

Genetic Variability for Morphological Traits in Released Varieties of Barley (*Hordeum vulgare* L.) under Partially Reclaimed Saline-Sodic Soil

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(Received: 26 March 2014; Revised: 06 September 2015; Accepted: 19 November 2015)

Morphological traits of barley showed differences among varieties released for different uses and climatic zones. Understanding these morphological variations is an important part for development of crop models for different purposes, and to know the plant worth. Narrow and waxy leaves are good indication for tolerant to abiotic stresses like drought, salinity, alkalinity and rainfed situation. Sixty four released varieties of barley were grown under partially reclaimed saline- sodic soil, under irrigated conditions during *rabi* 2010-11 showing wide spectrum of variation for various characters. The characters studied for morphological variation were—growth habit, morphology of leaf, presence of anthocyanin pigmentation, spikelet arrangement, presence of awn, tip sterility, waxiness on leaf, seed colour and seed shape. The characters studied for yield were namely plant height, days to maturity, fertile tillers/plant, length of main spike, grains per main spike, 1000-grains weight, grain yield per plant. The data on seven yield traits used for estimation of mean, range and least significant differences. Based on this study eight varieties selected were—RD-2552, HBL-276, RD-2592, PL-419, Kedar, PL-751, JB-58, K-508 produced higher grain yield plant⁻¹.

Key Words: Barley (*Hordeum vulgare* L.), Genetic Variability, Morphological characters, Partially reclaimed soil

Introduction

Barley (*Hordeum vulgare* L.) is an annual cereal crop, which belongs to the tribe Triticeae of family Poaceae (Harlan, 1976; Martin *et al.*, 2006). It has persisted as a major cereal crop through many centuries and it is the world's fourth important cereal crop after wheat, maize and rice (Martin *et al.*, 2006). Barley has a long history of cultivation in Ethiopia and it is reported to have coincided with the beginning of plow culture (Zemede, 2000). It is popular hunger breaker or relief crop during season of food shortage in some parts of the country (Baye and Berhane, 2006). It is a diploid ($2n=2x=14$), largely self fertilizing species with a large genome (Bennett and Smith, 1976). During centuries, early domestication and local knowledge have generated through diverse local barley used mainly for feed and lowly for food (Vavilov, 1951). Morphological characters have been used to evaluate distinctness, uniformity and stability, and to establish the description of a genotype. This method

is thought to be often influenced by environmental conditions (Russel *et al.*, 1997) as well as being labour intensive. Assessment of the extent of genetic variability within cultivated crop has important consequences in plant breeding and conservation of genetic resources (Petersen *et al.*, 1994). The objectives of this study were to assess the extent of morphological variation in released barley varieties in order to classify them into relatively homogenous groups and to identify the major traits contributing to the overall genetic diversity.

Materials and Methods

The experimental material comprised of sixty four released varieties of barley collected from Directorate of Wheat Research, Karnal, Haryana were grown under partially reclaimed saline- sodic soil (pH 8.6-8.9, EC = 4-4.2 dSm⁻¹, ESP => 15). These varieties were evaluated in a Simple Lattice Design with two replications. Each plot consisted of three rows, each of three meter long with

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spacing of 23 cm. The plants within a row were spaced approximately 10 cm apart. The eight contiguous plots collectively constituted one tier. Thus there were eight tiers each of eight plots in a replication. The varieties were allocated randomly in each replication. The data for morphological variation were recorded on growth habit, morphology of leaf, presence of anthocyanin pigmentation, spikelet arrangement, presence of awn, tip sterility, waxiness on leaf, seed colour and seed shape, and five randomly selected plants used for data on 7 quantitative traits namely, plant height (cm), days to maturity, number of fertile tillers⁻¹, length of main spike (cm), grains per main spike, 1000-grain weight (g), grain yield plant⁻¹ (g). The present investigation was conducted during *rabi* 2010-11 at Genetics and Plant Breeding Research Farm of Narendra Deva University of Agriculture & Technology, Narendra Nagar, Kumarganj, Faizabad Uttar Pradesh, situated between 26°47' N latitude, 82°12' E longitude and at an altitude of 113 m above the mean sea level. The climate of district Faizabad is semi-arid with hot summer and cold winter. Nearly 80 per cent of total rainfall is received during the monsoon with a few showers in the winter. The recommended cultural practices were adopted to grow varieties.

