72.27**	13.68**
Env.+ (Gen* Env.)	210	11.24**	9.07**	202.36**	6.72**	7.88	3.49**	1.04*	16.64**	97.45**	22.60	17.58**
Env. (Lin.)	1	490.48**	1183.51**	32659.66**	865.52**	571.14**	297.23**	66.44**	2015.59**	9250.62**	730.46**	2332.02**
Gen.* Env.(Lin.)	104	16.09**	5.92**	50.26	3.23**	3.90	1.87	0.72	8.16	75.03**	18.52	9.97**
Pooled Deviation	105	1.88**	1.00**	43.91**	2.01**	6.46**	2.31**	0.74**	6.01**	32.47**	19.89**	3.07**
Pooled Error	624	0.41	0.59	3.22	0.06	0.12	0.58	0.51	0.42	0.73	0.86	0.13

* Significant at 5% level and ** significant at 1% level.

Table 2. Environment index values (I_j) for different characters (Eberhart and Russell, 1966) in barley.

Character	Environmental indices		
	Agriculture Research Farm 2013	Agriculture Research Farm 2014	Farmer Field 2014
Days to heading	-1.178	-0.549	1.727
Days to maturity	-1.930	-0.721	2.651
Plant height (cm)	-12.066	-0.773	12.839
Tillers number per plant	-1.741	-0.490	2.230
Peduncle length (cm)	-1.716	0.144	-1.716
Spike length with awn (cm)	-0.481	-0.874	1.355
Spike length without awn (cm)	-0.281	-0.367	0.648
Flag leaf length (cm)	-3.240	2.934	0.306
Grains per ear	-0.281	-0.367	0.648
1000-grain weight (g)	-3.240	2.934	0.306
Grain yield per plant (g)	-2.244	-1.585	3.829

Therefore, it has been observed that relative performance in a set of varieties is altered, when comparisons are made over a series of environments. A stable genotype is one which performs well when it is grown under a wide range of environments. Unfortunately, the genetic effects are not independent of non-genetic environmental effects. This interplay between genotype and environment resulting in a phenotype is known as genotype x environment interaction, i.e. the failure of a genotype to express the same phenotypic performance when grown under different environments is the reflection of genotype x environment interaction (Comstock and Moll, 1963).

The desirable stable genotypes should have high mean (xi) performance, unit regression (bi = 1) and the deviation from regression as small as possible ($S^2di = 0$). Further, the genotypes with high mean (xi), bi >1 and $S^2di = 0$ are expected to perform better under favorable environmental conditions, (Eberhart and Russell, 1966). Mean performance, regression coefficient (b_i) and mean squared deviation from regression (S^2di) in respect of each genotype for different characters are given in Table 3. The results from pooled data over different environments are described below for each character.

Four genotypes revealed average mean performance, unit regression coefficient and non-significant deviation from regression for days to heading across environments, in which 3 best genotypes were, RD-2618, PL-760 and NDB-1229. Lakhan, RS-6, EIBGN-04-15 and RD-2637 accompanied with low mean performance, found suitable for early heading under favorable environment as they possessed low mean performances, b_i values greater than unity and non-significant deviation from regression, whereas the genotype DWR -46 was considered as suitable for early flowering under poor environmental conditions based on low mean, low b_i value and non-significant deviation from regression, that could be regarded as specifically adopted to poor environments. Lakhan, Clipper, JB-57, PL-760, Maria were suitable for short duration and RD-2618, BCU-554, BCU-4779, K-795 were suitable for long duration. Genotypes Beecher, JB-16 and NDB-1280 were found suitable for early maturity under favorable environment as it possessed low mean performances, b_i values greater than unity and non-significant deviation from regression. The significant genotype x environment interaction has been reported earlier for days to lowering by McGuire *et al*. (1979) and Costa and Bollero (2001). Genotypes ISBCB-213, BH-688, BC-112, K-603, RD-2624, BH-548 and DWR-51, Gitanjali and RD-2503 revealed average mean performance, unit regression coefficient and non-significant deviation from regression for plant height which showed wide

Table 3. Stability parameter of all the 11 character in 105 barley genotypes.

