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EVALUATION AND CHARACTERIZATION OF BARLEY GERMPLASM IN NATIONAL GENE BANK GENETIC RESOURCES IN EGYPT

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ABSTRACT

The present study two field experiments material comprised of one thousand and twelve genotypes of barley during 2003/2004 and 2004/2005 seasons to study characterize and evaluate the 1012 accessions for important agronomic and morphological traits which could be used in barley breeding ..

Grain yield of accessions of two and six rowed barley was normally nearly 27% of the two rowed had yield higher than 8-11 g ,but only 26 % of the six rowed type .Over 17 % of the six rowed type fell in the class 16- 19 g against 16 % in the same class .Although 6- rowed type predominate in Egypt barley cultivation ,the above result suggests that six rowed barley could be introduced successfully .

The interrelationships showed positive and significant phenotypic correlation between barley grain yield /plant and each of plant height ,spike length ,number of kernels /spike ,100 kernel weight and number of spikes /plant in the six and two rowed barley .However the phenotypic correlation of grain yield /plant with each of flag leaf glaucosty sheath ,ear glaucosty and grain speculation of inner lateral nerves of dorsal were negative and significant in the six rowed barley .

The path analysis showed that the number of spikes /plant , number of kernels /spike and 100 kernel weight had high direct effect and /or indirect effect through each others on grain yield /plant ,so, the barley breeder might take them into consideration in the selection programs aiming to improve new barley .

INTRODUCTION

The Biodiversity is the total variation found within living organisms, along with the ecological complex they inhabit. Cultivated barley (*H. vulgare*) is descended from wild barley (*Hordeum spontaneum*), which grows wild in the middle east Both forms are diploid (2n=14 chromosomes). As wild barley is interfertile with domesticated barley, the two forms are often treated as one species, divided into *Hordeum vulgare* subsp. *spontaneum* (wild) and subsp. *vulgare* (domesticated). Barley (*Hordeum vulgare* L) is a major food and animal feed crop, a member of the grass family Poaceae. Barley is grown for many purposes, but the majority of all barley is used for animal feed, human consumption, or malting High protein barleys are generally valued for food and feeding, and starchy barley for malting.

The history exact origin of barley is debatable, possibly originating in Egypt, Ethiopia, the Near East. However, we are fairly certain that barley was among the earliest cultivated grains, around the same time as domestication of wheat. *Hordeum* is a genus of about 30 species of annual and perennial grasses, native throughout the temperate Northern Hemisphere, temperate south America and also South Africa . One species, *H. vulgare* (barley) is of major commercial importance as a cereal grain, used as fodder crop and for malting in beer and whiskey production. Some species are nuisance weeds

introduced world-wide by human activities others endangered due to habitat loss.*Hordeum* species are used as food plants by the larvae of some Lepidoptera species .Barleys have two-kernel types, two-row and six-row. Two-row barleys are produced on varieties with just two rows of kernels on their heads. Six-row barleys are varieties with six rows of kernels on their heads. Two -row barley kernels have bottoms that are all uniform. Two-thirds of the kernels of six-row barley have a slight twist at their base because of the way they are fastened to the grain head.

The Common names for *Hordeum vulgare*, barley, barleycorn, barley flakes, barley grits, malt, naked barley, pearl barley, pot barley, Scotch barley, six-row barley, two-row barley, Arpa, Cebada, Common Barley, Gerst, Jo, Kung Mai, Kung Mai Nieh, Mai Ya, No Mai, Orzo, Sha'Ir, Six-rowed Barley, Ta Mai and the Synonyms for *Hordeum vulgare Hordeum* aegiceras Nees ex Royle, *Hordeum* distichon L., *Hordeum* hexastichon L., *Hordeum* hexastichum L., *Hordeum* irregulare Aberg & Wiebe, *Hordeum* sativum Pers., *Hordeum* vulgare var. trifurcatum (Schlecht.) Alef .

Landraces are largely an outcome of natural selection during centuries of cultivation. They usually exhibit genetic variation for qualitative and quantitative traits, have good adaptation for specific environmental condition and give dependable yield (Harlan, 1975). These merits sparked a renewed interest in utilizing wheat landraces for crop improvement, particularly in dry land agriculture (Srivastava *et al*.,1988).