Result and Discussion

The results of the analysis of variance for Simple Lattice Design in respect of 7 characters are presented in (Table 1). The variation due to replication was highly significant for plant height, days to maturity, fertile tillers per plant, and length of main spike, grains per main spike, 1000-grain weight, and grain yield per plant. The variation due to treatment were found to be highly significant for plant height, days to maturity, length of

main spike, grains per main spike, and significant for grain yield per plant, but non-significant for remaining two characters *viz.* fertile tillers per plant, 1000-grain weight. The mean performance for adjusted mean, range and least significant difference of 64 genotypes for 7 characters are presented in table 2. The general mean for plant height was 66.18 cm. The lowest value was recorded in case of BH-393 (52.46 cm) and highest value for RD-2035 (89.44 cm). Sixteen varieties were significantly shorter in plant stature than the general mean. Top eight significant groups for plant height were Alfa-93, Gitanjali, Manjula, RD-2503, JB-58, DWRUB-52, K-508, and DL-88. The days to maturity ranged from 110.98 (BG-101) to 119.05 days (RD-2552) with general mean of 115.27 days. Out of 64 varieties twenty two varieties matured significantly earlier than the general mean in which eight varieties namely BG-101, Bilara-2, BH-169, Vijay, K-508, Dolma, BH-75, and PL-419, matured earlier. Fertile tillers per plant ranged from 3.47 (BH-902) to 5.50 tillers per plant (HBL-276) with general mean of 4.375 tillers per plant. Among sixty four varieties, forty-six varieties showed significantly greater tillers per plant than the general mean in which top eight varieties order of merit were HBL-276, Lakhan, RD-2508, K-508, DL-88, PL-172, BHS-380, and Sonu. The general mean for length of main spike was 7.89 cm. The lowest value was recorded in case of PL-426 (5.39 cm) and highest value for Jagrity (8.89 cm). Thirty-seven varieties showed significantly longer spike length than general mean. Top eight varieties for longer spike length in order of merit were Jagrity, BHS-46, DL-88, UPB-1008, Alfa-93, RD-2552, K-141, and RD-2624. The lowest and highest values for grains per spikes were recorded for Clipper (29.34) and RD-2552 (39.18) respectively.

Table 1. Analysis of variance of Simple Lattice Design for 7 characters in released varieties of barley

S. No.	Character	Source of variation		
		Replication	Treatments	Error
	Degree of freedom (d. f.)	1.00	63.00	63.00
1	Plant height (cm)	214.78**	113.01**	2.46
2	Days to maturity	76.57**	6.09**	0.74
3	No. of fertile tillers per plant	13.78**	0.52	0.93
4	Length of main spike (cm)	15.46**	0.80**	0.30
5	No. of grains per main spike	250.32**	10.75**	5.00
6	1000-grain weight (g)	298.62**	6.02	4.70
7	Grain yield per plant (g)	21.73**	0.99*	0.64

* Significant at 5 % probability level,

** Significant at 1 % probability level.

Table 2. Adjusted means, range and least significant differences for 7 characters in released varieties of barley

