JAUNA LIETUVAS ŠĶIEDRAS LINU ŠĶIRNE 'SNAIGAI'

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Škiedras lini (*Linum usitatissimum* L.) ir nozīmīgākais dabīgo šķiedru nodrošinātājs tekstilrūpniecībā daudzās valstīs, kurās netiek audzēta kokvilna. Četrus tūkstošus gadu Lietuvā lini tika izmantoti apģērbam, pārtikai, medicīnai un citām vajadzībām. Lina audums (audums no linu šķidrām) ir izcili higroskopisks, tam piemīt gaisa caurlaidība un siltuma izolācija, tas neizraisa alerģiskas reakcijas un var tikt izmantots daudzu alerģisku traucējumu ārstēšanā. Tā kā augam piemīt izcila vērtība, kā arī balstoties uz audzētāju un pārstrādātāju ieinteresētību, šķiedras lini Lietuvā tiek selekcionēti kopš 1922. Astoņpadsmit šķidras linu šķirnes ir izveidotas kopš tā laika. Jaunā šķiedras linu šķirne 'Snaigiai' (līnija Nr. 2243-13) tika izveidota izmantojot starpšķirņu hibridizāciju. Selekcijas līnija tika pārbaudīta kontroles audzētavā 2001.-2002., iepriekšējā šķirņu pārbaudē – 2003.gadā. Salīdzinošajā šķirņu pārbaudē 'Snaigiai' tika pārbaudīta 2004.-2005. Tā ir baltziedu, vidēji agrīna, veldres izturīga šķirne. Sēklas ir brūnas, 1000 sēklu svars ir 5.53 g. Šķiedras kvalitāte ir augsta un ir piemērota tekstilrūpniecībai. Dr. K. Bačelis ir izveidojis šķirni 'Snaigiai'. Kopš 2005.gada šķirņu pārbaudi šķirnei veica Dr. Z. Jankauskienė. Kopš 2007. gada šķirne nodota AVS un SĪN pārbaudēm.

THE PATH ANALYSIS OF YIELD TRAITS IN SUNFLOWER (*Helianthus annuus* L)

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Abstract

Plant breeders have always tried to know that which characters contribute more in the seed yield that is a quantitative character influenced highly from environment and their relationships. Path coefficient analysis helps the breeders to explain the direct and indirect effects; hence it has been extensively used in breeding works by various researchers. The research covering yield performance and the path analysis of hybrids in the trials at the National Sunflower Research Project was conducted in Edirne province, where has 20% of thesunflower production in Turkey. The totals of 2932 sunflower hybrids were tested in 118 trials in this research. The 1000 seed weight gave the highest contribution to breeding for higher yield, and head diameter and plant height followed it respectively regarding to contribution to seed yield based on path and simple correlation analysis both in dry and rainy growing seasons.

Key words: sunflower, hybrid, seed yield, yield traits, path analysis.

Introduction

Seed yield is a quantitative character, which is influenced more from climate and environmental factors in sunflower because of being controlled large number of genes. To increase the yield, the study of direct and indirect effects of yield components provides the basis for successful breeding program and hence the problem of yield increase can be more effectively tackled based on the performance of yield components and selection for closely related traits (Fehr, 1993). Head diameter, 1000 seed weight, plant height are valuable yield parameters to determine for yield improvement in the sunflower (Miller and Fick, 1997).

The use of simple correlation analysis could not fully explain the relationships among yield characteristics. Path coefficient analysis helps the breeder(s) to explain the direct and indirect effects for a more and complete determination of the impact of independent variable on dependent one among important yield traits (Singh and Chaudhary, 1979). Therefore, path coefficient analysis has extensively been used by many researchers (Kaya and Atakisi, 2003; Kaya *et al.*, 2003; Vidhyavathi, *et al.*, 2005; Göksoy and Turan, 2007). This research was conducted to determine the direct and indirect effects of yield traits on the sunflower yield by path analysis in conducted trials over many years in dry (1999-2001) and in rainy seasons (2002-05)) in Edirne, Turkey.