Several studies have dealt with the variability landraces for morphological (pecetti *et al.,* 1992) and quality characters (Negassa, 1987), most of them geared towards quantifying the variation within and between geographic regions and population. Not with standing the significance of these studies in terms of collection strategies and for breeding purposes .there is little or no information available on the partitioning of availability and estimating genetic advance of agronomic characters, which is rather more useful to the plant breeder. The information on the interrelationship of agronomic traits is also too meager to allow the formulation of efficient selection procedures.Direct selection for grain yield of barley seems to be rather complex ,it might be more desirable to select for some easily identifiable characteristics proved to be closely correlated with grain yield .The objective of this study was to characterize and evaluate the 1012 accessions for important agronomic and morphological traits which could be used in barley breeding

MATERIALS AND METHODS

The present study two field experiments material comprised of one thousand and twelve genotypes of barley during 2003/2004 and 2004/2005 seasons , selected on the basis of their agronomic and morphological characters from the germplasm collection at the National gene bank and genetic recourses. The material was grown with eight check varieties in an augmented design at the research farm of National gene bank and genetic recourses at Giza, Agriculture, Research station. Each genotype was assigned to a single row, 2.m long plot , with 30 cm row to row distance with seed rate as recommended for commercial cultivation. From the center using

half meter long not plat out of the 2 meter long plot, five competitive plants were randomly taken to record observation on fourteen morphological quantitative characters Important morphological an agronomic traits studies were plant growth habit, flag leaf anthocyanin, plant frequency of plants with recurved flag leaves, flag leaf glaucosity of sheath, awns intensity of anthocyanin coloration of tips, ear glaucosity, spike length excluding awns, grain speculation of inner lateral nerves of dorsal side of lemma, plant height without awns, number. of kernels/ plant,1000 kernel weight ,number of spikes/ plant , grain yield/ plant, and heading date. The standard cultural practices were used in both seasons In all cases average values of the five plants were used for analysis .Range, mean, coefficient of variation , standard error values ,simple correlation coefficient between the various characters were calculated and path coefficient analysis for grain yield was carried out to partition the correlation coefficients into direct and indirect .

RESULTS AND DISCUSSION

The analysis of variance showed that the blocks were homogenous and genetic differences existed for most of the traits among the check varieties. Range, mean standard error and coefficient of variation values of the fourteen characters are given in table (1). grater variation was observed for grain yield /plant ,number of spikes /plant , flag leaf anthocyanin ,plant growth habit, Ear glaucosty and plant frequency of plant with recurved flag leaves, in the six and two rowed barley indicating wide opportunity of direct selection for yield among the genotypes. Therefore, these traits have higher contribution towards the total genetic divergence. Whereas grain spiculation of inner lateral nerves of dorsal side of lemma exhibited mininum variation in both type . The remaining characters showed low to intermediate variation.

1-Plant growth habit

The six rowed comprised 68.97% and the two rowed 31.02% of the accessions used. The mean and range were 4.192 and 1-9 for the six rowed types and 4.732 and 1-9 for the two rowed .More than 48.4 % of the two rowed types erect but only 42 % of the six rowed type fell in this class fig.(1) .On the other hand 1.3 % of the two rowed type in the fell class prostrate against the 6.4 % of six rowed in the same class .Also over 3.4 % of the six rowed type in the class intermediate against 1.3 % of the two rowed in the same class .

2-Plant frequency of plants with recurved flag leaves.

Plant frequency of plants with recurved flag leaves varied from very low to very high with several intermediate forms .In some cases ,this trait varied within accession because of the heterogeneity of the population .This made precise assessment of Plant frequency of plants with recurved flag leaves difficult .Nevertheless , an attempt was made to divide the accessions into five groups ,namely very low , low ,medium ,high and very high .The accessions clustered mainly around the five main Plant frequency of plants with recurved flag leaves (fig. 2) Very low formed 0.6 % ,low 48.7 % , medium 18.1 % , high 22 % and very high 10 % in the six rowed types and 1.3 % ,40.1 % ,14.3 % ,25.2 % and 19.1 % ,respectively ,in the two rowed types .

