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Correlation and Path Analysis in Barley under Rainfall Conditions

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Abstract

Some genotypes of six-rowed barley (*Hordeumvulgare* L.) were cultivated under rainfall conditions at two winter growing seasons 2012-2013 and 2013-2014 in the fields of Agriculture Research Station at Qlyasan, Faculty of Agricultural Sciences, University of Sulaimani in order to study the relationships between some agronomic traits and to identify the most important traits of a direct effect of the grain yield to be adopted as a criterion for selection. Highly significant and positive correlation were present between grain yield and all characters at both seasons except straw yield which was not significant at the first season and it was significant and positive at the second season, and harvest index at the first season which was significant and positive.Maximum positive direct effect in grain yield recorded by biological yield at both seasons, while maximum indirect effect recorded by 1000-grain weight via biological yield at the first season and straw yield via biological yield at the second season.

Introduction

Barley (*Hordeumvulgare* L.) is a common cereal used as food and as a feed crop, and the fourth most produced cereal worldwide [1]. Barley (*Hordeumvulgare* L.) is the major cereal in many dry areas of the world and is vital for the livelihoods of many farmers. Barley is an annual cereal crop and grown in environments ranging from the desert of the Middle East to the high elevation of Himalayas[2]. Of the need for new varieties, many studies aimed at creating improved, new genotypes have recently been conducted. A considerable number of grain production studies on barley include statistical correlations between morphological characteristics and grain yield. Although these correlations are helpful in determining the principal components influencing final grain yield, they provide an incomplete representation of the relative importance of direct and indirect influences on the individual factors involved [3].Path coefficient and correlation analyses are used widely in many crop species by plant breeders to define the nature of complex interrelationships among yield components and to identify the sources of variation in yield. Knowledge derived in this way can be used to develop selection criteria to improve grain yield in relation to agricultural practices [4,5,6,7,8]. A number of barley researchers sought to explain the relations of yield-related components by using path coefficient analysis [9,10,3,11,12]. These researchers and others obtained results that included some discrepancies. Some studies reported that grain yield was determined by three yield components, e.g., spike number per m^2, kernel number per spike and kernel weight per spike [10]. Some studies concluded that spike number per m^2 was the primary determinant of grain yield in barley [9].The aim of the study is to determining the relationship among studied characters and estimating the direct effect and indirect effect of the yield components in the grain yield.

Materials and Methods:

The present study was carried out in the fields of Agriculture Research Station at Qlyasan, Faculty of Agricultural sciences- University of Sulaimani, during winter seasons of 2012-2013 and 2013-2014. To study six genotypes of six-rowed barley (*Hordeumvulgare*L.) were used namely:

1- ESP/3/RHODES/CI14100/LINEE527/4/PETUNIA1 CBSS99Y00398T-0TOPM-5Y-1M-1Y-2M-0Y

2- ATACO/BERMEJO/HIGO/3/CLN-B/80.5138//…CBSS99M00320T-L-2M-1Y-1M-0Y

3- ALPHA-BAR/DURRA//CORACLE/3/ALELI/4/… CBSS99Y00032S-11Y-2M-2Y-1M-0Y

4- EBC(A)/PALTON//CABUYA CBSW99WM00073T-AA-1M-1Y-1M-0Y

5- QUINN/ALOE//CARDO/3/CIRU CBSS99M00038S-11M-1Y-1M-0Y

6- Check variety (Arivate)

The experiment was arranged as split plot layout in RCBD with three replicates. The six genotypes of barley were implemented in the main plots and the cutting treatments (cutting and non-cutting) were implemented in the sub plots. Each main plot consisted of two subplots with 4 m width by 3 m length, each subplot size was (1×4) m^2 and each sub plot consist of four rows of 4 m long and 0.25 m between rows.Grains of cultivars has been obtained from Bakrajo Research Center in Sulaimani.

Studied Characteristics:

No. of spikes/m^2, 1000-grain weight (g), straw yield (kg/ha), biological yield (kg/ha), harvest index and grain yield (kg/ha).

Correlation Analysis:

The correlation coefficient was conducted to determine the degree of association of characters with yield and also among themselves in each Season and at cutting and non-cutting treatments. You must add these results separately. Phenotypic correlations were computed between characters in each Season and at cutting and non-cutting treatments by using the formula given by Singh and Chaudhary (1985) [13].

Path Coefficient Analysis:

The path coefficient analysis was carried out as suggested by Dewey and Lu (1959) [14]. Grain yield was kept as resultant variable and other traits as causal through (Analysis of Moment Structures) AMOS Ver. 18 Software.