S. No.	Varieties	Plant height (cm)	Days to maturity	No. of fertile tillers/plant	Length of main spike (cm)	No. of grains/ Main spike	1000 grain weight (g)	Grain yield/ plant (cm)
1	Clipper	53.39	116.01	4.52	7.19	29.34	38.53	6.20
2	Jyoti	64.12	115.99	4.50	7.48	31.50	36.59	6.09
3	Amber	63.41	115.01	3.51	8.22	33.39	36.63	6.13
4	RS-6	55.52	115.02	4.51	7.78	31.64	36.56	6.79
5	Ratna	52.92	113.95	4.47	6.89	31.80	34.78	6.17
6	RDB-1	55.37	115.98	3.50	6.90	32.02	36.62	5.85
7	Vijay	54.93	112.48	3.49	6.25	31.93	36.82	7.16
8	Himani	63.45	115.02	4.00	7.27	30.59	35.47	6.40
9	Dolma	58.28	113.00	4.52	7.50	32.55	35.18	6.81
10	BG-101	59.96	110.98	4.50	8.09	33.71	39.01	6.21
11	Azad	55.40	113.99	4.51	7.18	34.09	38.28	7.09
12	PL-56	57.06	116.01	3.51	7.49	31.84	38.41	6.60
13	RD-31	71.51	115.44	4.47	8.40	34.00	41.16	7.64
14	Bilara-2	62.61	111.97	3.50	7.06	31.73	37.33	6.43
15	Kedar	73.17	115.97	4.49	8.51	36.14	40.07	8.11
16	Sonu	77.14	115.01	5.00	8.08	34.30	40.46	7.17
17	K-141	76.12	114.00	4.02	8.77	37.21	40.01	7.16
18	Lakhan	68.76	115.98	5.50	8.11	34.86	38.58	7.08
19	Jagrity	71.80	116.99	4.51	8.89	38.25	41.67	7.79
20	BH-75	68.85	113.01	3.51	8.06	34.50	37.53	6.72
21	BHS-46	77.00	113.94	4.47	8.87	36.66	40.07	7.36
22	PL-172	68.81	115.47	5.00	8.12	32.89	39.66	7.18
23	VLB-1	69.56	115.97	4.49	8.03	34.30	36.52	6.88
24	RD-2052	60.43	114.01	4.00	7.84	31.45	38.94	6.51
25	Manjula	66.01	115.03	3.52	8.73	36.48	38.36	7.54
26	BH-169	62.10	112.01	4.50	7.97	34.14	38.03	6.91
27	Karan-16	59.68	114.53	4.01	7.35	30.52	35.79	6.39
28	Gitanjali	66.04	116.04	4.51	8.07	34.77	40.44	7.78
29	RD-2035	89.44	114.47	4.97	8.08	36.93	39.66	7.45
30	HBL-316	52.90	114.00	4.50	7.38	33.66	37.88	6.76
31	Alfa-93	66.10	115.00	4.99	8.78	38.07	38.26	7.09
32	PL-419	77.37	113.04	4.50	7.75	34.73	37.04	8.15
33	PL-426	67.18	116.03	4.53	5.39	33.39	34.51	5.64
34	BCU-73	67.77	116.51	4.52	7.83	31.55	40.30	7.83
35	RD-2503	65.16	115.02	4.02	7.97	29.43	38.80	7.41
36	RD-2508	75.67	115.03	5.03	7.18	30.68	38.10	6.82
37	K-409	73.11	116.47	4.49	7.89	31.84	37.89	7.84
38	K-508	64.42	112.99	5.02	7.84	35.57	40.95	7.96
39	K-551	74.52	116.49	4.01	7.90	36.98	38.63	6.88
40	K-560	73.55	114.03	4.52	7.66	33.14	39.61	7.03
41	DL-88	64.17	116.04	5.02	8.84	36.02	37.22	7.17
42	RD-2552	71.91	117.02	4.50	8.78	39.18	39.89	8.52
43	HBL-276	70.60	115.53	5.51	8.67	33.07	40.37	8.35
44	NB-1	63.16	115.05	3.51	7.83	34.32	38.01	6.29
45	NB-2	68.96	115.98	3.97	8.14	33.98	37.78	6.63
46	K-603	54.41	113.51	4.50	7.80	32.21	35.77	6.33
47	BH-393	52.46	116.51	4.49	7.90	30.11	35.67	5.72
48	NB-3	60.84	113.05	4.00	7.02	33.77	37.15	6.16
49	DWR-28	70.29	115.04	4.50	8.20	33.39	37.47	7.07
50	RD-2624	68.33	117.52	4.48	8.74	38.05	36.38	5.87