T1

3-Flag leaf glaucosity of sheath

With regard to flag leaf glaucasity of sheath could be classified into five categories (Fig 3) .The first category show very weak 0.9 % ,weak 10 % ,medium 54.4 % ,strong 28.7% and very strong 5.9 % in the six rowed type and 0.3 % ,13.7 % ,55.1 % ,19.7 % and 11.1 % ,respectively, in the two rowed type .

4- Awns anthocyanin coloration of tips

Concerning awns anthocyanin coloration of tips (Fig.4) barley genotypes could be classified into five categories .The first category shows very weak for this trait about 2.1 % ,the second category about 48.4% ,where awns anthocyanin coloration of tips is weak ,the 24.4 % have medium as a third category ,strong 14 % and very strong 11 % in the six rowed type ,while the 3.2 % , 32.2% ,22.3 % ,20.4 and 22, respectively , in the two rowed type.

5-Ear glaucasty :

Mean and range were 6.11 and 1-9 for the six rowed type and 5.789 and 3-9 for the two rowed barley. The accessions clustered mainly around the five main categories (Fig. 5) very early 1.4 % ,weak 4.2 % , medium 35.3% , strong 55.2 % and very strong 3.7 % in the six rowed type and 15.0 % ,39.5 % , 36.6 % and 8.9 % in the two rowed types .

6-Spike length excluding awns

The spike length of six rowed barley were generally longer than those of two rowed type.The standard deviation was also greater ,suggesting slightly more variation .The mean and range were 6.761% cm., and 4-8 cm for the six rowed type and 7.213cm. and 4 – 14 cm. for the two rowed type .More than 51.% of the six rowed types in the second category short but only 36.8 % of the two rowed type fell in this class (Fig.6) .On the other hand ,over 50% of the six rowed type in the first category against 44.8 % for the two rowed barley .This suggests that six rowed types are mostly longer than two rowed types **.**

7- Grain speculation of inner lateral nerves of dorsal side of lemma .

The mean and range were 4.877 and 1-7 for the six rowed type and 4.624 and 3-9 for the two rowed .More than 40 % of the two rowed type weak **speculation of inner lateral nerves of dorsal side of lemma** but 30.7 % of the six rowed type fell in this class fig.(7) .On the other hand 44.4 % of the six rowed type in the fell class medium against the 37.3 % of two rowed in the same class .Also over 24 % of the six rowed type in the class strong against 22% of the two rowed in the same class .

8-Plant height .

The two rowed type presented broader variability in plant height than the six rowed type .Mean and range were 92.35 cm. and 63 –99 cm. In the two rowed barley and 82.94 cm. And 63 – 109 in the six rowed type .The class 85-92(5) cm., formed 45.9 % of the six rowed type and 0.3 of the two rowed type which could be viewed more suitable for high fodder yield in the absence of detrimental factors .On the other hand ,the 103-112 cm., class formed 6.3 % of the six rowed barleys and 52% of the two rowed barley .This suggests that two rowed type had higher average lodging than six rowed barley .However ,higher lodging was not necessarily an indication of poor yield in this study .

F1+2+3

F4+5+6

9-Number of grains /spike

The mean and range were 40.704 and 21.9 to 41.83 grain in the six rowed types and 30.86 grain and 25.67 to 53.97 grain in the two rowed barley .More than 69 % of the six rowed type increased number of kernels /spike (36-39 grain),but only 4.6 % of the two rowed fell in this class (Fig.9).However over 43% of the two rowed type increased 28-31 grain against 5.8 %for the six rowed barley .The class 32-35 grain formed 29.3% of the two type and 20% of the six rowed type ,which could be viewed more suitable for yield .

10- 1000-grain weight.

