

Morphological Diversity in *Hordeum spontaneum* C. Koch of Northern Jordan (Ajloun Area)

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Abstract: The objectives of this study were to locate and collect wild barley accessions of the species (*Hordeum spontaneum* C. Koch) from certain regions in northern Jordan (Ajloun area) to characterize the morphological diversity of the collected barley accessions. Fifty samples representing five populations of *Hordeum spontaneum* C. Koch from northern Jordan (Ajloun area) were included in this study and were subjected to analysis for the number of roots character, plant height, spike length, root length, grain width, number of grains per spike, grain length, number of leaves and the number of days for flowering. Significant variation between samples of the whole collection was observed for all of the measured quantitative characters. Based on the calculated coefficient of variation, the number of roots character expressed the highest variability (C.V. ~ 48%) and was followed by plant height (C.V. ~ 35%), spike length, root length, grain width, number of grains per spike, grain length, number of leaves and the number of days for flowering respectively. Species *Hordeum spontaneum* C. Koch has considerable amounts of variation for investigated morphometric characters, which can be useful in selecting for these characters especially for spike length, root number and plant height in the arid regions of Jordan.

Key words: *Hordeum spontaneum* • Morphology • Diversity • Jordan

INTRODUCTION

Barley (*Hordeum* L) is one of the important crops in the world, ranking fifth in the world production that is used for animal feed, brewing malts and human consumption [1].

Hordeum L. is a widely distributed genus of the tribe Triticeae of the Poaceae (Graminae) family. There are about 45 species and subspecies, most of which represent weedy annual or perennial grasses, found throughout the temperate zones of both northern and southern hemispheres [2]. *H. spontaneum* C. Koch, the only recognized wild progenitor of cultivated barley (*Hordeum vulgare*), is a self-pollinating diploid ($2n = 14$) originates from the Fertile Crescent areas of southwest Asia [2].

Different approaches were used to assay genetic diversity in crop plants including morphological traits and isozyme electrophoresis [3].

The objectives of this study were to locate and collect wild barley accessions of the species (*Hordeum spontaneum*) from certain regions in northern Jordan (Ajloun area) to characterize them

morphologically and evaluate and improve such technique as suitable strategies for barley germplasm characterization.

MATERIALS AND METHODS

Plant Material: This study was conducted between 2000-2002 in northern Jordan (Ajloun area). Grains, represented five populations of *H. spontaneum* C. Koch, were collected from various locations in the northern Jordan (Ajloun area which situated between 32°20' North to 35°45' East with average 760 meters above sea level) on August 18, 2000, which covered five locations, (representing five different populations). These locations were Zubyia, Barkash, Wadi Rayan, Wadi Baun and Samtah (Table 1).

Morphological Evaluation: To provide plant material for morphological evaluation the collected grains were kept at 4°C for 48 hrs for chilling after they were photographed. One hundred grains, each originally from a single spike (50 grains from 10 spikes per each location), were planted on August 23, 2000 in the green house at Yarmouk

Table 1: Sites of Collection (Coordinates and Description)

SITE	LON	LAT	ALT(Meter)	Site Description
Zubya	35° 44' 11" E	32° 26' 04" N	785	Medium degradation of environment, high erosion, soil in pockets, vegetation mainly fruit trees and few shrubs.
Barkash	35° 44' 13" E	32° 26' 07" N	805	Grazed over land, vegetation mainly annuals with trees of <i>Quercus calliprinos</i> and <i>Pistacia</i> , highly degraded.
Wadi Rayan	35° 41' 18" E	32° 24' 12" N	336	Cultivated area with orchard and vinyards, the slopes of the valley medium degraded.
Wadi Baun	35° 42' 30" E	32° 23' 18" N	576	High degradation, high erosion, soil in pockets, vegetation mainly herbaceous and shrubby with few scattered trees, the slope is about 65 degree.
Samtah	35° 50' 13" E	32° 23' 38" N	1040	Grazed over land, vegetation mainly annuals with few scattered trees like <i>Quercus calliprinos</i> and <i>Pistacia</i> , highly degraded.

LON: Longitude, LAT: Latitude, ALT: Altitude. E: East, N: North

University. In addition four grains of the same spike of the same species of the same location were planted on November 6, 2001. Grains were planted in small pots (20×20 cm) (50 grains in each) in ordinary soil with betemous in a depth of 3-5 cm from soil surface under green house conditions (at temperature 25° to 27°C, 65% moisture and moderate sunlight intensity).