S. No.	Varieties	Plant height (cm)	Days to maturity	No. of fertile tillers/plant	Length of main spike (cm)	No. of grains/main spike	1000 grain weight (g)	Grain yield/plant (cm)
51	BHS-352	76.66	115.53	4.99	8.07	35.93	37.14	6.99
52	RD-2592	76.32	119.05	4.49	8.69	32.18	39.83	8.17
53	NDB-1173	75.37	117.48	4.46	8.35	30.34	38.45	6.42
54	JB-58	64.88	114.51	4.99	7.30	31.07	35.82	8.06
55	VLB-56	66.18	117.51	4.48	7.50	31.98	36.60	7.00
56	RD-2660	64.05	113.05	3.98	7.97	30.64	36.09	6.33
57	DWRUB-52	64.59	115.49	5.02	7.54	32.66	36.21	7.50
58	RD-2668	66.83	115.97	4.00	7.58	30.82	35.05	6.29
59	PL-751	62.57	114.48	4.50	8.12	33.71	35.85	8.10
60	RD-2715	62.98	118.99	3.51	8.03	32.95	38.99	6.39
61	BH-902	60.22	116.92	3.47	8.29	35.12	36.85	7.06
62	BHS-380	69.28	118.45	5.00	8.19	35.34	37.75	6.84
63	DWR-73	69.48	118.95	3.99	8.15	36.25	40.16	6.39
64	UPB-1008	70.46	117.99	4.50	8.81	37.91	38.42	7.84
Lowest		52.46	52.46	110.98	3.47	5.39	29.34	34.51
Highest		89.44	89.44	119.05	5.51	8.89	39.18	41.67
Mean value		66.181	66.18	115.27	4.38	7.89	33.65	37.94
LSD1 5%		3.034	3.03	1.74	1.95	1.09	4.33	4.32
LSD2 5%		3.100	3.10	1.73	1.95	1.10	4.42	4.35
LSD3 5%		3.086	3.09	1.73	1.95	1.10	4.40	4.35

The general mean for grains per spike was 33.64. Out of 64 varieties, thirty one varieties exhibited significantly greater number of grains per spike as compared to general mean. The eight promising varieties for greater number of grains per spike identified on the basis of merit were RD-2552, Jagrity, Alfa-93, RD-2624, UPB-1008, K-141, K-551, and RD-2035. The general mean for 1000-seed weight was 37.93g and varied from 34.51g (PL-426) to 41.67g (Jagrity). Among 64 varieties, thirty two varieties showed significantly greater 1000-seed weight than the general mean, in which eight varieties had higher 1000 seed weight. These were Jagrity, RD-31, K-508, Sonu, Gitanjali, HBL-276, BCU-73, and DWR-73. The general mean calculated for grain yield per plant was 6.97g. It ranged from 5.63g (PL-426) to 8.52g (RD-2552). Twenty varieties showed significantly higher grain yield per plant than the general mean. Eight varieties most promising for grain yield identified on the basis of merit were RD-2552, HBL-276, RD-2592, PL-419, Kedar, PL-751, JB-58, and K-508.