Variety	Days to Heading			Days to Maturity			Plant height (cm)		
	Mean	Bi	s²di	Mean	bi	s²di	Mean	bi	s²Di
Jyoti	75.00	-0.49	0.19	105.67	-0.13	1.63	116.02	0.41	2.46
Manjula	73.33	-0.12	-0.10	100.67	1.58	-0.41	94.23	0.52	-6.86
Lakhan	75.67	1.85	0.00	99.33	1.05	-0.57	110.77	0.65	-5.80
Clipper	76.00	2.22	0.31	99.33	1.05	-0.57	117.33	0.28	10.55
RS-6	76.67	1.85	0.00	101.33	-0.06	-0.24	118.74	0.75	5.15
C-138	72.33	-0.61	2.25*	101.33	-0.17	-0.52	102.84	0.82	17.87
Azad	70.33	-2.20	9.32**	102.33	0.24	-0.81	86.78	1.54	166.32**
Gitanjali	76.00	3.95	0.44	102.00	1.41	0.70	117.20	1.05	-4.94
Karan-4	71.33	-0.74	-0.59	105.00	3.23	3.655*	101.03	1.37	89.99**
Karan-15	74.33	-0.61	2.25*	103.00	0.51	2.17	87.88	0.93	15.18
Karan - 16	72.67	-0.24	1.70	101.00	0.81	-0.30	99.75	0.81	7.31
Karan -19	72.67	-0.24	1.70	101.33	0.64	-0.83	94.10	1.94	40.27**
Karan-92	75.33	-0.25	-0.34	103.00	0.71	-0.47	98.35	1.03	31.345*
Karan-280	79.00	3.19	7.68	112.00	1.22	0.39	96.70	1.06	5.90
Karan-521	75.33	-0.87	0.39	110.00	1.73	7.292**	121.96	0.78	-2.26
Karan-741	74.67	0.12	-0.10	108.67	0.88	-0.86	105.37	0.73	-6.93
DL-88	74.00	-0.62	-0.51	102.00	0.71	-0.47	106.57	1.34	29.72*
DWR-39	74.33	-0.87	0.39	102.00	0.60	3.109*	95.92	0.80	-4.37
DWR-42	77.00	-1.73	-0.70	101.67	0.88	-0.86	98.29	1.09	12.12
DWR-46	77.00	-1.24	0.07	101.00	0.30	0.13	99.04	-0.04	192.88**
DWR-49	77.33	-1.98	-0.41	103.67	0.88	-0.86	112.18	1.31	5.79
DWR-50	77.00	-1.11	-0.45	104.00	1.22	0.39	102.42	1.09	-6.35
DWR-51	78.33	-1.23	0.93	103.67	0.88	-0.86	105.63	1.00	11.04
RD-2035	73.00	0.62	-0.51	101.00	0.71	-0.47	98.80	0.72	55.49**
RD-2503	73.67	1.36	-0.69	109.00	1.22	0.39	122.45	1.06	-2.91
RD-2508	73.00	0.62	-0.51	104.67	1.58	-0.41	112.28	1.23	-1.67
RD-2552	73.67	0.25	-0.34	105.00	1.63	1.35	101.35	1.21	12.40
RD-2618	74.33	0.99	-0.63	106.33	1.05	-0.57	99.83	1.15	4.43
RD-2621	74.67	0.25	-0.34	107.67	1.28	-0.75	102.52	1.13	-6.46
RD-2631	75.00	0.62	-0.51	108.00	1.11	-0.79	104.55	1.12	-5.66
RD-2624	74.00	0.00	-0.71	107.67	1.18	0.22	102.84	1.04	8.76
RD-2634	74.33	0.50	0.77	108.67	1.69	-0.37	93.18	2.10	321.09**
RD-2637	74.00	1.24	0.07	109.67	1.28	-0.75	105.46	0.74	-5.79
RD-2640	75.33	-0.12	-0.10	110.00	1.11	-0.79	98.88	0.18	57.76**
RD-2541	75.00	0.00	-0.71	106.33	2.35	3.469*	95.08	1.08	14.25
RD-2620	75.00	0.14	1.21	109.00	1.11	-0.79	106.18	0.82	-6.38
RD-2660	75.00	0.62	-0.51	107.00	1.11	-0.79	101.80	-0.38	67.02**
RD-2662	74.67	0.25	-0.34	107.33	2.05	0.32	116.33	0.20	205.29**
BCU-73	74.67	0.25	-0.34	106.33	1.65	1.26	91.24	0.83	33.795*
BCU-112	74.33	1.48	-0.25	105.67	1.88	1.91	95.15	1.03	-6.08
BCU-131	82.67	2.96	1.10	109.67	0.36	2.32	112.33	0.69	47.33**
BCU-96	74.00	1.24	0.07	107.67	0.88	-0.86	104.37	1.44	-1.22
BCU-455	75.33	-0.61	2.23*	104.33	-0.06	-0.24	106.12	1.87	2.68
BCU-546	80.33	1.61	-0.20	103.00	0.41	-0.72	114.68	0.80	35.94*
BCU-550	81.00	1.24	0.07	113.00	1.71	4.177*	107.32	1.68	209.01**
BCU-551	79.00	3.46	-0.69	107.67	1.28	-0.75	90.48	0.56	-5.57
BCU-554	78.33	1.61	-0.20	108.33	1.05	-0.57	98.63	0.40	101.25**

Variety	Days to Heading			Days to Maturity			Plant height(cm)		
	Mean	Bi	s²di	Mean	bi	s²di	Mean	bi	s²Di
BH-556	79.33	1.61	-0.20	102.00	0.41	-0.72	107.42	0.99	36.16*
BCU-775	81.67	2.47	-0.55	106.67	1.28	-0.75	105.55	0.82	-6.81
BCU-1206	61.00	1.46	7.31**	92.33	0.34	0.49	79.60	1.38	-5.61
BCB(Hyl)-5	79.00	4.57	-0.31	106.67	0.88	-0.86	104.88	0.33	-6.85
BCU-4779	79.00	2.44	21.57**	106.33	1.05	-0.57	121.17	1.09	13.32
BCB-W-03-91	77.67	3.58	0.11	108.00	1.11	-0.79	108.25	1.31	-6.34
BH-544	79.00	3.95	0.44	111.00	1.11	-0.79	100.31	0.35	142.12**
BH-688	73.67	0.25	-0.34	105.00	1.63	1.35	101.35	1.21	12.40
BH-548	82.67	1.98	-0.41	107.33	1.75	-0.85	93.91	1.04	1.00
BH-543	76.00	2.84	-0.38	107.00	1.82	-0.09	117.03	1.01	41.28**
BCU-IC-437851	76.67	3.71	-0.47	105.67	1.58	-0.41	98.37	0.53	-6.06
K-551	76.00	5.19	-0.67	106.33	1.35	-0.65	111.82	1.34	-3.14
K-560	74.00	0.76	2.623*	107.00	1.52	-0.84	101.58	1.26	-5.42
K-603	72.67	1.36	-0.69	107.33	1.75	-0.85	102.43	1.04	-6.59
K-604	74.33	3.70	2.115*	108.00	1.52	-0.84	103.12	1.15	2.21
K-678	75.00	0.49	0.19	109.00	1.52	-0.84	97.47	0.90	21.81*
K-727	75.33	0.50	0.77	104.67	3.29	7.63**	98.83	0.98	11.24
K-729	75.33	1.61	-0.20	105.33	3.06	6.45**	96.23	1.28	2.18
K-742	74.33	1.61	-0.20	100.33	0.34	0.49	114.78	2.19	19.53
K-745	77.33	3.83	-0.62	102.33	-0.06	-0.24	98.56	0.59	50.91**
K-743	77.00	1.60	1.39	103.33	0.34	0.49	108.40	1.40	201.83**
K-771	78.33	1.97	1.91	103.00	0.00	-0.86	97.92	1.16	1.55
K-795	78.33	3.21	-0.16	107.33	1.05	-0.57	112.29	0.80	1.25
K-796	77.67	3.09	-0.70	108.00	0.81	-0.30	101.89	0.67	-5.21
K-805	77.67	3.09	-0.70	110.00	1.11	-0.79	114.87	1.30	9.10
JB-15	78.67	0.25	-0.34	108.00	1.52	-0.84	115.73	0.70	-3.58
JB-16	75.33	1.34	3.521*	107.33	1.45	-0.03	95.80	0.85	9.43
JB-57	77.33	-0.12	-0.10	105.33	1.05	-0.57	114.13	0.93	19.78
PL-760	74.00	1.11	-0.45	104.33	1.05	-0.57	90.97	0.86	-6.68
NDB-1229	75.00	1.11	-0.45	103.67	1.28	-0.75	95.64	0.99	117.46**
NDB-1173	77.67	3.31	12.77**	104.33	1.35	-0.65	90.85	0.81	110.20**
NDB-1280	77.00	2.71	3.13*	105.67	2.69	-0.01	94.51	0.78	175.48**
NDB-1180	77.33	-1.36	-0.69	103.67	0.77	1.14	108.15	0.44	82.56**
EIBGN-2-1	88.00	-1.60	1.39	100.00	0.41	-0.72	101.80	1.07	-6.90
EIBGN-04-14	80.33	1.61	-0.20	102.00	0.81	-0.30	106.22	1.22	-5.77
EIBGN-041	77.67	3.58	0.11	102.33	0.75	1.49	91.96	1.30	88.19**
EIBGN-04-16	82.33	0.50	0.77	106.33	0.64	-0.83	109.77	1.10	77.38**
EIBGN-04-3	83.00	0.14	1.21	102.33	-0.17	-0.52	111.48	1.49	42.45**
EIBGN-04-10	82.00	1.87	1.04	107.33	0.64	-0.83	95.07	1.45	16.56
EIBGN-04-11	82.33	1.13	2.038*	107.00	0.81	-0.30	109.03	1.17	0.82
EIBGN-04-13	81.67	2.47	-0.55	110.00	1.52	-0.84	118.68	1.35	-2.88
EIBGN-04-15	82.67	1.85	0.00	112.33	1.05	-0.57	110.17	1.46	136.45**
IBGP-03-65	79.00	5.41	14.56**	113.33	0.64	-0.83	108.57	1.18	11.09
CIHO-3510	76.33	0.86	0.53	102.67	0.17	-0.52	109.26	0.79	11.97
CIHO-5924	85.00	0.62	-0.51	103.67	0.17	-0.52	115.24	1.36	-3.95
CIHO-5925	76.00	0.49	0.19	103.00	0.41	-0.72	113.61	1.26	28.18*

