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Relationships Among Some Quantitative Traits and Heritablities İn Cultivated Oats (*Avena sativa L.*)*

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Abstract: The objectives of this study were to examine the relationships among quantitative traits and to estimate their broad sense heritabilities in cultivated oats (*Avena sativa L.*). Four oat crosses were used in this experiment.

Biological yield had the highest correlation with grain yield in all F_2 populations, followed by harvest index. Grains per panicle appeared to be the most useful trait to use in indirect selection for grain yield among yield components in terms of heritability values and correlations with grain yield. Grain yield per plant significantly and positively associated with groat oil content in two oat populations.

The broad sense heritability values of groat oil content ranged from 13 to 77%. Grain yield per plant had heritability estimates between low and moderate values.

Key words: Broad sense heritability, correlation, oats (*Avena sativa L.*), quantitative trait.

Kültürü Yapılan Yulafta (*Avena sativa L.*) Bazı Kantitatif Karakterler Arasında İlişkiler ve Kalıtım Dereceleri

Özet: Bu çalışmanın amacı, kültürü yapılan yulaflarda kantitatif karakterler arasındaki ilişkileri incelemek ve karakterlerin geniş anlamda kalıtım derecelerini belirlemektir. Araştırmada dört yulaf melezinden elde edilen F_2 populasyonları kullanılmıştır.

Bütün F_2 populasyonlarında biyolojik verim, dane verimi ile en yüksek korelasyona sahip olmuştur, onu hasat indeksi izlemiştir. Kalıtım derecesi ve dane verimi ile olan korelasyon değerleri göz önünde bulundurulduğunda; salkımda dane sayısının, verim komponentleri arasında, indirekt seleksiyonda kullanma açısından en uygun karakter olabileceği görülmüştür. Dane verimi iki yulaf populasyonunda, dane yağ oranı ile önemli ve pozitif ilişkiye sahip olmuştur.

Dane yağ oranı için tesbit edilen geniş anlamda kalıtım derecesi %13 ve %77 arasında değişim göstermiştir. Dane verimi ise düşük ve orta arasında kalıtım derecesi değerleri almıştır.

Anahtar Kelimeler: Geniş anlamda kalıtım derecesi, korelasyon, yulaf (*Avena sativa* L.), kantitatif karakter.

Introduction

Increasing grain yield per unit of land area is a primary goal of small grain breeders. For oats and other cereals, grain yield is a complex trait that results from the expression of many genes and their interaction with each other and the elements of environment. In order to develop greater selection efficiency for grain yield, much research has been devoted to studying correlations between various oat plant traits and yield.

Forsberg *et al.*,(1974) and Gullord (1980) found a significant positive correlation between groat oil content and grain yield. Rosielle an Frey (1975) reported that harvest index was 43 percent as efficient as direct selection for grain yield.

Pixley an Frey (1992) used direct and indirect selection for quality indicators and agronomic traits for oat. They suggested that direct selections was always the most effective method for improving single traits.

The heritability of a metric character is one of its most important properties. It is defined as the ratio of additive genetic variance to phenotypic variance (Falconer, 1989).

Helsel (1985) pointed out that biomass was largely controlled by additive gene action and genotypic variation of the biomass was significant in all cases. He found an average 58% broad sense heritability for biomass and considered biomass as a selection criterion.

Baker and McKenzie (1972) studied heritability of oil content in F_4 lines. Heritability of oil content was high in all crosses, except, a cross between sister cultivars.

The objectives of this study were to examine the relationships among quantitative traits and to estimate their broad sense heritability in cultivated oats (*Avena sativa L.*).

Materials and Methods

Four oat crosses involving, Pendragon, N327-6, N313-2, 78-34Cn5, and Exeter cultivars, were used in this experiment. The characteristics of parental lines are given in Table 1. The crosses utilized in this study are (N327-6 x 78-34cn5), (N313-2 x Pendragon), (N313 x Exeter), and (N313-2 x 78-34Cn5). The F_2 populations of these crosses were used for correlation estimates. The

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Table 1. The characteristics of parental oat cultivars

Cultivars	Pedigree	Origin	Spring/winter	Husked/Naked	Notes
Pendragon	06765Cnl10/Bulwark	UK	W	N	Naked, medium oil
N327-6	Unknown	USA	S	H	High oil line
N313-2	Unknown	USA	S	H	High oil line
78-34Cn5	Pioneer x Oyster	USA, UK	W	H	Medium oil line
Exeter	Victory x Rusota	USA	S	H	Low oil line

variances of parents, F_1 and F_2 generations were utilized for broad sense heritability estimate. The total 614 seeds from different generations (parents, F_1 and F_2) were sown in 30 cm pots containing J No. 3 compost in a non-replicated completely randomized design in the glasshouse as a pot experiment at Welsh Plant Breeding Station on 25 th March 1992. The plants were harvested in the last week of July. Observations were recorded for 14 characters.

Statistical Analyses

Simple correlations were calculated by the general formula, $r = \sum X_1 X_2 / \sqrt{(X_1^2)\ (X_2^2)}$, where r = correlation coefficient, X_1 and X_2 two different characters.