Nine morphological characters were recorded for morphological variation in released varieties (Fig. 1) of barley, the details are:

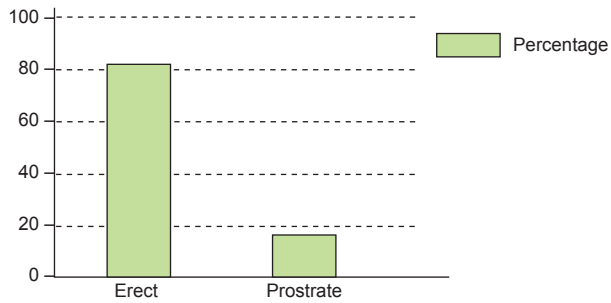
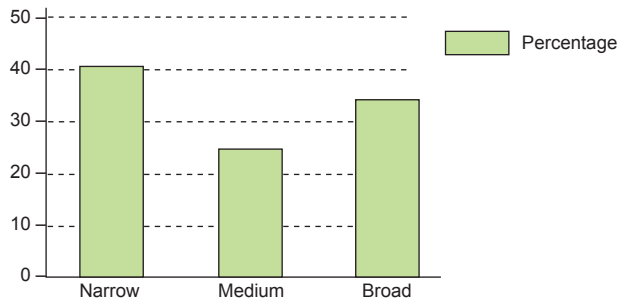
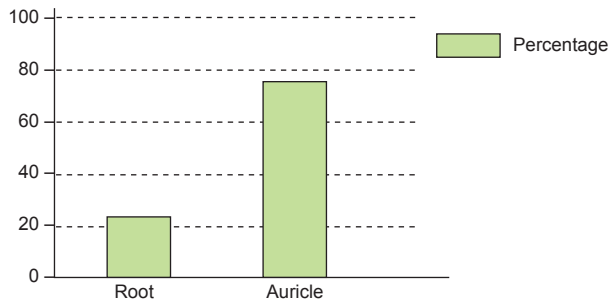
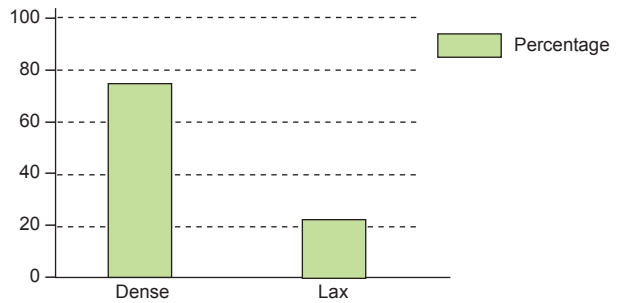
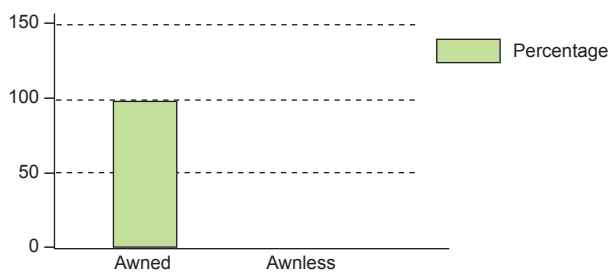
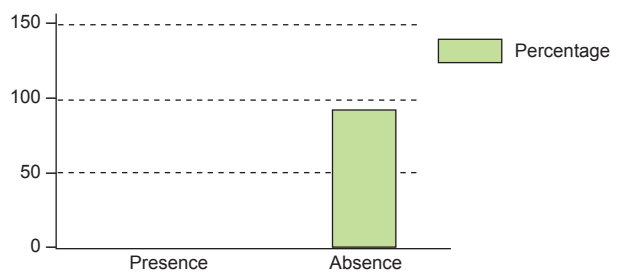
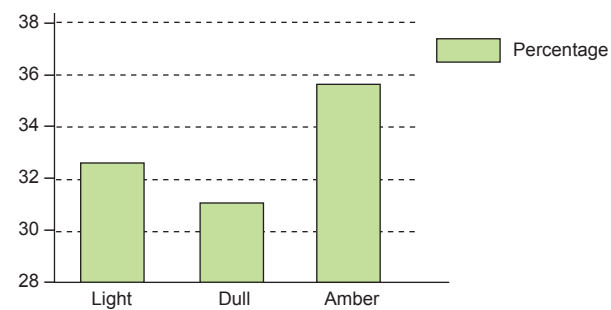
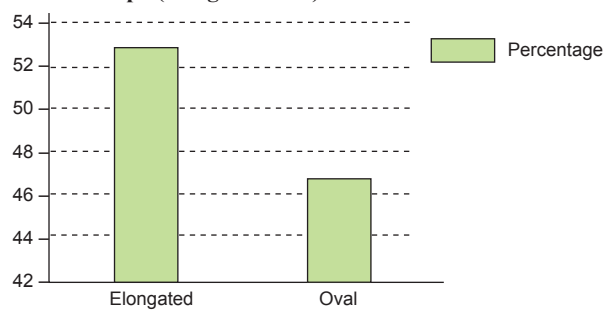
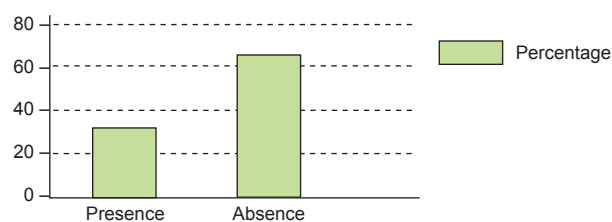
Growth Habit (erect/prostrate): The erect group had higher plant yield than prostrate which indicate to be