Variety	Days to Heading			Days to Maturity			Plant height(cm)		
	Mean	Bi	s²di	Mean	bi	s²di	Mean	bi	s²Di
ISBCB-02-9	81.00	-2.08	5.04**	102.33	0.34	0.49	99.85	0.93	92.58**
ISBCB-03-16	81.33	-2.34	2.48	101.33	0.13	1.63	102.31	1.15	204.47**
EIBGN-04-18	82.33	-4.61	12.93**	104.33	-0.77	1.14	98.33	0.74	6.99
IBGP-03-49	87.00	1.24	0.07	108.67	0.88	-0.86	109.62	1.24	-3.74
ISBCB-0213	81.67	5.31	0.23	111.33	1.24	2.48*	96.46	0.99	10.42
ISBCB-03-153	78.33	-1.36	-0.69	112.00	0.30	0.13	97.45	0.87	-6.03
ISBCB-02-10	76.67	-0.24	1.70	110.67	0.88	-0.86	100.56	1.11	-5.14
Beecher	88.33	-2.34	2.476*	103.33	1.45	-0.03	91.01	1.03	64.18**
Maria	76.67	2.47	-0.55	104.33	1.05	-0.57	96.22	0.99	46.47**
V Moreis	79.67	0.25	-0.34	103.67	1.58	-0.41	84.54	1.06	98.97**
Prestige	77.00	-0.98	2.859*	105.33	-0.36	2.32	88.35	1.31	121.48**
Yardu	75.33	-0.61	2.253*	107.00	-0.71	-0.47	81.96	1.14	114.25**
Population mean	77.01			105.540			103.000		

Variety	Effective tiller/plant			Peduncle length(cm)			Spike length with awn(cm)		
	Mean	Bi	s²di	Mean	bi	s²di	Mean	bi	s²di
Jyoti	7.42	0.74	0.28	12.96	1.68	0.88*	21.83	0.82	-0.44
Manjula	8.34	1.92	1.88**	11.28	1.22	1.11*	16.12	0.90	0.78
Lakhan	7.26	1.38	5.09**	12.27	1.46	-0.15	22.14	1.01	-0.68
Clipper	7.10	-0.20	1.52**	12.07	0.12	16.28**	20.94	-0.43	-0.17
RS-6	7.29	1.11	4.19**	12.63	0.96	5.84**	19.09	-0.57	4.63**
C-138	7.71	-0.58	2.55**	10.41	0.84	1.73**	18.04	0.49	-0.60
Azad	8.42	0.94	15.83**	6.98	0.53	3.87**	17.30	0.16	-0.68
Gitanjali	7.34	1.45	0.24	12.59	2.17	2.74**	20.62	2.05	-0.13
Karan-4	6.74	0.85	2.17**	7.64	1.12	9.15**	17.54	0.79	0.30
Karan-15	9.79	1.64	7.63**	6.80	0.66	-0.15	16.10	1.01	-0.61
Karan - 16	8.97	-0.23	7.92**	6.57	1.15	-0.20	19.40	1.23	-0.43
Karan -19	7.09	1.32	0.96*	7.12	0.79	1.44*	19.87	1.83	0.65
Karan-92	8.33	1.09	8.76**	8.68	1.37	5.28**	19.16	0.34	0.33
Karan-280	6.88	0.99	1.65**	7.36	-0.51	7.77**	19.27	1.32	1.28
Karan-521	7.41	1.08	-0.20	12.77	-0.25	4.96**	20.28	0.48	-0.40
Karan-741	4.93	0.23	1.25*	8.07	1.97	1.73**	19.12	0.88	-0.53
DL-88	7.32	1.41	4.08**	9.20	2.59	-0.26	18.68	0.99	-0.43
DWR-39	11.97	2.40	0.29	6.18	0.82	0.12	19.86	0.61	-0.49
DWR-42	8.67	1.78	-0.08	7.68	1.97	6.16**	19.06	0.14	0.06
DWR-46	7.51	1.92	3.28**	9.35	1.66	0.70	19.31	0.92	-0.46
DWR-49	7.12	0.91	0.12	8.55	2.25	-0.17	21.11	-0.04	-0.53
DWR-50	7.60	1.35	-0.05	5.48	0.33	-0.28	19.23	0.96	-0.60
DWR-51	8.99	2.18	-0.11	11.94	1.10	4.05**	21.19	1.27	0.63
RD-2035	7.70	2.28	0.47	11.05	1.17	8.54**	16.77	0.61	-0.22
RD-2503	7.25	1.99	4.68**	12.72	1.30	9.09**	22.38	1.49	0.49
RD-2508	8.20	1.53	2.20**	9.73	1.68	5.61**	18.54	1.48	1.60
RD-2552	6.64	2.12	-0.04	7.91	1.18	2.20**	16.88	1.18	2.12*
RD-2618	9.10	2.70	1.91**	7.78	1.81	8.70**	16.32	1.17	0.53
RD-2621	7.02	1.31	1.23*	8.33	1.39	4.25	16.65	0.49	-0.61
RD-2631	7.34	1.40	-0.23	8.75	1.76	-0.04	16.38	0.26	-0.69