Materials and Methods

The experimental hybrids developed by crossing female CMS and restorer lines and five control hybrids that have highest selling market share in Turkey and existed each year in the trials used in the research. The research was conducted in the Trakya Agricultural Research Institute fields in Edirne province which has the 20% of sunflower production proportion in Turkey between 1999 and 2005 as part of Turkish National Sunflower Research Project. The total of 2932 sunflower hybrids were tested in 118 trials in this project (635 hybrids in 26 yield trials in 1999, 650 hybrids in 23 trials in 2000, 457 hybrids in 17 trials in 2001, 365 hybrids in 15 trials in 2002, 176 hybrids in 8 trials in 2003, 295 hybrids in 13 yield trials in 2004 and 355 hybrids in 16 trials in 2005).
The experiments were conducted based on the Randomized Complete Block Design with three replicates. The TARPOPGEN statistical package (Ozcan and Acikgoz, 1999) was used to analyze these relationships with detailed examination by path analysis (Singh and Chaudhary, 1979). The three rows plots were 6-m long with 70 x 35 cm plant spacing. The middle row was harvested and the border rows were discarded, and the plot size was 3.78 m² at harvest. Seed yield (SY) (kg ha^{-1}), 1000 seed weight (TSW) (g), flowering (FP) and physiological maturity period (PM) (day), plant height (PH) and head diameter (HD) (cm), oil (OC) and husk content (HC) (%) were measured.

Results and Discussion

Highly significant and positive correlations of SY with TSW were found in all years except in 2003. HD and PH were also significantly correlated with SY in the dry period (1999-2001). OC were also positive and significant in 2001 and 2004, both HC only in 2000 and 2001 (Table 1, 3, 5, 7, 9, 11, 13).

Table 1: Correlation values of sunflower hybrids in 1999.

	Seed Yield	1000 SW	Husk C.	Flw P.	P. Mat.	P. Height	Head Diam.
Seed Yield	1.000						
1000 S Weight	0.324**	1.000					
Husk Content	-0.014ns	0.105**	1.000				
F. period	-0.047ns	-0.101**	-0.035ns	1.000			
Phy. Maturity	0.073*	-0.019ns	-0.019ns	0.384**	1.000		
Plant Height	0.310**	0.302**	0.143**	0.138**	0.240**	1.000	
Head Diameter	0.355**	0.252**	-0.008ns	0.040ns	0.162**	0.244**	1.000

** = Significant at 1 % level, * = Significant at 5 % level, ns= Non Significant

FP and PM had generally non-significant relationships based on correlation analysis. FP was negatively correlated with SY in the dry seasons so it meant that earlier hybrids got higher yields.
Since the simple correlation coefficients did not give clear information about the interrelationship between the causal and resultant variables, the correlation coefficient estimates were partitioned into direct and indirect effects to establish the intensity of effects of independent variables on dependent ones in path analysis. The path analysis of yield traits in the research is given in Table 2, 4, 6, 8, 10, 12 and 14.

Table 2: The path (p) coefficients and percentages (%) in seed yields of hybrids in 1999.

	1000 S W		Husk Content		Flower. period		Phy. Maturity		Plant Height		Head Diameter	
	P	%	P	%	P	%	P	%	P	%	p	%
TSW	0.197	58.4	0.021	17.3	-0.020	14.4	-0.004	2.8	0.060	17.1	0.050	13.8
HC	-0.007	2.0	-0.065	54.1	0.002	1.7	0.001	0.9	-0.009	2.7	0.001	0.1
FP	0.007	2.2	0.003	2.2	-0.073	52.6	-0.028	20.5	-0.010	2.9	-0.003	0.8
PM	0.000	0.1	0.000	0.2	0.005	3.6	0.013	9.6	0.003	0.9	0.002	0.6
PH	0.062	18.2	0.029	24.5	0.028	20.3	0.049	35.9	0.204	58.5	0.050	13.8
HD	0.064	19.1	-0.002	1.7	0.010	7.5	0.041	30.3	0.062	17.9	0.256	70.9

*Bold lines direct effect of trait.

The 1000 seed weight had the highest direct effect amount (84.4% in 2005) on setting of yield and plant height followed by 82.5% in the 2002 research.

FP had a higher influence on seed yield due to the dry spring years in 1999-2001 than PM's ones. The direct effect of important yield traits such as TSW and PH was less in dry years so they affected positively seed yield utilizing over other traits.

Table 3: Correlation values of sunflower hybrids in 2000.