The 1000 kernel weight of the six rowed barley were generally heavier than those of two rowed barley .The standard deviation was also greater ,suggesting slightly more variation. Over 36% of the six rowed lines fell in the 31-34 g class against only 32.8 % of the two rowed type (Fig 10) On the other hand the 27- 30 g class formed 30.8% of the six rowed barley and 25.79 of the two rowed ,while the 35-38 g class formed 6.02% of the six rowed and 5.1 of the two rowed barley

11- Number of spikes /plant

Mean and range were 9.714 spike and 4.5- 15.67 spike for the six rowed types and 9.578 spike and 4.5-15.67 spike for the two rowed barley .The class 4-5 spike formed 32.23% of the two rowed types and 27.7 of the six rowed types which could be suitable for high yield .Over 33 % of the two rowed lines fell in the 8-9 spike class against 29.9 % of the six rowed types .On the other hand , the 6-7 spike formed 8.6 of the six rowed and only 0.7% of the two rowed barley ,while the six rowed equal the two rowed in the class 10-11 spike (24.2% and 24.07 ,respectively).

12-grain yield /plant .

Grain varied greatly among accessions .Grain from some accessions could hardly be recovered because of sever lodging .The average grain yield of the six rowed barley was significantly greater than that of the two rowed type .Grain yield of accessions of two and six rowed barley was normally distributed (Fig.12).Nearly 27% of the two rowed had yield higher than 8-11 g ,but only 26 % of the six rowed type .Over 17 % of the six rowed type fell in the class 16- 19 g against 16 % in the same class .Although 6- rowed type predominate in Egypt barley cultivation ,the above result suggests that six rowed barley could be introduced successfully .

13-Heading date

Mean and range were 91.13 days and 74-99 days for the six rowed types and 91.159 days and 82-99 days for the two rowed barley .The class (3) days formed 37.6% of the six rowed types (Fig .13) and 7.55 only of the two rowed types which could be viewed more suitable for high yield because this class escaping the diseases and heat stress in Egypt. The accessions clustered mainly around the four main categories (Fig. 13) very early 17.5% ,early 37.6, medium 39% , and late 1% in the six rowed types and 14 %,7.55% ,37.9% and 6.7% in the two rowed types .

F7+8+9

f10+11+12

14- Flag leaf anthocyanin

The accessions clustered mainly around the two main categories (Fig. 14) absent 71.1% and present 55.1% for six rowed barley while , the categories apsent around 28.9% and the second categories 44.9% for the two rowed types barley.

Correlation among barley characters

The phenotypic correlation coefficients estimated in six and two rowed barley for all pairs of studied are presented in tables (2 and 3) .The interrelationships showed positive and significant phenotypic correlation between barley grain yield /plant and each of plant height ,spike length ,number of kernels /spike ,100 kernel weight and number of spikes /plant in the six and two rowed barley .However the phenotypic correlation of grain yield /plant with each of flag leaf glaucosty sheath ,ear glaucosty and grain speculation of inner lateral nerves of dorsal were negative and significant in the six rowed barley .Plant height showed positive significant phenotypic correlation with each of spike length ,number of kernels /spike 100 kernel weight and number of spikes /plant in the six and two rowed barley while the plant height negative significant phenotypic correlation with only 100 kernel weight in the six barley . Similar results were previously drawn by Kishor and Yoshida (1996) and Woldeyesus Sinebo (2002) .

Spike length was significantly and positively correlated with number of kernels /spike, 100 kernel weight and number of spikes /plant in the six and two rowed barley .Number of kernels /spike showed positive signicant phenotypic correlation with 100 kernel weight and number of spikes /plant in the six and two rowed .100 kernel weight showed positive significant phenotypic correlation with number of spikes /plant in the six and two rowed barley .Flag leaf anthocyanin was significantly and negatively correlated with ear glaucosty and grain speculation of inner lateral nerves of dorsal side of lemma while significant and positively with awns intensity of anthocyanin coloration of tips in the six rowed correlation .However the flag leaf anthocyanin was significantly and positively correlated with awns intensity of anthocyanin coloration of tips in the two rowed barley .Positive and significant phenotypic correlation coefficient was found between flag leaf glaucosty sheath and each of awns intensity of anthocyanin coloration of tips in the two rowed barley and ear glaucosty in the two and six rowed barley .However the phenotypic correlation of flag leaf glaucosty sheath with each of number of kernels /spike in the six rowed barley were significant and negative phenotypic correlation .Plant growth habit showed negative and significant phenotypic correlation with awns intensity of anthocyanin coloration of tips in the six and two rowed barley ,while positive and significant with number of kernels /spike in the six rowed barley .It is worth mentioning that the significantly positive phenotypic correlation coefficients obtained herein between grain yield and each of number of spikes /plant number of kernels /spike ,100 kernel weight ,spike length and plant height in the six and two rowed barley indicated the the increases of these attributes may considerably increase the grain yield .In addition it could be attribute the significance of correlation to the common genetic control and peliotropic or linkage.Therefore ,it is possible to increase the efficiency of selection for yield by indirect