Variety	Effective tiller/plant			Peduncle length (cm)			Spike length with awn (cm)		
	Mean	bi	s²di	Mean	bi	s²di	Mean	bi	s²di
RD-2624	6.41	0.44	2.14**	10.62	2.28	11.08**	16.50	-0.28	0.05
RD-2634	5.96	1.11	-0.16	9.92	0.20	0.82*	18.62	-0.35	-0.11
RD-2637	9.23	1.49	4.81**	10.10	1.51	4.70**	17.64	0.28	2.70*
RD-2640	5.14	0.65	-0.11	10.85	-0.31	0.36	19.50	0.66	6.04**
RD-2541	5.82	0.45	2.81**	8.12	1.14	1.30*	17.02	2.19	0.59
RD-2620	5.19	0.92	-0.26	9.39	-0.48	0.34	18.17	1.50	-0.59
RD-2660	5.86	0.58	1.65**	13.55	0.56	-0.26	19.69	1.01	1.32
RD-2662	5.49	0.66	-0.24	13.24	1.03	3.28**	20.85	-0.33	8.32**
BCU-73	8.36	0.88	0.23	5.36	-0.10	-0.24	20.42	1.46	0.36
BCU-112	6.48	0.79	0.60	6.35	0.67	1.73**	18.06	1.61	-0.68
BCU-131	6.50	1.17	1.99**	10.42	1.56	3.36**	8.95	0.57	-0.64
BCU-96	5.72	0.91	0.72	12.13	2.44	0.74	20.83	3.04	-0.57
BCU-455	6.71	1.78	0.30	11.55	2.39	0.68	18.35	1.50	0.08
BCU-546	6.13	1.22	-0.12	10.95	-0.33	27.54**	17.71	1.42	0.44
BCU-550	5.93	1.37	-0.25	13.17	0.34	6.53**	14.23	2.79	52.75**
BCU-551	8.02	1.67	3.75**	6.35	-0.14	0.40	19.01	1.38	0.23
BCU-554	9.63	1.17	8.32**	8.32	0.60	57.66**	17.78	0.89	-0.67
BH-556	6.36	0.70	0.15	7.29	0.23	25.99**	19.77	1.93	0.00
BCU-775	6.83	1.77	3.41**	5.75	0.32	0.95*	19.68	1.22	-0.26
BCU-1206	6.13	0.68	0.14	10.51	1.78	9.63**	17.73	1.11	-0.69
BCB(Hyl)-5	6.88	0.08	4.81**	10.52	0.06	0.00	17.59	0.63	-0.53
BCU-4779	7.69	0.86	1.85**	15.03	0.74	0.75	18.91	0.93	-0.29
BCB-W-03-91	7.09	0.70	2.32**	7.14	1.01	0.29	17.85	1.97	3.13*
BH-544	5.57	0.61	1.33*	10.36	1.80	22.43**	18.68	-0.03	-0.06
BH-688	7.38	1.18	3.59**	6.80	0.73	-0.27	17.37	0.42	-0.46
BH-548	7.20	2.01	1.36*	5.63	-0.15	0.43	17.08	1.20	-0.62
BH-543	5.06	0.38	-0.12	13.12	1.13	13.08**	20.20	-1.60	3.60*
BCU-IC-437851	7.57	0.68	-0.15	12.62	0.62	3.06**	16.38	0.99	1.92
K-551	5.37	0.69	0.19	13.27	1.60	-0.18	19.26	2.12	0.24
K-560	4.49	0.69	-0.24	10.53	0.59	-0.28	17.53	1.95	1.00
K-603	5.77	1.12	-0.26	14.60	0.21	-0.17	17.55	1.40	1.47
K-604	5.93	0.98	1.95**	13.44	1.07	-0.22	16.47	1.08	1.04
K-678	5.16	0.58	2.78**	11.90	0.30	-0.27	16.91	1.87	10.11**
K-727	7.34	1.44	1.10*	12.40	0.70	5.74**	17.62	0.44	-0.63
K-729	5.54	1.21	0.79*	11.44	1.13	14.62**	18.69	0.25	1.98*
K-742	4.91	0.59	0.53	13.29	0.87	1.82**	20.52	1.28	-0.69
K-745	3.54	0.29	-0.17	9.56	1.19	-0.09	16.98	0.54	2.97*
K-743	4.65	0.75	-0.19	13.06	1.87	0.39	17.36	1.55	4.02**
K-771	4.18	0.80	0.99*	6.71	-0.31	-0.04	18.40	0.39	-0.40
K-795	5.10	1.21	0.32	12.25	1.87	-0.26	16.92	1.39	4.17**
K-796	4.92	0.29	4.74**	10.27	-0.63	15.94**	17.17	1.13	-0.59
K-805	5.36	0.59	2.65**	13.34	0.52	20.14**	20.80	2.10	0.03
JB-15	5.23	-0.03	1.46*	12.67	1.67	2.65**	16.65	1.02	-0.66
JB-16	6.21	-0.16	0.07	8.22	1.02	-0.25	16.65	1.66	0.54
JB-57	6.58	0.83	5.05**	11.77	2.67	-0.22	21.85	0.11	2.67*
PL-760	5.10	0.82	-0.20	5.09	-0.04	-0.28	19.00	1.22	0.66