Results and Discussion:

Data in Tables (1) explain the averages of the interaction between genotypes and cutting treatments for studied characters at both seasons. Regards to no. of spike/m^2 maximum value recorded by the interaction of genotype 3 coupled with non cutting at both seasons recording 572.080 and 719.220 respectively. Concerning 1000-grain weight, maximum value reached 41.420 g recorded by the interaction between genotype 6 associated with non cutting at the first season, while at the second season it was 43.980 g recorded by the interaction between genotype 4 and non cutting treatment. Maximum straw yield recorded 1162.230 Kg at the first season by the interaction of genotype 1 with non cutting treatment, while at the second season it was reached 14143.330 Kg by the interaction between genotype 5 and non cutting treatment. The highest biological yield recorded by the interaction of genotype 1 with non cutting treatment reached 18644.220 Kg at the first season, while at the second season it was reached 20854.240 Kg by the

interaction genotype 1 and non cutting treatment. The interaction between genotype 2 and non cutting treatment gave maximum value due to harvest index reaching 0.450 at the first season, while at the second season it was 0.41 recorded by genotype 4 with non cutting treatment. Maximum grain yield was 7252.430 Kg recorded by genotype 2 coupled with non cutting treatment at the first season, while at the second season reached to 9012.220 Kg recorded by genotype 4 with non cutting treatment.

The correlation coefficient among studied characters at both season present in table (2).Regarding to the first season highly significant and positive correlation was present between no. of spike/ m^2 with 1000-grain weight, harvest index and grain yield recording 0.808, 0.735 and 0.770 respectively, while positive and significant correlation was recorded between no. of spike/m^2 and biological yield with 0.624. The character 1000-grain weight correlated high significantly and positively with grain yield recording 0.748 and correlated significantly and positively with biological yield recording 0.697. Highly significant and positive correlation was recorded between biological yield and grain yield with 0.940. Harvest index showed significant and positive correlation with grain yield recording 0.629. At the second season highly significant and positive correlation were recorded between no. of spike/m^2 with biological yield and grain yield with 0.828 and 0.870 respectively, while there were significant and positive correlation between no. of spikes/$m^2$and each of 1000-grain weight, straw yield and harvest index with 0.673, 0.633 and 0.577 respectively. 1000- grain weight showed highly significant and positive correlation with harvest index and grain yield recording 0.852 and 0.818 respectively, while it correlated significantly and positive with biological yield recording 0.616. Straw yield exhibited highly significant and positive correlation with biological yield with 0.906 and positive and significant correlation with grain yield recording 0.599. Highly significant and positive correlations were representing between biological yield and grain yield recording 0.880. Harvest index gave highly significant and positive correlation with grain yield recording 0.741. There was positive correlation between kernel yield and each of spike number/m^2, number of kernels/spike, while negative and significant correlation between the number of spike/m^2 and kernel weight was recorded by [15]. Grain yield showed positive correlation with above-ground biomass, number of spikes/m^2 and no. of grains/spike. Path analysis revealed positive direct effect and moderate correlation of number of spike/m^2 and no. of grains/spike with grain yield [16]. The character biological yield recorded high significant and positive correlation with harvest index and grain yield/plant showing 0.695 and 0.580 respectively, the character biological weight correlated high significantly and positively with all characters , similar results recorded previously by [17, 18].

The path coefficient analysis between studied characters and grain yield to show the direct and indirect effect in grain yield represent in Table (3) for both seasons. Regarding to the first season maximum and positive direct effect in grain yield was recorded by biological yield with 0.829 and followed by harvest index with 0.350. Maximum positive indirect effect recorded by 1000-grain weight via biological yield with 0.578 and followed by no. of spike/m^2 via biological yield also recording 0.517. Concerning to the second season biological yield gave maximum positive direct effect in grain yield recording 1.889, while maximum negative direct effecting grain yield recorded by straw yield with -1.141. Maximum positive indirect effect in grain yield recorded by straw yield via biological yield with 1.712 and followed by 1.564 for no. of spike/m^2 via biological yield, while maximum negative indirect effect in grain yield recorded by biological yield via straw yield recording – 1.034 . The path coefficient analysis showed that harvest index and biological yield had the maximum positive direct effect in grain yield of durum wheat [19]. Maximum negative indirect effect value was -0.171 produced by no. of spikes/plant via harvest index [20].

