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Relationships among Nut Characteristics in the Important Hazelnut Cultivars

[1]Ali Islam, [2]Ahsen Işık Özgüven, [1]S.Z. Bostan, [1]Turan Karadenız
[1]Department of Horticulture, Faculty of Agriculture,
Karadeniz Technical University, 52100-Ordu, Turkey
[2]Department of Horticulture, Faculty of Agriculture,
Çukurova University, 01330-Adana, Turkey

Abstract: This research was carried out on five important hazelnut cultivars (Tombul, Palaz, Kalınkara, Çakıldak and Uzunmusa), which is in round shape group, between 1999-2001 years. Nut characteristics such as nut number per cluster, nut size, nut weight, shell thickness, kernel percentage, kernel weight, kernel cavity were investigated. Correlation coefficients among these characters, both direct and indirect effects were determined. In the result of this study it was found that nut number per cluster and kernel percentage increased; whereas nut size, shell thickness and kernel cavity size decreased. Connected with shell thickness increase, nut weight increased, but kernel percent decreased. Small nuts had thinner shell and higher kernel percentage.

Key words: Turkish hazelnut, filbert, correlation, kernel percent, nut size, shell thickness, nut number per cluster

INTRODUCTION

The origin of hazelnut is Anatolia, the Black Sea Region where the hazelnut cultivation began. Therefore, hazelnut growing was started as a traditional method and now, this status is continued. Cultivars grown in this region was revealed with grower's selection. This case gives an important advantage to breeders. High yield, high kernel percentage, good kernel, thinner shell, round shape, little kernel cavity are desired in hazelnut breeding. It is priority wished round shape in hazelnut consumption[1-3].

Traits of plants are generally correlated. Correlation studies on various agricultural and physiological traits of the plants aid in developing criteria for selection of the desired traits in crop improvements programs[4]. Path analysis is a straightforward extension of multiple regressions. Its aim is to provide estimates of the magnitude and significance of hypothesized causal connections between sets of variables. This is best explained by considering a path diagram[5].

Path analysis is an extension of the regression model, used to test the fit of the correlation matrix against two or more causal models which are being compared by the researcher. The model is usually depicted in a circle-and-arrow figure in which single arrows indicate causation. A regression is done for each variable in the model as a dependent on others which the model indicates are causes. The regression weights predicted by the model are compared with the observed correlation matrix for the variables and a goodness-of-fit statistic is calculated. The best-fitting of two or more models is selected by the researcher as the best model for advancement of theory[6].

Correlation coefficient gives us information about correlation between two variables. If there are many variables, it may not be explained to interactions. Relation between two variables may depend on third variable. On account of the third variable, interaction may appear. The use of path analysis provides a plausible explanation of observed correlations by modeling the cause and effect relations between the variables. Thus, it is possible to analysis the correlation coefficient of variables in the form of variance and covariance using path analysis[7].

Selection studies is tired. To make easy the study is determined of relationship among traits. The aim of this research is to determine relationships among important nut quality characteristics and to ease difficulty in breeding by some clues.

MATERIALS AND METHODS

This research, between 1999-2001 years, was carried out on five hazelnut cultivars, which are in round shape

Corresponding Author: Dr. Ali Islam, Department of Horticulture, Faculty of Agriculture,
Karadeniz Technical University, 52200-Ordu, Turkey
Tel: +90 452 2300556 Fax: +90 452 2251261

group such as Tombul, Palaz, Cakıldak, Kalınkara and Uzunmusa, grown in Ordu. These consist of 80% of hazelnut cultivars grown in Turkey. In this cultivars, nut number per cluster (NC), nut size (NS, mm), nut weight (NW, g), shell thickness (ST, mm), kernel percentage (KP,%), kernel weight (KW, g) and kernel cavity (KC, mm) were examined. They were calculated from records on 5400 individual samples (nuts) and the research was replicated for three times. Tarist statistical program was used.

Nut size was average nut length, nut height and nut thickness. Shell thickness was considered from central part of shell. Kernel cavity was the cavity between cotyledons.

Correlations coefficient between nut characteristics was calculated and then, direct and indirect effects were determined by path analysis.

RESULTS

In the Table 1, average of nut number per cluster was 3.73, nut size was 17.79 mm, nut weight was 2.13 g, shell thickness was 1.00 mm, kernel percentage was 54.78%, kernel weight was 1.16 g and kernel cavity was 1.79 mm.