Variety	Effective tiller/plant			Peduncle length (cm)			Spike length with awn (cm)		
	Mean	Bi	s²di	Mean	bi	s²di	Mean	bi	s²di
NDB-1229	6.58	1.38	-0.11	7.13	1.50	4.52**	13.27	3.41	39.84**
NDB-1173	6.14	0.46	5.09**	6.40	0.67	-0.27	17.25	1.83	2.08*
NDB-1280	5.39	0.03	1.15*	5.91	-0.05	1.16*	17.12	0.90	-0.21
NDB-1180	5.83	-0.52	5.10**	14.06	-0.17	0.26	19.45	0.02	2.01*
EIBGN-2-1	6.31	1.08	4.33**	7.51	1.44	0.74	17.33	0.97	0.50
EIBGN-04-14	6.58	1.53	3.72**	8.60	0.93	4.97**	19.06	1.20	-0.49
EIBGN-041	6.25	1.20	0.19	8.93	2.87	11.10**	16.13	1.78	-0.61
EIBGN-04-16	5.42	0.74	-0.19	11.43	2.06	53.52**	18.60	0.69	-0.59
EIBGN-04-3	6.93	1.37	-0.25	9.72	2.16	-0.20	19.09	1.19	1.56
EIBGN-04-10	6.11	0.99	0.30	7.82	1.02	3.93**	17.89	1.32	1.05
EIBGN-04-11	5.89	0.72	0.77*	6.81	-0.49	2.13**	21.10	0.13	1.92
EIBGN-04-13	5.13	0.31	0.27	12.93	2.37	7.92**	18.92	0.58	-0.60
EIBGN-04-15	6.12	1.50	-0.24	8.01	1.44	3.16**	19.50	0.12	5.77**
IBGP-03-65	5.81	0.23	0.24	9.26	0.28	86.18**	19.66	1.31	-0.48
CIHO-3510	5.95	1.05	-0.22	13.00	-0.11	13.41**	19.58	0.05	-0.16
CIHO-5924	5.54	1.21	0.79*	9.01	1.39	2.73**	17.66	0.58	-0.54
CIHO-5925	6.59	1.17	1.15*	14.55	1.21	-0.27	20.51	0.30	-0.38
ISBCB-02-9	5.33	0.60	1.44*	5.68	-0.01	0.71	19.73	0.08	0.68
ISBCB-03-16	4.84	0.63	0.74	9.72	2.54	36.32**	20.68	0.65	-0.45
EIBGN-04-18	6.04	0.48	1.87**	9.97	2.29	40.24**	18.17	0.23	-0.65
IBGP-03-49	6.63	0.62	4.13**	5.15	0.00	-0.28	19.01	0.41	-0.45
ISBCB-0213	6.10	1.05	-0.20	7.56	1.13	3.60**	15.89	0.27	2.67*
ISBCB-03-153	5.31	0.00	-0.22	6.46	1.38	3.28**	18.61	1.26	5.06**
ISBCB-02-10	6.74	0.69	4.09**	9.82	1.97	-0.15	16.42	0.90	0.33
Beecher	8.48	1.37	0.05	5.25	-0.29	-0.16	16.72	2.29	1.16
Maria	5.51	2.09	1.49**	14.72	1.06	2.55**	18.40	1.97	3.10*
V.Morles	5.73	1.90	1.76**	5.51	-0.03	-0.14	18.41	2.52	0.99
Prestige	4.84	1.09	-0.19	5.59	0.84	0.03	16.98	2.59	-0.69
Yardu	5.89	1.44	0.62	11.08	1.41	1.61**	16.24	2.02	-0.50
Population mean	6.56			9.690			18.36		

Variety	Spike length without awn (cm)			Flag leaf length (cm)			Grains/ear		
	Mean	bi	s²di	Mean	bi	s²Di	Mean	bi	s²Di
Jyoti	9.92	0.95	-0.30	15.35	0.14	-0.08	50.12	0.85	2.35
Manjula	6.54	1.02	0.01	13.24	-0.02	0.93	42.08	0.97	1.65
Lakhan	8.00	-0.91	1.45	15.82	1.07	-0.09	45.49	-0.24	24.58**
Clipper	7.91	-2.08	0.50	16.34	0.10	1.26	45.26	0.80	38.15**
RS-6	9.10	-0.99	-0.19	14.92	0.97	0.42	49.54	0.43	11.58**
C-138	8.08	0.66	-0.60	15.77	0.39	4.58**	52.01	2.41	14.82**
Azad	8.21	0.08	-0.59	14.58	0.55	0.20	59.82	1.96	-1.40
Gitanjali	8.47	3.09	-0.32	16.29	1.33	-0.34	54.59	1.47	13.78**
Karan-4	8.15	1.24	-0.14	13.95	1.29	0.60	58.51	0.82	-1.29
Karan-15	7.65	1.70	-0.61	10.32	0.17	0.53	58.38	1.34	1.01
Karan - 16	7.57	0.10	3.89**	9.31	0.50	0.76	40.72	2.05	43.20**
Karan -19	8.76	2.68	-0.61	16.25	2.52	13.13**	57.83	-0.67	15.85**
Karan-92	7.45	0.37	0.42	19.53	1.72	0.70	49.79	-0.21	21.08**

Variety	Spike length without awn(cm)			Flag leaf length(cm)			Grains/ear		
	Mean	bi	s²di	Mean	bi	s²Di	Mean	bi	s²Di
Karan-280	8.03	0.64	0.18	19.73	1.64	17.65**	43.59	0.83	-1.61
Karan-521	8.08	0.20	-0.27	13.82	0.75	1.02	52.45	0.80	175.06**
Karan-741	8.10	1.40	-0.59	15.97	1.19	2.05*	55.56	1.48	6.58*
DL-88	7.93	0.26	-0.57	14.75	1.04	7.44**	62.16	1.11	46.62**
DWR-39	7.68	0.88	-0.60	13.52	1.80	3.58*	23.09	-0.04	16.83**
DWR-42	8.17	-0.26	-0.61	14.45	1.19	-0.64	24.63	0.02	11.31**
DWR-46	7.62	0.61	-0.53	15.63	1.38	9.21**	46.33	1.09	6.10*
DWR-49	11.03	-0.07	-0.58	13.14	1.45	-0.48	26.40	0.48	-1.57
DWR-50	7.81	0.32	-0.55	13.92	1.64	9.09**	21.43	-0.06	6.93*
DWR-51	8.77	1.09	0.97	15.39	1.85	10.43**	26.00	0.08	0.40
RD-2035	7.69	0.55	-0.40	19.02	1.57	5.41**	49.85	2.35	8.28*
RD-2503	8.37	1.44	9.68**	19.04	1.39	12.69**	51.47	0.76	71.20**
RD-2508	7.89	1.38	1.65	12.14	0.92	10.18**	53.29	2.52	47.22**
RD-2552	7.27	2.07	-0.59	14.69	1.05	-0.54	45.32	1.74	1.13
RD-2618	5.92	-0.20	-0.27	12.97	1.18	-0.14	46.84	0.49	17.47**
RD-2621	6.97	0.08	1.03	13.62	1.58	6.06**	38.87	0.84	39.17**
RD-2631	7.18	0.01	0.24	14.39	1.90	2.09*	37.89	1.72	5.13*
RD-2624	6.26	-1.65	-0.60	16.82	1.16	3.09*	36.61	0.20	7.84*
RD-2634	7.58	-1.31	-0.57	17.32	2.01	29.05**	57.62	-0.94	29.04**
RD-2637	7.98	0.73	1.13	15.59	2.07	12.71**	53.32	1.27	5.17*
RD-2640	9.26	1.39	-0.17	17.20	1.31	-0.61	50.90	3.14	14.31**
RD-2541	7.06	2.35	-0.61	16.31	2.85	10.20**	50.34	1.64	-1.37
RD-2620	8.96	1.18	-0.51	17.97	2.02	2.06*	51.12	1.41	43.63**
RD-2660	9.82	1.76	-0.21	19.53	1.19	0.55	63.80	1.66	16.84**
RD-2662	10.25	2.71	-0.60	18.91	1.50	-0.07	62.48	2.76	106.07**
BCU-73	7.90	0.88	-0.38	15.11	1.49	5.01**	21.67	0.35	0.90
BCU-112	7.50	0.32	-0.02	17.50	1.70	2.86*	49.97	1.26	19.34**
BCU-131	8.95	1.22	-0.59	13.20	1.09	-0.32	36.86	1.57	16.91**
BCU-96	8.84	2.67	0.66	16.83	0.53	7.07**	28.60	0.53	-1.29
BCU-455	7.40	0.56	-0.52	13.91	1.09	2.77*	26.17	-0.02	30.93**
BCU-546	7.13	2.58	0.14	14.17	0.75	2.31*	35.27	0.14	1.10
BCU-550	7.08	1.12	0.10	13.46	0.95	-0.06	38.68	1.16	1.10
BCU-551	7.45	0.58	0.93	16.56	1.09	3.27*	26.77	0.30	270.15**
BCU-554	7.76	0.79	-0.55	16.91	1.32	5.81**	19.74	-0.63	43.37**
BH-556	6.82	1.08	-0.50	16.12	2.38	4.81**	50.82	1.55	57.09**
BCU-775	7.05	1.12	-0.48	10.17	0.72	-0.44	45.89	2.36	-0.54
BCU-1206	7.11	0.62	-0.53	12.15	-0.22	2.38*	22.69	0.13	4.14
BCB(Hyl)-5	7.86	0.12	0.42	12.18	0.40	2.42*	53.59	0.20	-1.36
BCU-4779	8.87	0.99	-0.59	14.67	0.62	-0.61	47.80	0.74	30.75**
BCB-W-03-91	7.26	2.23	0.96	18.11	0.42	0.90	45.14	0.59	58.28**
BH-544	8.76	-0.11	0.48	16.69	1.46	19.33**	46.17	2.81	10.42**
BH-688	6.75	0.75	-0.57	15.89	1.84	0.31	46.32	2.22	1.63
BH-548	7.97	2.00	-0.55	14.17	1.03	4.06**	47.82	2.33	13.01**
BH-543	8.75	0.51	0.03	17.56	1.21	-0.49	43.13	2.33	-1.56
BCU-IC-437851	7.64	1.06	-0.61	15.58	2.10	5.26**	58.00	1.10	65.32**
K-551	8.28	0.81	0.86	16.15	1.42	6.31**	45.71	1.81	4.87*