Heritability:Broad sense heritability was estimated by using $[VF_2-VP_1+VP_2+VF_1/3]/ VF_2$. where, VP_1, VP_2, VF_1 and VF_2 were the variance of the parents, F_1 and F_2, respectively.

Results and Discussion

The Associations Among Quantitative Characters

The correlations among quantitative characters in the F_2 populations are given in Tables 2, 3, 4, and 5.

Grain yield had positive significant associations with tiller number per plant and grains per panicle in all crosses. However, the grain weight possessed significant association only in one cross. Similar results were obtained by Stoskopf and Reinberg (1966) in spring oats and barley. On the other hand, Sampson (1971) reported positive significant correlations between grain yield and yield components, though the association with seeds per panicle was more significant than with other components.

Significant associations were observed for grain yield with harvest index in all F_2 populations. These results agree with Lawes (1977) and Wych and Stuthman (1983). They found that grain yield increases in modern cultivars were due to changes in the harvest index.

In this study, grain yield was correlated more strongly with biological yield than with harvest index. It was probably the most effective character for index selection of grain yield. Similar results were obtained by Kolb et al., (1990) in oats. Helsel (1985) used biomass and harvest index as a selection criterion in oats. He reported that harvest index was more effective way of improving grain yield than biomass.

As it seen in Table 6, the associations between graot oil content and ear emergence, maturity, and grain filling period were not significant in the all F_2 populations. Similar result was obtained by Luby and Stuthman (1983).

A remarkable point here is that grain yield was significantly and positively associated with groat oil content in two populations. This agrees with Brown *et al.*, (1966), Gullord (1980), and Branson and Frey (1989).

Harvest index had significant correlation with groat oil content in the three F_2 populations, while biological yield in the two F_2 populations. Similar results were obtained by Branson and Frey (1989) for harvest index and Schipper and Frey (1991) for biological yield.

Kernel weight and kernel content possessed negative correlations with groat oil content. These results are in contrast to those of Baker and McKenzie (1972) and Luby and Stuthman (1983) for kernel content. However, it agrees with Brown *et al.*, (1966) for kernel weight.

Broad Sense Heritabilities

The broad sense heritability values of groat oil content ranged from 13 to 77% (Table 7) this agrees with Baker and McKenzie (1972).

Grains per panicle was the most heritable trait among yield components, followed by grain weight. However, Sampson (1971) found high narrow sense heritabilities for seed weight (74%), seeds per panicle (61%), panicle number (58%) in plot experiment.

Grain yield had heritability estimates between low and moderate values. This agrees with Sampson (1971).

Biological yield possessed very low heritability estimates in three F_2 populations and a moderate value in one population. This is in contrast to Helsel (1985). Harvest index was more heritable than the biological yield. Heritability values for harvest index in this study agree with Takeda and Frey (1985).

Table 2. Correlation (df=198) between quantitative characters in the N327-6 x 78Cn5 F_2 population.

1. Ear Emergence	--								
2. Maturity	0.739**	--							
3. Plant Height	0.323**	0.248*	--						
4. Panicle Length	-0..070	-0.135	0.452**	--					
5. Tiller per Plant	0.037	-0.142	0.023	0.171*	--				
6. Grains per Panicle	-0.001	0.040	0.420**	0.540**	0i174*	--			
7. Biological Yield	0.082	-0.060	0.361**	0.503**	0.721**	0.725**	--		
8. Harvest Index	-0.288**	-0.233*	0.249*	0.444**	0.176*	0.803**	0.514**	--	
9. Grain weight	-0.451**	-.0.488**	0.201*	0.441**	0.046	0.320**	0.309**	0.548**	--
10. Grain Yield	-0.027	-0.116	0.350**	0.530**	0.584**	0.847**	0.924**	0.763**	0.408**
	1	2	3	4	5	6	7	8	9

*P< 0.05 **P< 0.01

Table 3. Correlations (df=97) between quantitative characters in the N313-2 x Pendragon F_2 population.

1. Ear Emergence	--								
2. Maturity	0.708**	--							
3. Plant Height	0.461**	0.372**	--						
4. Panicle Length	-0.251*	-0.258*	0.047	--					
5. Tiller per Plant	0.146	0.012	0.065	0.148	--				
6. Grains per Panicle	0.192	0.178	0.261**	0.161	-0.034	--			
7. Biological Yield	0.274**	0.199*	0.314**	0.221*	0.744**	0.509**	--		
8. Harvest Index	-0.179	-0.074	-0.245*	0.225*	0.128	0.273**	0.183	--	
9. Grain weight	-0.190	-0.074	-0.175	0.114	-0.051	- 0.432**	-0.090	0.464**	--
10. Grain Yield	0.144	0.133	0.155	0.277**	0.669**	0.522**	0.897**	0.577**	0.145
	1	2	3	4	5	6	7	8	9

*P< 0.05 **P< 0.01

Table 4. Correlations (df=98) between quantitative characters in the N313-2 x Exeter F_2 population.