	S. Yield	Oil Cont.	1000 S W	Husk Con.	Flowering	Phy Mat.	Plant Hgt	Hd Diam.
Seed Yield	1.000							
Oil Content	0.017ns	1.000						
1000 S Weight	0.313**	-0.151**	1.000					
Husk Content	0.195**	-0.514**	0.234**	1.000				
Flow. period	0.068*	0.091**	0.013ns	0.009ns	1.000			
Phy. Maturity	0.061ns	0.073*	0.073*	0.078*	0.254**	1.000		
Plant Height	0.323**	0.094**	0.173**	0.094**	0.013ns	0.082**	1.000	
Head Diameter	-0.017ns	-0.016ns	0.043ns	-0.034ns	-0.056ns	0.109**	0.267**	1.000

Table 4: The path (p) coefficients and percentages (%) in seed yields of hybrids in 2000.

	Oil Cont.		1000 S W		Husk Con.		Flowering		Phy Mat.		Plant Height		Head Diam.	
	P	%	P	%	P	%	P	%	P	%	P	%	P	%
OC	0.105	40.9	-0.016	4.5	-0.054	17.9	0.010	13.9	0.008	9.2	0.010	2.7	-0.002	0.9
TSW	-0.037	14.4	0.246	69.7	0.058	19.0	0.003	4.5	0.018	21.3	0.043	11.4	0.011	5.7
HC	-0.083	32.2	0.038	10.7	0.162	53.3	0.002	2.2	0.013	15.1	0.015	4.1	-0.005	2.9
FP	0.004	1.6	0.001	0.2	0.000	0.1	0.045	66.1	0.012	13.7	0.001	0.2	-0.003	1.4
PM	0.000	0.1	0.000	0.1	0.000	0.1	0.000	0.4	-0.001	1.3	0.000	0.1	0.000	0.1
PH	0.026	10.2	0.048	13.7	0.026	8.6	0.004	5.2	0.023	27.3	0.280	75.1	0.075	39.8
HD	0.002	0.6	-0.004	1.1	0.003	1.0	0.005	7.6	-0.010	12.1	-0.025	6.7	-0.093	49.4

Table 5: Correlation values of sunflower hybrids in 2001.

	S. Yield	Oil Cont.	1000 SW	Husk C.	Flowering	Phy Mat.	Plant Hgt	Hd Diam.
Seed Yield	1.000							
Oil Content	0.323**	1.000						
1000 S W	0.497**	0.311**	1.000					
Husk Cont	0.104*	-0.547**	0.165**	1.000				
F. period	-0.167**	0.034ns	-0.154**	-0.070ns	1.000			
Phy. Maturi.	0.078ns	0.082ns	0.016ns	-0.019ns	0.411**	1.000		
Plant Height	0.242**	0.227**	0.380**	0.131**	0.073ns	0.064ns	1.000	
Head Diam.	0.131**	0.160**	0.159**	0.115*	-0.116**	-0.005ns	0.225**	1.000

Table 6: The path (p) coefficients and percentages (%) in seed yields of hybrids in 2001.

	Oil Cont.		1000 S W		Husk Con.		Flowering		Phy Mat.		Plant Height		Head Diam.	
	P	%	P	%	P	%	P	%	P	%	p	%	P	%
OC	0.344	57.9	0.107	21.2	0.188	38.4	0.012	4.0	0.028	12.7	0.078	28.1	0.055	30.3
TSW	0.100	16.8	0.321	63.4	0.053	10.8	-0.049	16.8	0.005	2.3	0.122	43.9	0.051	27.9
HC	-0.126	21.2	0.038	7.5	0.230	46.9	-0.016	5.4	-0.004	1.9	0.030	10.9	0.026	14.5
FP	-0.006	0.9	0.026	5.0	0.012	2.3	-0.165	56.2	-0.068	30.6	-0.012	4.4	0.019	10.5
PM	0.010	1.6	0.002	0.4	-0.002	0.4	0.048	16.1	0.116	51.9	0.007	2.7	-0.001	0.3
PH	0.005	0.9	0.009	1.7	0.003	0.6	0.002	0.6	0.001	0.7	0.023	8.1	0.005	2.8
HD	-0.004	0.7	-0.004	0.8	-0.003	0.6	0.003	1.0	0.000	0.1	-0.006	2.0	-0.025	13.7

Table 7: Correlation values of sunflower hybrids in 2002.

	S. Yield	Oil Cont.	1000 SW	Flowering	Phy Mat	Plant Height	Head Diam.
Seed Yield	1.000						
Oil Cont	0.080ns	1.000					
1000 S W	0.231**	-0.067ns	1.000				
F. period	0.004ns	0.093ns	-0.321**	1.000			
Phy. Mat.	0.134**	0.311**	-0.076ns	0.730**	1.000		
Plant Hght	0.297**	0.027ns	0.129**	0.084ns	0.168**	1.000	
Head Dim	0.099*	0.120*	0.226**	-0.030ns	0.085ns	0.118*	1.000

Table 8: The path (p) coefficients and percentages (%) in seed yields of hybrids in 2002.