attributable mainly to the significantly larger grain size of this group. The erect group was also significantly earlier and taller than the prostrate group. The erect type bended at an angle of 30° are supposed to accumulate more photosynthate during photosynthesis. Chlorophyll content and its kind differ in erect and prostrate type which is researchable.

Morphology of Leaf (narrow/medium/broad): Broad leaved plants had more green biomass, more chlorophyll content indicating suitable for green forage i.e., dual purpose. On the other hand plants having narrow leaves become tolerant to abiotic stresses like drought, salinity, alkalinity and rainfed situation.

Presence of Anthocyanin Pigmentation (root/auricle): Anthocyanin pigment is an indication of presence of malt in barley. The barley varieties having anthocyanin pigment on awn/tip of the ear, were categorised in two groups malty or non-malty barley. Anthocyanin pigment is associated with photosynthetic activity.

Spikelet Arrangement (dense/lax): An arrangement of spikelet expresses their ability to enhance productivity in crop. Denser and bolder grain add per unit increase in grain yield. Denser arrangement of spikelet provides less opportunity to reside the spore of serious disease.

a. Growth habit (erect/prostrate)**b. Morphology of leaf (narrow/medium/broad)****c. Presence of anthocyanin pigmentation (root/auricle)****d. Spikelet arrangement (dense/lax)****e. Awned/awnless****f. Tip sterility (presence/absence)****g. Seed colour (light/dull/amber)****h. Seed shape (elongated/oval)****i. Waxiness on leaf (presence/absence)****Fig. 1: Morphological characters for variation in traits (a-i)**

Awned/ Awnless: Awned trait is a specification hulled form of barley. It assists in scarring of birds thus facilitates non damaging the crop yield. Awned trait is indirectly influenced the photosynthetic activity/formation of chlorophyll.

Tip Sterility (presence/absence): Tip sterility had raised variety to variety reflection and crop to crop. This trait had negative effect on yield. This trait, in general appears under abiotic stress condition e.g., problematic soil. For this trait arises due to physiological irregularities/nutrient deficiency.

Seed Colour (light yellow/dull/amber): Seed colour is a quality trait which attracts the preference of consumers, processors or grower. Most appealing seed colour is amber (in case of cereals) and light yellow in other. Dull-ness downs the rate of grain as much as purchase is concerned.

Seed Shape (elongated/oval): Seed shape varied crop to crop and variety to variety. In general oval type grains are much preferred by the people in cereals. Elongated or oblong grain is a special trait in barley which differentiates it from other cereals.