selection via number of spikes /plant ,number of kernels /spike ,100 kernel weight ,spike length and plant height which could be used as selection criteria for improving barley yield .On the other hand ,the negative correlation between yield and each of grain speculation of inner lateral nerves of dorsal emphasized the point that selection for these characters should be avoided when selection is aimed to increase barley grain yield .It could be stated that the knowledge of the phenotypic correlation help the breeder to improve the efficiently of selection by using the favorable combinations of characters and to minimize the regarding effect of negative correlation. These results are in the same line with those reported by Kishor and Yoshida (1996), and Martinez and Foster. 1998

Path coefficient analysis :

Further information of the relative importance of yield related characters on total grain yield were determined path coefficient analysis in the six and two rowed barley .In this analysis barley grain yield was considered the resultant variable and plant height ,spike length ,number of kernels/spike ,number of spikes /plant and 100 kernel weight were causal variables .As shown in table (4) in the six rowed barley ,number of spikes /plant exhibited the highest phenotypic direct effect (15.420%)followed by number of kernels/spike (7.321%) .The indirect effect was the highest value for number of kernels /spike via number of spikes /plant (20.254%) followed by number of spikes /plant via 100 kernel weight (7.826%) and then spike length via number of kernels /spike (4.848%).The direct and indirect joint effects of the five studied characters amounted to 85.757% for phenotypic grain yield variability. At the two rowed barley ,the results clearly show that number of spikes /plant had the highest phenotypic direct effect (19.846%) followed by 100 kernel weight .In this connection , Slavko and William (1982) showed that number of spikes/plant and 100 grain weight, had positive effect on grain yield .The indirect effect was the highest value for number of kernels /spike via number of spikes /plant (7.756%) followed by spike length via number of spikes /plant (4.161%)and then plant height via number of spikes /plant (1.849%). The direct and indirect joint effects of the studied characters amounted to 92.737% for phenotypic grain yield variability. These results are in the same line with those reported by Hamada (1988) ;Garcı´a *et al* (1991); Atlin *et al* (2000) Woldeyesus (2002) Shahinnia *et al.* (2005) and Morad (2006).The path analysis showed that the three characters had high direct effect and /or indirect effect through each others on grain yield /plant ,so, the barley breeder might take them into consideration in the selection programs aiming to improve new barley .

T2

T3

T4

f13+14

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تقييم وتوصيف الاصول الوراثية للشعير فى البنك القومى للجينات والموارد الوراثية

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البنك القومى للجينات والموارد الوراثية - قسم المحاصيل

اجريت هذة الدراسة خلال موسمى ٢٠٠٣/٢٠٠٤ ،٢٠٠٤/ ٢٠٠٥ بهدف تقييم وتوصيف ١٠١٢ اصل وراثى من الشعير للصفات المورفولوجية والمحصول ومكوناتة . كان محصول الحبوب للنبات فى الاصول الوراثية للشعير وخاصة الشعير الثنائى حوالى ٢٧ % من جملة الاصول الوراثية كلها فى المدى ٨ - ١١ جرام للنبات بالمقارنة مع الشعير السداسى الذى كان يمثل نسبة ٢٦ % فقط وكان الشعير الساسى يمثل نسبة ١٧,١% فى المدى ١٦- ١٩ جرام والشعير الثنائى ١٦,٥ % .