Variety	Spike length without awn (cm)			Flag leaf length (cm)			Grains/ear		
	Mean	bi	s²di	Mean	bi	s²Di	Mean	Bi	s²Di
K-560	8.27	1.66	-0.36	13.63	0.95	3.15*	54.39	0.11	104.15**
K-603	7.74	1.24	-0.09	15.89	1.03	-0.64	48.51	2.02	120.83**
K-604	7.34	2.03	-0.41	12.75	0.85	0.18	47.26	1.75	4.11
K-678	7.79	0.14	-0.61	11.77	0.87	-0.39	45.76	1.32	7.13*
K-727	8.07	-0.17	-0.12	15.00	1.57	3.21*	50.11	-1.26	19.53**
K-729	7.78	1.03	0.17	14.07	0.83	5.74**	56.02	0.58	0.01
K-742	8.29	1.62	-0.26	18.56	0.48	2.55*	45.30	0.39	5.78*
K-745	7.93	-1.14	0.50	15.29	0.39	0.42	52.83	1.31	19.87**
K-743	7.75	0.86	0.54	20.00	1.75	1.58	60.03	0.31	1.60
K-771	8.80	-0.29	-0.57	16.39	1.52	16.35**	48.38	-0.34	31.86**
K-795	7.78	0.74	-0.60	20.05	1.49	-0.55	56.41	0.34	-0.09
K-796	7.96	0.20	1.53	16.19	0.88	13.65**	52.81	1.94	4.92*
K-805	7.85	2.54	-0.59	20.60	0.78	16.93**	50.47	0.95	36.56**
JB-15	7.34	1.19	-0.56	11.16	0.80	2.33*	46.81	1.15	115.21**
JB-16	6.53	1.59	0.33	13.79	0.82	8.51**	45.34	0.75	23.23**
JB-57	8.80	-0.39	0.04	14.92	0.93	-0.34	48.57	0.54	39.53**
PL-760	9.29	1.82	1.70	14.31	0.73	1.59	47.33	0.48	19.18**
NDB-1229	7.34	2.15	2.32*	12.89	0.45	5.24**	49.59	1.65	161.10**
NDB-1173	7.75	2.50	2.93*	13.96	0.70	31.03**	64.16	-2.04	43.77**
NDB-1280	7.50	0.69	0.61	11.69	0.59	2.81*	52.85	0.94	25.17**
NDB-1180	8.19	1.40	1.65	18.32	0.48	2.62*	48.02	1.33	49.30**
EIBGN-2-1	7.55	1.94	0.28	12.43	-0.15	11.74**	43.08	2.34	2.02
EIBGN-04-14	6.77	0.83	-0.57	9.78	0.96	0.06	55.02	0.99	3.03
EIBGN-041	5.13	3.41	-0.01	13.45	1.90	48.71**	44.17	1.24	-0.41
EIBGN-04-16	7.91	1.06	-0.30	16.88	0.81	41.08**	52.64	0.28	11.83**
EIBGN-04-3	5.43	0.77	0.06	13.38	0.89	0.80	41.50	0.91	35.82**
EIBGN-04-10	6.35	1.38	-0.60	12.77	1.41	0.94	43.39	1.91	20.07**
EIBGN-04-11	7.39	2.25	-0.37	14.24	1.11	12.20**	32.54	0.95	16.46**
EIBGN-04-13	7.97	2.22	-0.47	17.47	1.61	1.87*	61.34	1.58	92.95**
EIBGN-04-15	8.95	3.48	0.00	13.32	1.35	2.85*	46.97	-0.03	36.60**
IBGP-03-65	8.21	2.22	-0.53	18.05	0.73	8.66**	51.16	0.77	64.79**
CIHO-3510	7.47	-0.49	-0.47	18.54	1.09	-0.06	49.13	0.63	-0.16
CIHO-5924	9.68	1.41	1.41	12.53	-0.19	-0.39	50.29	1.54	0.47
CIHO-5925	7.64	0.76	-0.60	16.18	1.01	0.24	50.36	-0.06	11.16**
ISBCB-02-9	9.04	0.42	0.44	14.86	-0.46	-0.52	36.66	1.42	91.58**
ISBCB-03-16	7.31	0.47	-0.50	13.39	0.41	6.93**	50.55	0.61	3.52
EIBGN-04-18	7.40	0.12	-0.48	13.06	0.98	1.34	48.23	1.66	0.27
IBGP-03-49	7.92	1.14	-0.40	13.32	0.00	7.51**	46.94	1.28	16.24**
ISBCB-0213	6.38	-0.01	1.53	15.68	-0.01	10.15**	52.42	2.80	13.11**
ISBCB-03-153	6.26	1.76	-0.51	15.60	0.49	-0.26	32.21	0.97	6.60*
ISBCB-02-10	6.78	1.73	0.97	16.24	-0.30	9.96**	61.74	1.85	-1.19
Beecher	8.71	2.17	0.10	8.62	0.40	9.48**	27.50	0.48	34.15**
Maria	8.25	3.39	0.15	12.62	0.39	16.22**	47.79	0.86	42.43**
V Morles	8.32	0.86	-0.18	16.08	-0.18	6.33**	31.43	0.88	37.11**
Prestige	8.14	2.23	-0.60	14.29	0.09	3.94**	38.32	2.41	377.40**
Yardu	7.31	0.69	-0.60	12.95	0.03	0.54	46.40	0.32	-0.24
Population mean	7.86			15.06			46.14		