Many of the phenotypic correlation coefficients were significant and different from other. In the Table 2, a correlation between kernel percentage and kernel weight was non-significant, a correlation between kernel percentage and kernel cavity was significant (at level 0.05) and other correlations were very significant (at level 0.01).

In the Table 3, there was negative direct effect of nut weight to kernel percentage (55.53%) and there was positive effect of kernel weight on kernel percentage (49.91%). On kernel cavity, the most direct effect was made by nut weight and kernel weight. Direct effects to kernel cavity were 45.53% for nut weight, 50.48% for kernel weight.

Direct effect to kernel weight of nut weight was 82.54%. Direct effect to kernel weight of kernel percentage was 49.89%. Indirect effect of shell thickness on kernel weight was 69.02% because of nut weight. Indirect effect of nut size to kernel weight was 84.41% because of nut weight. Indirect effect of nut number per cluster on kernel weight was 76.42% because of nut weight. Indirect effect of kernel cavity to kernel weight was 85.35% because of nut weight.

In the Table 3, a correlation coefficient was higher between shell thickness and nut weight and between shell thickness and kernel percentage than the others. The highest direct effect to shell thickness was positive aspect by nut weight 62.91%. The direct effect to shell thickness of kernel percentage was 2.18%; indirect effect was 90.51% because of nut weight. We observed an important indirect effect of nut weight.

Table 1: Minimum, maximum, average and standard deviation values in Turkish hazelnut cultivars

	KP	NC	NS	NW	ST	KW	KC
Minimum	43.08	2.00	15.02	1.37	0.69	0.76	0.00
Maximum	65.48	5.50	20.39	3.64	1.56	1.75	9.40
Average	54.78	3.73	17.79	2.13	1.00	1.16	1.79
Standard Deviation	3.66	0.65	0.81	0.33	0.14	0.15	0.99

Table 2: Correlation coefficient matrix between nut characteristics, in Turkish hazelnut cultivars

	KP	NC	NS	NW	ST	KW	KC
KP	1.000						
NC	0.135**	1.000					
NS	-0.235**	-0.292**	1.000				
NW	-0.434**	-0.244**	0.667**	1.000			
ST	-0.596**	-0.184**	0.361**	0.632**	1.000		
KW	0.018ns	-0.211**	0.617**	0.889**	0.398**	1.000	
KC	-0.077*	-0.125**	0.268**	0.311**	0.242**	0.318**	1.000

*,**: Significant at alfa level 5 and 1%, respectively; ns: non-significant

Table 3: Path coefficients of direct and indirect effects among nut characteristics