أظهرت أهم النتائج أن معاملات الارتباط المظهرية بين محصول الحبوب / للنبات وكل من طول النبات وطول السنبلة وعدد حبوب السنبلة ووزن ١٠٠ حبة وعدد السنابل /للنبات كانت موجبة ومعنوية فى الشعير الثنائى والسداسى بينما كان سالبا وغير معنويا بين محصول الحبوب للنبات وكل من شمعية ورقة العلم وشمعية السنبلة ودرجة تعريق العروق الداخلية على السطح الظهريللعصيفة السفلى. وقد اظهر تحليل معامل المرور أن كلا من عدد السنابل للنبات وعدد الحبوب /سنبلة ووزن المائة حبة هي أهم المكونات التي تساهم فى تباين المحصول وبالتالي يمكن استخدام هذه المكونات فى تربية أصناف جديدة من الشعير .

Table (1). General mean, coefficient of variability ,variance and range for agronomic and morphological characters measured in six-rowed and 2- rowed barley accessions

characters	6-rowed (698)				2-rowed(314)			
	Mean ± SD	CV	variance	range	Mean ± SD	CV	variance	range
Plant growth habit	4.192 ±2.543	50.406	4.465	1-9	4.732±2.187	46.222	4.784	1- 9
Flag leaf anthocyanin	5.315 ±3.630	60.030	10.180	1-9	4.592±3.985	52.824	5.884	1- 9
Plant frequency of plants with recurved flag leaves	4.857 ±2.130	43.849	4.536	1-9	5.414±2.391	44.171	5.719	1- 9
Flag leaf glaucosity of sheath	5.570 ±1.519	27.280	2.309	1-9	5.554±1.695	30.523	2.874	1- 9
Awns intensity of anthocyanin coloration of tips	4.668 ±2.122	31.8.33	4.503	1-9	5.515±2.424	43.960	5.880	1- 9
Ear glaucosity	6.112 ±1.402	54.177	10.965	1-9	5.789±1.695	29.289	2.876	3 - 9
spike length excluding awns	6.761 ±1.807	26.721	3.264	4-18	7.213 ± 2.189	30.358	4.795	4-14
Grain spiculation of inner lateral nerves of dorsal side of lemma	4.877 ±1.493	30.612	2.229	1-7	4.624 ± 1.541	33.335	2.376	3-7
Plant height	82.948 ±4.814	9.582	63.177	63- 109	92.359 ± 3.363	7.755	51.311	63 - 99
No. of kernels/ spike	40.704 ±5.612	23.82	53.497	21.9- 41.83	30.868 ± 5.435	28.892	79.540	25.67- 53.97
1000 kernel weight	31.890 ±4.004	21.275	46.031	19.93-41.90	31.761 ± 4.096	23.839	56.784	21.9 - 41.83
No. of spikes/ plant	9.714 ±2.891	63.750	38.356	4.50 -15.67	9.578 ± 3.011	49.047	22.069	4.5 - 15.67
Grain yield/ plant	13.739 ± 4.026	67.580	86.209	6.54 -21.75	13.605 ± 4.020	59.333	65.163	6.54 - 21.57
Heading date	91.130 ±3.037	6.872	39.224	74 - 99	91.159 ± 3.110	10.388	89.674	82 - 99

Table (2) Correlation coefficient between agronomic characters in 698 landraces of six rowed barley

Traits	A	B	C	D	E	F	G	H	I	J	K	L	M	N
A		-0.036	0.087	-0.067	-0.145*	-0.081	-0.090	0.084	-0.007	0.143*	0.092	0.065	0.058	0.032
B			-0.006	-0.091	0.151*	-0.141*	0.077	0.047	-0.154*	0.036	-0.017	-0.021	0.032	0.003
C				-0.073	-0.088	-0.071	0.070	0.028	0.077	0.048	0.024	0.013	0.007	0.080
D					0.048	0.301*	-0.015	-0.016	-0.033	-0.127*	-0.094	-0.104	-0.141*	-0.011
E						0.012	0.108	0.032	-0.057	-0.094	-0.089	-0.045	-0.084	-0.091
F							0.072	0.023	0.036	-0.081	-0.041	-0.031	-0.152*	-0.002
G								0.234*	-0.016	0.356**	-0.256*	0.641**	0.563**	0.003
H									-0.101	0.663**	0.565**	0.432**	0.596**	-0.013
I										-0.104	-0.102	-0.115	-0.154*	0.138*
J										0.092	0.120*	0.087	0.042	-0.024
K											0.458**	0.953**	0.863**	0.345**
L												0.974**	0.689**	-0.044
M													0.962**	-0.060
N														0.021
O														