Ten barley seedlings (3 week-old) from each accession were harvested after being photographed in the green house. The harvesting was done on September 13, 2000. The rest of the barley seedlings were harvested on March 14, 2000. Nine quantitative characters were recorded for each plant, which were: (1) plant height (in centimeters measured from the base of the main culm to the top of the plant), (2) number of leaves, (3) roots number, (4) roots length, (5) spike length (in centimeters) of the main spike measured from the base of the spike to the apex of the terminal spikelet, awns are not included), (6) number of grains per spike (number of fertile spikelets per spike in the spike of the main culm), (7) grains length in millimeter, (8) grains width in millimeter and (9) days of flowering.

Characters (spike length, number of grains per spike and days of flowering) were recorded for mature plants harvested on March 14, 2001). Also, the four barley seedlings were harvested each of the individual spike on December 6, 2001.

Statistical Analysis of Morphological Data: The morphological data were analyzed and summarized using a number of preliminary descriptive statistics (mean, range, standard deviation and coefficient of variation for all quantitative variables). The coefficient of variation (C.V.) is simply the standard deviation expressed as a percentage of the mean:

$$C.V. = \frac{\text{Standard deviation}}{\text{Mean}} \times 100$$

It is possible to use C.V. to compare the relative amount of variation in traits having different measurement units.

Morphometric variables were subjected to analysis of variance (one way ANOVA) to compare more than two populations or samples.

RESULTS

Significant variation between samples of the whole collection was observed for all of the measured quantitative characters. Table 2 presents a number of descriptive statistics (i.e., minimum, maximum values, mean ± standard deviation and the coefficient of variation) for each of the studied quantitative characters. Based on the calculated coefficient of variation, the number of roots character expressed the highest variability (C.V. ~ 48%) and was followed by plant height (C.V. ~ 35%), spike length, root length, grain width, number of grains per spike, grain length, number of leaves and the number of days for flowering respectively.

The arrangement of these characters, according to their variation between the sampled populations of *H. spontaneum* C. Koch, as indicated by their “f” values and the highest value was that for plant height, followed by the number of days for flowering, the number of grains per spike, root length, spike length, number of roots, grain length, grain width and the number of leaves respectively.

In the morphological assay, unique interesting character was observed in one of individual plants that belong to Wadi Rayan accession (named Rayan 4) in

Table 2: Minimum values, mean, standard deviation, maximum values, coefficients of variation and ANOVA results for nine quantitative characters of *H. spontaneum* through the whole collection

Character	Descriptive Statistics					One way ANOVA		
	Minimum	Mean	Maximum	SD	C.V.	MS between population	MS within	F ratio
Plant height (cm)	23.00	27.64	36.00	9.60	34.73%	42.11	1.35	31.19
No. of leaves	2.00	2.46	3.00	0.30	12.20%	0.59	0.18	3.28
Root length (cm)	6.30	9.69	13.00	1.75	18.06%	11.97	0.79	15.15
No. of roots	3.00	3.90	6.00	1.89	48.46%	1.93	0.49	3.94
Grain length (mm)	0.40	1.32	1.50	0.20	15.15%	9.13	2.37	3.85
Grain width (mm)	0.22	0.62	0.80	0.10	16.13%	5.67	1.60	3.54
Spike length (cm)	5.50	9.04	13.00	1.98	21.90%	12.73	1.66	7.67
No. of grains per spike	14.00	23.48	32.00	3.68	15.67%	53.85	3.18	16.93
Days for flowering	189.00	198.20	203.00	4.71	2.38%	961.10	32.55	29.53

F_{0.05} (8, 41) = 2.18, MS: Mean Square, SD: Standard Deviation, C.V: Coefficient of variation, Total number of collected samples = 50

which two spikes were carried by this individual plant and not one spike as is the usual case. This character is not documented to be observed in barley. The individual plant (Rayan 4) was left in the green house until harvesting to see if this unique character still holds.

DISCUSSION

Although the morphological characterization was not the ultimate goal of this study and it was carried out to be the base line to interrupt the genetic analysis and assay [4], a considerable morphometric variation (Quantitative morphological characters) was found in *H. spontaneum* populations in northern Jordan (Ajloun area). This genetic diversity was further demonstrated and analyzed by two sets of DNA-based markers (RAPD and AFLP) analysis that resulted in a significant amount of variation among the five studied *H. spontaneum* accessions.

Since all investigated morphometric characters contributed either directly or indirectly to the final yield of the plant, expressed by most of these characters, provided a very useful and wide scope for selection to plant breeders. Plant height, number of roots, spike length and days for flowering were all highly and positively correlated with each other and at the same time all were correlated with environmental factors. This considerable morphometric variation was due to the diversity in habitats of *H. spontaneum* and the surrounding environmental conditions such as (Temperature, moisture, altitude, soil types and depth and amount of rainfall) as indicated by some studies [5, 6, 7].

Species *Hordeum spontaneum* C. Koch has considerable amounts of variation for investigated morphometric characters, which can be useful in

selecting for these characters specially for spike length, root number and plant height in the arid regions of Jordan.

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