1. Ear Emergence	--								
2. Maturity	0.0.86	--							
3. Plant Height	0.160	-0.031	--						
4. Panicle Length	0.034	0.122	0.355**	--					
5. Tiller per Plant	0.061	-0.162	0.015	0.110	--				
6. Grains per Panicle	-0.156	-0.097	0.063	0.103	-0.001	--			
7. Biological Yield	0.150	-0.196*	0.244*	0.166	0.705**	0.517**	--		
8. Harvest Index	-0.343**	-0.178	-0.165	0.090	0.295**	0.633**	0.378**	--	
9. Grain weight	0.073	-0.129	0.219*	0.092	-0.131	-0.224*	0.012	0.148	--
10. Grain Yield	-0.011	-0.240*	0.071	0.133	0.667**	0.652**	-0.918**	0.685**	0.022
	1	2	3	4	5	6	7	8	9

*P< 0.05 **P< 0.01

Table 5. Correlations (df=97) between quantitative characters in the N313-2 x 78-34Cn5 F_2 population.

1. Ear Emergence	--								
2. Maturity	0.739**	--							
3. Plant Height	0.437**	0.386**	--						
4. Panicle Length	0.041	0.019	0.152	--					
5. Tiller per Plant	0.064	-0.192	-0.168	-0.129	-				
6. Grains per Panicle	-0.033	0.114	0.097	0.091	-0.380**	--			
7. Biological Yield	0.185	-0.024	0.074	0.024	0.706**	0.269**	--		
8. Harvest Index	-0.305**	-0.191	-0.182	-0.013	-0.106	0.633**	0.173	--	
9. Grain weight	-0.058	-0.240*	0.099	0.194	0.139	-0.438**	0.029	-0.103	--
10. Grain Yield	0.029	-0.116	-0.045	0.003	0.568**	0.469**	0.926**	0.512**	-0.013
	1	2	3	4	5	6	7	8	9

*P< 0.05 **P< 0.01

Table 6. Correlations between oil content and the other characters (df=48) in the F_2 population.

Traits	Crosses			
	91-228 (N327-6 x 78-34Cn5)	91-229 (N313-2 x Pendragon)	91-231 (N313-2 x Exeter)	91-232 (N313-2 x 78-34Cn5)
1. Ear Emergence	-0.161	-0.032	-0.240	-0.183
2. Maturity	-0.256	-0.075	-0.075	-0.207
3. Grain Filling Period	-0.210	-0.063	-0.038	-0.054
4. Plant Height	0.020	-0.0.94	0.174	-0.095
5. Panicle Length	-0.053	-0.204	-0.278*	-0.214
6. Tiller Number per Plant	0.482**	0.371**	0.023	0.140
7. Grains per Panicle	0.089	0.016	0.138	0.106
8. Biological Yield	0.351*	0.360**	0.089	0.100
9. Grain Yield per Plant	0.395**	0.485**	0.071	0.184
10. Harvest İndex	0.338*	0.443**	0.042	0.287*
11. Grain weight	0.054	0.328*	-0.327*	-0.008
12. Kernel Weight	-0.070	0.090	-0.400**	-0.097
13. Kernel Content (%)	-0.393**	-0.541**	-0.356**	-0.268

*P< 0.05 **P< 0.01

Table 7. Broad sense heritabilities (%) of the quantitative Characters.

Traits	Crosses			
	91-228 (N327-6 x 78-34Cn5)	91-229 (N313-2 x Pendragon)	91-231 (N313-2 x Exeter)	91-232 (N313-2 x 78-34Cn5)
1. Ear Emergence	74.9	75.6	69.7	48.5
2. Maturity	68.4	67.5	60.3	73.0
3. Grain Filling Period	67.2	45.8	57.2	21.4
4. Plant Height	50.5	50.5	73.5	25.7
5. Panicle Length	19.1	12.2	62.6	53.1
6. Tiller Number per Plant	33.8	4.3	18.3	50.2
7. Grains per Panicle	63.4	35.4	71.0	57.9
8. Biological Yield	55.0	19.8	15.1	9.5
9. Grain Yield per Plant	54.9	38.4	40.8	22.2
10. Harvest İndex	61.0	57.1	53.9	24.8
11. Grain weight	60.4	66.8	44.6	4.3
12. Kernel Weight	30.4	44.0	35.0	32.0
13. Kernel Content (%)	2.2	90.0	12.2	23.1
14. Groat Oil Content	39.6	13.0	72.8	77.1

Conculusion

Biological yield had the highest correlation with grain yield, followed by harvest index. However, the harvest index was more heritable than biological yield. The biological yield and harvest index seem to be more reliable traits to use in the selection as selection criterion than yield components.

Grains per panicle appeared to be the most useful trait to use in indirect selection for grain yield among yield components in terms of hertability values and correlations with grain yield.

Although groat oil content had some significant associations with some quantitative characters, in general, it seems to be an independent trait.

The broad sense heritability values of groat oil content ranged from 13 to 77%. Grain yield per plant had heritability estimates between low and moderate values.

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