Variety	1000-grain weight (g)			Grain yield/plant (g)		
	Mean	bi	s²di	Mean	bi	s²Di
Jyoti	41.44	0.38	-0.41	12.74	1.00	-0.22
Manjula	30.17	-2.46	40.55**	7.36	0.79	-0.25
Lakhan	40.63	-0.12	9.73**	10.16	0.50	29.09**
Clipper	41.81	-1.64	6.90*	9.59	-0.74	3.797**
RS-6	35.91	0.57	160.53**	8.52	0.16	16.08**
C-138	42.38	-0.03	7.67**	13.72	0.35	-0.14
Azad	33.55	2.41	-0.70	11.87	1.82	-0.18
Gitanjali	36.96	-1.94	41.57**	11.71	1.50	-0.12
Karan-4	37.50	2.29	41.22**	11.17	1.55	1.07*
Karan-15	29.91	1.87	3.35	11.62	1.57	-0.07
Karan - 16	29.87	0.67	0.33	7.45	-0.10	2.91**
Karan -19	35.02	2.03	98.54**	9.06	0.89	0.63
Karan-92	43.51	0.85	142.93**	10.70	1.35	0.03
Karan-280	45.51	3.85	6.49*	9.24	1.48	0.14
Karan-521	35.60	0.97	8.47**	10.10	0.01	0.04
Karan-741	37.04	1.35	7.84**	8.31	0.24	0.96*
DL-88	39.01	3.49	5.29*	13.40	1.52	-0.10
DWR-39	43.19	0.52	23.24**	9.33	1.07	6.79**
DWR-42	43.77	-0.94	-1.34	7.35	0.78	-0.27
DWR-46	41.07	2.39	-0.74	9.92	1.39	0.58
DWR-49	42.54	3.99	-0.87	7.25	0.81	-0.17
DWR-50	52.82	3.68	18.41**	7.56	0.87	-0.06
DWR-51	44.10	1.83	17.20**	8.11	1.40	-0.13
RD-2035	40.09	2.22	3.95*	11.59	2.66	9.735**
RD-2503	45.68	-3.22	75.63**	13.36	2.13	45.15**
RD-2508	37.62	0.51	-0.81	16.04	1.62	0.60
RD-2552	38.70	1.49	2.34	10.30	1.65	0.96*
RD-2618	38.73	2.57	-0.03	10.83	2.36	7.359**
RD-2621	44.64	0.53	52.31**	8.49	0.72	4.65**
RD-2631	44.34	0.70	9.69**	9.13	1.04	4.39**
RD-2624	39.97	1.05	6.17*	7.96	0.12	-0.11
RD-2634	39.38	1.88	20.19**	9.73	0.93	-0.25
RD-2637	37.47	-1.27	-1.17	13.46	1.27	-0.09
RD-2640	37.32	-1.34	5.13*	8.94	0.11	1.45*
RD-2541	32.64	-1.24	22.11**	8.31	0.20	9.41**
RD-2620	39.07	-1.39	1.93	8.14	0.90	-0.27
RD-2660	36.27	-1.73	30.10**	10.72	1.16	0.70
RD-2662	39.40	2.86	-0.06	11.19	2.53	6.59**
BCU-73	42.53	0.71	-0.33	5.78	0.43	-0.27
BCU-112	29.06	1.32	9.73**	8.15	1.47	-0.16
BCU-131	32.36	1.97	17.63**	8.15	1.52	0.04
BCU-96	39.81	3.09	1.03	6.78	0.57	-0.10
BCU-455	40.43	1.94	90.02**	7.65	1.38	-0.05
BCU-546	42.20	3.08	-0.38	7.77	1.30	-0.26
BCU-550	37.52	2.62	14.49**	7.65	1.36	-0.03
BCU-551	37.59	3.84	40.66**	5.97	-0.02	0.80*

Variety	1000-grain weight (g)			Grain yield/plant(g)		
	Mean	bi	s²di	Mean	bi	s²Di
BCU-554	49.14	-2.54	7.15*	5.39	0.09	-0.24
BH-556	36.57	1.83	8.54**	9.51	1.08	0.29
BCU-775	30.56	1.94	56.46**	10.20	2.18	0.00
BCU-1206	44.40	1.56	10.89**	6.27	0.49	-0.25
BCB(Hyl)-5	33.99	0.24	1.17	12.22	-0.04	15.38**
BCU-4779	42.62	0.93	6.39*	13.63	1.10	4.42**
BCB-W-03-91	44.48	1.35	33.88**	12.66	1.38	7.15**
BH-544	42.09	1.82	13.45**	11.89	0.82	-0.26
BH-688	40.64	1.75	35.33**	13.76	2.44	27.38**
BH-548	38.91	-0.34	76.28**	10.49	1.81	4.40**
BH-543	41.10	-0.51	-1.21	9.66	0.54	1.09*
BCU-IC-437851	35.18	0.21	9.10**	11.94	1.03	-0.25
K-551	41.81	-0.03	64.25**	9.33	1.37	0.48
K-560	38.38	1.81	13.23**	9.86	1.11	6.76**
K-603	32.76	-0.52	-0.27	8.80	1.26	0.09
K-604	28.97	1.33	17.43**	7.77	1.31	-0.10
K-678	44.55	0.60	1.52	9.49	1.09	1.98**
K-727	37.79	1.21	10.56**	9.42	0.46	11.48**
K-729	37.55	1.45	52.06**	9.44	0.94	2.64**
K-742	41.63	0.33	-0.47	7.13	0.82	0.18
K-745	33.03	-1.27	5.80*	6.60	0.64	-0.11
K-743	31.67	0.85	-1.21	7.83	0.54	3.72**
K-771	37.50	2.24	5.36*	7.32	0.71	-0.18
K-795	37.39	0.41	15.20**	8.91	1.50	0.06
K-796	36.32	-0.61	-0.82	6.05	0.39	-0.10
K-805	45.18	1.89	52.52**	10.54	1.13	12.65**
JB-15	42.61	0.11	18.39**	9.41	-0.22	12.541**
JB-16	43.21	2.11	12.60**	12.31	-0.18	-0.17
JB-57	36.08	-3.38	-1.34	10.43	0.00	17.94**
PL-760	41.63	0.17	37.76**	9.65	1.16	0.26
NDB-1229	30.37	0.25	29.44**	7.93	0.82	2.18**
NDB-1173	30.30	1.71	0.30	9.90	0.19	-0.27
NDB-1280	28.77	0.22	1.09	8.44	0.15	-0.26
NDB-1180	38.82	-0.36	32.87**	7.35	0.43	-0.27
EIBGN-2-1	35.80	2.60	-1.26	8.78	0.98	-0.21
EIBGN-04-14	29.63	1.15	-1.27	8.61	0.82	-0.10
EIBGN-041	33.92	-2.40	17.26**	8.51	1.30	0.37
EIBGN-04-16	35.84	-0.54	6.90**	7.36	1.08	-0.23
EIBGN-04-3	37.84	0.75	13.72**	8.25	1.35	-0.27
EIBGN-04-10	37.36	2.53	25.35**	8.78	1.41	-0.08
EIBGN-04-11	33.01	0.36	-1.32	5.04	-0.09	-0.15
EIBGN-04-13	38.20	0.77	3.73	11.57	0.53	-0.24
EIBGN-04-15	36.21	2.16	17.47**	8.98	1.02	1.61**
IBGP-03-65	34.30	2.45	72.97**	8.35	0.95	0.24