			Indirect effects						
		Direct effect	NC	NS	NW	ST	KW	KC	KP
KP	NC	0.021	0.021	-0.006	0.525	0.000	-0.408	0.003	-
	NS	0.020	-0.006	0.020	-1.436	0.000	1.194	-0.007	-
	NW	-2.154	-0.005	0.013	-2.154	-0.001	1.720	-0.007	-
	ST	-0.001	-0.004	0.007	-1.361	-0.001	0.769	-0.006	-
	KW	1.934	-0.004	0.012	-1.916	0.000	-1.934	-0.008	-
	KC	-0.023	-0.003	0.005	-0.670	0.000	0.614	-0.023	-
KC	NC	-0.020	-0.020	-0.035	0.387	-0.031	-0.337	-	-0.089
	NS	0.118	0.006	0.118	-1.057	0.061	0.984	-	0.156
	NW	-1.585	0.004	0.078	-1.585	0.107	1.419	-	0.288
	ST	0.169	0.004	0.042	-1.002	0.169	0.634	-	0.395
	KW	1.596	0.004	0.073	-1.410	0.067	1.596	-	-0.012
	KP	-0.662	-0.003	-0.027	0.688	-0.101	0.028	-	-0.662
KW	NC	-0.010	-0.010	0.003	-0.271	0.003	-	-0.002	0.066
	NS	-0.009	0.003	-0.009	0.740	-0.005	-	0.004	-0.116
	NW	1.111	0.002	-0.006	1.111	-0.009	-	0.005	-0.214
	ST	-0.013	0.002	-0.003	0.702	-0.013	-	0.003	-0.293
	KC	0.014	0.001	-0.003	0.345	-0.003	-	0.014	-0.038
	KP	0.492	-0.001	0.002	-0.482	0.008	-	-0.001	0.492
ST	NC	-0.035	-0.035	0.027	-0.325	-	0.162	-0.011	-0.002
	NS	-0.092	0.010	-0.092	0.888	-	-0.473	0.024	0.004
	NW	1.333	0.008	-0.061	1.333	-	-0.682	0.028	0.006
	KW	-0.767	0.008	-0.057	1.185	-	-0.767	0.029	0.000
	KC	0.090	0.004	-0.025	0.415	-	-0.243	0.090	0.001
	KP	-0.014	-0.005	0.022	-0.578	-	-0.014	-0.007	-0.014
NW	NC	0.009	0.009	-0.005	-	-0.003	-0.187	0.001	-0.059
	NS	0.016	-0.003	0.016	-	0.007	0.547	-0.003	0.103
	ST	0.018	-0.002	0.006	-	0.018	0.352	-0.003	0.261
	KW	0.886	-0.002	0.010	-	0.007	0.886	-0.004	-0.008
	KC	-0.011	-0.001	0.004	-	0.004	0.281	-0.011	0.034
	KP	-0.437	0.001	-0.004	-	-0.011	0.016	0.001	-0.437
NS	NC	-0.144	-0.144	-	-0.337	0.019	0.133	-0.009	0.046
	NW	1.383	0.035	-	1.383	-0.066	-0.561	0.023	-0.147
	ST	-0.105	0.027	-	0.874	-0.105	-0.251	0.018	-0.202
	KW	-0.631	0.031	-	1.231	-0.042	-0.631	0.022	0.006
	KC	0.072	0.018	-	0.431	-0.026	-0.201	0.072	-0.026
	KP	0.339	-0.019	-	-0.601	0.062	-0.011	-0.005	0.339

There were important direct positive effect to nut weight of kernel weight (96.68%) and negative effect to nut weight of kernel percentage (93.14%). Moreover there were important indirect effects to nut weight because of the other characteristics of kernel percentage and kernel weight.

It was shown in the Table 3 that there were higher correlation coefficient between nut size-nut weight, nut size-kernel weight than the others. Direct effect to nut size of nut weight was 62.46% as positive aspect. In the other side Still, indirect effects of nut weight were 49.00% because of nut number per cluster, 59.26% due to shell thickness, 57.87% on account of kernel percentage, 62.72% because of kernel weight and 55.78% on account of kernel cavity.

DISCUSSION

We observed correlations between kernel weight-nut weight and kernel weight-nut size as positive. And correlation coefficients between nut size and nut weight and between nut size and kernel weight were highly determined. Romero *et al.*[8] explained that nut weight and kernel weight, kernel size was correlated with another positive in hazelnut CVS.

Mehlenbacher[9] described that kernel percentage, the ratio of kernel weight to nut weight, is a function of shell thickness. And kernel percentage appears to be highly heritable[10]. We found correlation coefficient is as negative high between kernel percentage and shell thickness. Kernel percentage was high and negative correlated with nut light (-0.46), thin shells result in both higher kernel percentage and lighter nuts[11].

We observed that correlation between kernel percentage and kernel weight was non-significant. Bostan and Islam[12] determined that correlation between kernel percentage and kernel weight was non-significant and the other correlations were significant, in Palaz. The result of this study was similar to the presented results.

Sen[13] observed that correlation coefficients between nut weight and kernel weight and between nut weight and kernel percentage were very high in walnut. Besides, Oğuz *et al.*[14] emphasized that there was as negative an important effect of shell thickness on kernel percentage in almond.

Nuts should have highly kernel percentage, well-filled, medium or large size, thin shells, few kernel cavity, many nut number per cluster and round shape. These characteristics for hazelnut breeding were important.

In conclusion, those results were obtained from the research.

1. While shell thickness decrease, kernel percentage increases.
2. The higher nut number per cluster, the higher kernel percentage
3. Small nut has thinner shell and higher kernel percentage
4. Nut weight and kernel percentage are changed depend on shell thickness.
5. As nut size is small connected with increasing of nut number per cluster, shell thickness and kernel cavity become small as well.
6. The bigger the nut size is, the more nut weight, shell thickness and kernel cavity are.

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