***,** significant at the 5 % and 1 % level ,respectively**

Where :

A Plant growth habit
B Flag leaf anthocyanin
C Plant frequency of plant with recuved flag leaves
D Flag leaf glaucosty sheath
E Awns intensity of anthocyanin coloration of tips
F Ear glaucosty.
G Plant height.
H Spike length excluding awns.
I Grain speculation of inner lateral nerves of dorsal side of lemma
J No. of kernels/ plant
K 100 kernel weight
L No. of spikes/ plant
M Grain yield/ plant
N Heading date

Table (3) Correlation coefficient between agronomic characters in 314 landraces of two rowed barley

Traits	A	B	C	D	E	F	G	H	I	J	K	L	M	N
A		-0.051	-0.031	-0.030	-0.193*	0.109	-0.056	-0.054	-0.035	0.084	0.067	0.049	0.009	-0.038
B			0.007	0.089	0.127*	0.017	0.018	0.023	-0.032	-0.018	-0.039	-0.020	0.006	-0.005
C				0.011	-0.013	0.015	-0.007	0.043	0.029	-0.056	-0.011	-0.031	-0.041	-0.012
D					0.126*	0.149*	-0.054	-0.012	-0.037	-0.045	0.030	0.017	-0.048	-0.022
E						-0.097	0.034	0.032	-0.046	-0.005	0.028	0.027	0.040	0.060
F							-0.043	-0.038	0.005	-0.088	-0.030	-0.024	-0.103	-0.006
G								0.432**	0.022	0.211*	0.396**	0.324**	0.463**	0.022
H									0.022	0.569**	0.775**	0.434**	0.339**	-0.018
I										-0.087	-0.006	-0.007	-0.017	0.033
J										-0.072	-0.046	-0.094	-0.091	-0.048
K											0.865**	0.789**	0.748**	0.008
L												0.886**	0.912**	0.042
M													0.843**	0.106
N														0.114
O														

***,** significant at the 5 % and 1 % level ,respectively .**

Where:

A Plant growth habit
B Flag leaf anthocyanin
C Plant frequency of plant with recuved flag leaves
D Flag leaf glaucosty sheath
E Awns intensity of anthocyanin coloration of tips
F Ear glaucosty.
G Plant height.
H Spike length excluding awns.
I Grain speculation of inner lateral nerves of dorsal side of lemma
J No. of kernels/ plant
K 100 kernel weight
L No. of spikes/ plant
M Grain yield/ plant
N Heading date

Table (4).Direct and joint effects of yield attributes as percentage of yield for the six and two rowed barley

Characters		Six rowed	Two rowed
Plant height	$X1^2$	4.139031	0.410368
Spike length	$X2^2$	1.826641	1.158061
Number of kernels /spike	$X3^2$	7.320542	1.217362
Number of spikes /plant	$X4^2$	15.4265	19.84615
1000-grain weight	$X5^2$	1.046406	14.98068
Plant height vs Spike length	X_1X_2	1.286832	0.595616
Plant height vs Number of kernels /spike	X_1X_3	3.919232	0.29827
Plant height vs Number of spikes /plant	X_1X_4	10.24403	1.849269
Plant height vs 1000-grain weight	X_1X_5	-1.06554	-1.96371
Spike length vs Number of kernels /spike	X_2X_3	4.848883	1.351195
Spike length vs Number of spikes /plant	X_2X_4	4.586422	4.161248
Spike length vs 1000-grain weight	X_2X_5	1.562267	-6.456
Number of kernels /spike vs Number of spikes /plant	X_3X_4	20.25481	7.756309
Number of kernels /spike vs 1000-grain weight	X_3X_5	2.535229	-7.38791
Number of spikes /plant vs 1000-grain weight	X_4X_5	7.826593	-30.554
Residual		14.24212	7.26294
R^2		85.75788	92.73706
Total		100.0	100.0