Variety	1000-grain weight (g)			Grain yield/plant(g)		
	Mean	bi	s²di	Mean	bi	s²Di
CIHO-3510	46.17	3.90	3.06	12.08	1.99	4.68**
CIHO-5924	29.85	1.68	31.65**	8.07	1.49	-0.16
CIHO-5925	42.66	2.73	-1.24	11.47	2.07	0.47
ISBCB-02-9	32.99	0.82	0.52	6.22	0.56	-0.27
ISBCB-03-16	32.32	-1.59	4.89*	7.34	0.93	-0.19
EIBGN-04-18	37.86	2.68	53.13**	8.27	1.06	3.61**
IBGP-03-49	38.17	3.15	5.56*	9.65	1.49	-0.01
ISBCB-0213	33.57	2.81	10.26**	9.70	2.21	0.52
ISBCB-03-153	37.30	0.16	-0.04	6.32	0.37	-0.22
ISBCB-02-10	36.49	3.43	2.26	11.43	1.80	0.66
Beecher	38.14	0.81	0.18	8.85	0.41	-0.26
Maria	45.38	1.94	16.98**	11.98	2.07	3.43**
V Morles	46.19	1.18	3.13	6.29	0.57	-0.27
Prestige	42.59	3.20	4.64*	10.48	1.11	-0.06
Yardu	42.34	1.29	-1.34	10.46	1.43	0.13
Population mean	38.35			9.397		

adaptation for short stature of plant across environments. For tiller number EIBGN-04-10, ISBCB-0213 and CIHO-3510 showed stability over range of environments as they had average mean performance, unit regression coefficient and non-significant deviation from regression. Genotypes DWR-42, DWR-50, DWR-2552 and Beecher had higher mean associated with bi > 1 and S^2di = 0 indicating their stability for favorable environmental conditions. The significant genotype x environment interaction were reported by scientists for plant height (Costa and Bollero, 2001; Tamm, 2003) and tillers per plant (Birch and Long, 1990; Tamm, 2003).

BCB-W-03-91 and JB-16 showed stability over range of environments for peduncle length whereas, RD-2631 revealed stability for favorable environmental conditions. Genotypes K-771 and BCB (Hyl)-5 were considered suitable for poor environmental conditions based on low mean, low b_i value and non-significant deviation from regression that could be regarded as specifically adopted to poor environments. DWR-50, EIBGN-2-1, DL-88, BCU-IC-437851, Karan-15, RD-2660, Lakhan and JB-15 exhibited stability over range of environments for spike length with awn while, for spike length without awn Jyoti, BCU-4779, Manjula and K-729 exhibited stability over range of environments. For flag leaf length BCU-550, EIBGN-04-14, RS-6, EIBGN-04-18, CIHO-5925 and K-603 exhibited stability over the environments while, RD-2662 and Lakhan expressed stability for favorable environmental conditions. Moreover, Manjula and EIBGN-04-14 exhibited stability over the environments for grains per ear and EIBGN-041 and Karan-15 indicated stability under favorable environment. The significant genotype x environment interaction has been reported earlier by various workers for grain per spike (Ockay, 1979; Scriban *et al*., 1981; Hadjichristoboulou, 1990; Sainio and Peltonen, 1993).

RD-2662 and RD-2618 expressed stability under favorable environmental conditions for 1000-grain weight. For grain yield per plant, IBGP-03-65, EIBGN-2-1, Jyoti, BCU-IC-477851 had higher mean performance, regression coefficient around unity and non-significant deviation from regression was identified for wide adaptation over all sites across environments, none of genotype suitable for favorable environments. Three genotypes *viz*. BCU-455, BCU-550, Karan-92, BCU-775 and K-795 had higher mean associated with regression coefficient more than unity and non-significant deviation from regression indicating their stability for favorable environmental conditions. Genotype Karan-521 found to be suitable for poor environmental conditions based on low mean, low b_i value and non-significant deviation from regression that could be regarded as specifically adopted to poor environments. The significant genotype x environment interaction has been reported earlier by various workers for grain yield (McGuire *et al*., 1979; Hadjichristoboulou, 1990; Sainio and Peltonen, 1993; Costa and Bollero, 2001; Tamm, 2003; Kavitha *et al*., 2009).

In conclusion, the genotypes RD-2618, PL-760 and NDB-1229 for days to heading; Lakhan, Clipper, JB-57, PL-760 and Maria for short duration; BH-688, BC-112, K-603, RD-2624 and BH-548 for dwarf stature; CIHO-3510 for tiller number; JB-16 for peduncle length, DL-88, BCU-IC-437851, Karan-15, RD-2660, Lakhan and JB-15 for spike length; BCU-550, EIBGN-04-14 and RS-6 for flag leaf length; Manjula and EIBGN-04-14 for grains per ear; EIBGN-2-1 and Jyoti for grain yield were found to be comparatively stable by meeting all the 3 parameters of stability over the environments. This indicates specific genotypes based on its performance should be recommended for a specific favorable environment. The data presented here supports a testing program over more environments to fully characterize the performance of new barley cultivars. High performance and high stability might transmit high means and increased phenotypic stability to the next progenies which may be considered as an ideal genotype for developing improved barley varieties. These promising genotypes may be utilized as a donor in barley improvement program for target ecosystems.

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