Waxiness on Leaf (presence/absence): Waxiness on leaf is a peculiar trait in cereal. Waxiness having genotype may be well suited for rainfed/drought/salt affected condition because waxiness restricts evaporation as well as transpiration in plant. Waxiness also reflects beta glucon particularly in barley which regulates deposition of cholesterol level in the body.

The erect group (82.81%) had higher plant yield and also significantly earlier and taller than the prostrate group (17.18%). Broad leaves (34.37%) plants revealed more green biomass as a consequence more chlorophyll content indicating suitable for green forage, whereas narrow leaves (40.62%) revealed tolerant to abiotic stresses like drought, and rainfed situation, medium leaves plants (25%) performed intermediate. Some of the varieties had anthocyanin pigmentation on root (23.43%) and some on auricle (76.56%), Anthocyanin pigment is an indication of presence of malt in barley, on the basis presence of anthocyanin pigmentation varieties we can categories in two group malty or non malty barley. Anthocyanin pigment is associated with photosynthetic activity. Anthocyanins play key roles in many plant physiological processes; for example, they form photoprotective screens in vegetative tissue, act as visual attractors to aid pollination and seed dispersal,

and function as antimicrobial agents and feeding deterrents in the defense response, Winkel-Shirley (2001). Anthocyanin accumulation in vegetative organs has a relationship to stress resistance in plants; biosynthetic pathway of anthocyanin is well described in plants in *Arabidopsis* and other plants, including *Antirrhinum majus* and *Petunia hybrida*.

Spikelet arrangement expresses their ability to enhance productivity in crop, denser (76.56%) arrangement of spikelet provides less opportunity to reside the spore of serious disease, while lax (23.43%) spikelet avoid these. Awned (100%) trait is indirectly influenced the photosynthetic activity/ formation of chlorophyll content, contributed 80-90% of total spike photosynthesis. Some varieties have fertile tip (96.87 %), while some are sterile (3.12%), tip sterility had negative on yield, physiological irregularities. Seed colour is the quality trait which attracts the preference of consumer processors and grower, most appealing seed colour is amber (35.93%) and light yellow (32.81%) while, dull colour (31.25%) downs the rate of grain. Seed shape varied crop to crop and variety to variety. In general oval type (46.87%) grains are much preferred by the people in cereals, elongated (53.12%) grain is a special trait in barley which differentiates it from other cereals. Waxiness on leaf is a peculiar trait in cereals; waxiness restricts evaporation as well as transpiration in plant. Some varieties exhibited waxiness (32.81%), rest of varieties lack this trait. Presence of substantial variation in the barley varieties indicated possibility of selection in these traits.

The structure of morphological variation in barley varieties strongly influenced by the environmental factors so that the degree of variation of characters differs with regions and altitudes from where the accessions collected. In studies of spring barley (*Hordeum vulgare* L.) awned isolines had higher yield, seed weight and seed plumpness than awnless isolines (Quaset *et al.*, 1965; Schaller *et al.*, 1972). Full and half-awned lines of Atlas barley produce more grain than quarter-awned and awnless lines. Computations of Schaller *et al.* (1972) showed that the awns of a full awned Atlas type contributed 19.3Va of the total grain yield. Kjack and Witters (1974) used the same lines as those of the Schaller *et al.* (1972).

Based on this study eight varieties were selected namely RD-2552, HBL-276, RD-2592, PL-419, Kedar, PL-751, JB-58 and K-508 produced higher grain yield plant⁻¹ and showed high to very high mean performance

for several other yield component also. These varieties can be used in barley improvement programme and will be helpful in breaking the yield plateau.

Acknowledgement

This research work was supported by Directorate of Wheat Research, Karnal. The authors thank to Project Director, Directorate of Wheat Research, Karnal for provide experimental material, valuable help and support.

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