Table 1: Means of the studied character at 2012-2013 and 2013-2014 seasons

Genotypes	Cutting treatments	No. of spikes/m²	1000-grain weight (g)	Straw yield (Kg/ha)	Biological yield (kg /ha)	Harvest index	grain yield (kg /ha)
The First Season							
1	Non Cutting	488.470	39.020	11962.230	18644.220	0.360	6682.370
	Cutting	483.960	36.460	8094.720	12911.430	0.370	4817.230
2	Non Cutting	499.670	41.020	10925.250	18177.340	0.410	7252.430
	Cutting	525.430	39.160	6819.810	12377.720	0.450	5558.290
3	Non Cutting	572.080	40.220	8304.900	14333.530	0.420	6029.880
	Cutting	502.220	38.780	6629.320	10822.620	0.390	4193.480
4	Non Cutting	443.390	36.660	8480.300	13733.410	0.380	5253.750
	Cutting	409.690	35.290	7648.820	11666.820	0.340	4018.530
5	Non Cutting	330.470	34.390	6040.090	9799.910	0.380	3759.390
	Cutting	291.490	32.220	5961.080	8510.890	0.300	2549.370
6	Non Cutting	482.930	41.420	9319.330	14822.470	0.370	5503.480
	Cutting	438.310	40.830	8538.011	12879.880	0.340	4341.420
Grand mean		**455.676**	**37.956**	**719016.404**	**13223.353**	**0.376**	**4996.635**
Standard deviation		**79.964**	**2.934**	**2462345.398**	**3030.475**	**0.040**	**1321.827**
The Second Season							
1	Non Cutting	397.780	37.050	10776.000	16463.330	0.340	5660.440
	Cutting	367.670	35.540	8406.880	12711.350	0.330	4304.440
2	Non Cutting	417.780	40.310	9754.770	15743.480	0.380	5988.550
	Cutting	403.110	38.250	7911.770	11974.440	0.350	4304.660
3	Non Cutting	719.220	40.560	12390.660	20854.240	0.380	8685.550
	Cutting	685.440	38.680	10752.330	17280.860	0.380	6528.550
4	Non Cutting	759.780	43.980	12862.110	21875.660	0.410	9012.220
	Cutting	734.440	41.790	12456.550	20063.120	0.380	7939.880
5	Non Cutting	503.330	35.070	14143.330	19400.510	0.290	5588.440
	Cutting	478.440	33.010	10848.660	14824.550	0.290	4198.110
6	Non Cutting	583.220	40.770	13437.660	20018.310	0.330	6580.440

Cutting	565.100	39.150	11811.330	17149.770	0.330	5338.440
Grand mean	**551.276**	**38.680**	**11296.004**	**17363.302**	**0.349**	**6177.477**
Standard deviation	**144.313**	**3.110**	**1928.233**	**3185.881**	**0.038**	**1651.596**

Table 2: Correlation coefficient among the studied character at both seasons

Characters	No. of spikes/m²	1000-grain weight (g)	Straw yield (Kg/ha)	Biological yield (kg /ha)	Harvest index
The First Season					
1000-grain weight (g)	0.808**				
Straw yield (Kg/ha)	-0.068$^{n.s}$	0.309$^{n.s}$			
Biological yield (Kg /ha)	0.624*	0.697*	-0.035$^{n.s}$		
Harvest index	0.735**	0.532$^{n.s}$	-0.283$^{n.s}$	0.332$^{n.s}$	
Grain yield (kg /ha)	0.770**	0.748**	-0.155$^{n.s}$	0.940**	0.629*
The Second Season					
1000-grain weight (g)	0.673*				
Straw yield (Kg/ha)	0.633*	0.300$^{n.s}$			
Biological yield (kg /ha)	0.828**	0.616*	0.906**		
Harvest index	0.577*	0.852**	-0.044$^{n.s}$	0.369$^{n.s}$	
Grain yield (kg /ha)	0.870**	0.818**	0.599*	0.880**	0.741**

**. Correlation is significant at the 0.05 level (2-tailed) ,* $t_{0.05}(10)=2.228$

***. Correlation is significant at the 0.01 level (2-tailed) ,* $t_{0.01}(10)=3.169$

Table 3: Path coefficient analysis among the studied character at both seasons

Characters	No. of spikes/m²	1000-grain weight (g)	Straw yield (Kg/ha)	Biological yield (kg /ha)	Harvest index
The First Season					
No. of spikes/m²	**0.003**	0.002	0.000	0.002	0.002
1000-grain weight (g)	-0.009	**-0.011**	-0.003	-0.008	-0.006
Straw yield (Kg/ha)	0.002	-0.007	**-0.024**	0.001	0.007

Biological yield (kg /ha)	0.517	0.578	-0.029	**0.829**	0.275
Harvest index	0.257	0.186	-0.099	0.116	**0.350**
Grain yield Correlation	***0.770*****	***0.748*****	***-0.155$^{n.s}$***	***0.940*****	***0.629****
The Second Season					
No. of spikes/m²	**0.057**	0.038	0.036	0.047	0.033
1000-grain weight (g)	-0.017	**-0.026**	-0.008	-0.016	-0.022
Straw yield (Kg/ha)	-0.723	-0.343	**-1.141**	-1.034	0.050
Biological yield (kg /ha)	1.564	1.163	1.712	**1.889**	0.698
Harvest index	-0.010	-0.014	0.001	-0.006	**-0.017**
Grain yield Correlation	***0.870*****	***0.818*****	***0.599****	***0.880*****	***0.741*****

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