	Oil Cont.		1000 SW		Flowering		Phy Mat		Plant Height		Head Diam.	
	P	%	P	%	P	%	P	%	P	%	P	%
OC	0.050	43.3	-0.003	1.3	0.005	2.0	0.016	6.4	0.001	0.4	0.006	6.1
TSW	-0.013	11.1	0.193	74.8	-0.062	26.0	-0.015	6.1	0.025	8.1	0.044	44.1
FP	-0.005	4.4	0.018	6.8	-0.055	23.1	-0.040	16.5	-0.005	1.5	0.002	1.7
PM	0.040	34.7	-0.010	3.9	0.095	39.9	0.130	53.4	0.022	7.1	0.011	11.2
PH	0.007	5.8	0.033	12.7	0.021	8.9	0.042	17.4	0.253	82.5	0.030	30.3
HD	0.001	0.7	0.002	0.6	0.000	0.1	0.001	0.2	0.001	0.3	0.007	6.7

Table 9: Correlation values of sunflower hybrids in 2003.

	S. Yield	Oil Cont.	1000 SW	Flowering	Phy Mat	Plant Height	Head Diam.
Seed Yield	1.000						
Oil Content	0.037ns	1.000					
1000 S Wgt	0.055ns	-0.126ns	1.000				
Flw. Period	0.108ns	-0.059ns	-0.229**	1.000			
Phy. Matur.	0.157*	0.250**	-0.158*	0.670**	1.000		
Plant Hght	0.095ns	-0.233**	0.282**	0.078ns	-0.019ns	1.000	
Head Diam.	0.097ns	-0.105ns	0.148*	-0.012ns	-0.013ns	0.300**	1.000

The path coefficient analysis further indicated that the positive direct effect of OC was masked by the negative indirect effect of HC in the dry years, whereas there was positive and direct effect of some other characteristics including TSW, FP and PM in rainy seasons. The direct effect of FP was also masked mainly by PM especially in the rainy years, but the indirect effect of FP over PM was not higher like PM's.

Table 10: The path (p) coefficients and percentages (%) in the seed yields of hybrids in 2003.

	Oil Cont.		1000 SW		Flowering		Phy Mat		Plant Height		Head Diam.	
	P	%	P	%	P	%	P	%	p	%	P	%
OC	0.032	32.1	-0.004	3.4	-0.002	1.4	0.008	4.5	-0.008	6.5	-0.003	3.1
TSW	-0.007	7.2	0.057	48.3	-0.013	9.4	-0.009	5.0	0.016	14.0	0.008	7.8
FP	-0.001	1.2	-0.005	4.0	0.021	14.9	0.014	7.8	0.002	1.4	0.000	0.2
PM	0.037	36.5	-0.023	19.5	0.098	70.2	0.146	81.5	-0.003	2.4	-0.002	1.8
PH	-0.015	15.0	0.018	15.4	0.005	3.6	-0.001	0.7	0.065	56.1	0.019	17.9
HD	-0.008	7.9	0.011	9.4	-0.001	0.7	-0.001	0.6	0.023	19.6	0.075	69.3

Table 11: Correlation values of sunflower hybrids in 2004.

	S. Yield	Oil Cont.	1000 SW	Flowering P.	Phy Mat.	Plant Height	Head Diam.
Seed Yield	1.000						
Oil Content	0.148*	1.000					
1000 S Wgt	0.349**	0.158**	1.000				
F. period	0.484**	0.149**	-0.224**	1.000			
Phy. Mat.	0.098ns	0.043ns	0.041ns	0.104ns	1.000		
Plant Height	0.081ns	0.280**	-0.168**	0.418**	-0.087ns	1.000	
Head Diam.	0.043ns	-0.040ns	-0.015ns	-0.027ns	-0.161**	0.113*	1.000

Table 12: The path (p) coefficients and percentages (%) in seed yields of hybrids in 2004.

	Oil Cont.		1000 SW		Flowering P.		Phy Maturity		Plant Height		Head Diam.	
	P	%	P	%	P	%	P	%	p	%	P	%
OC	0.014	6.4	0.002	0.4	0.002	0.3	0.001	0.5	0.004	0.8	-0.001	0.5
TSW	0.075	33.7	0.470	73.8	-0.105	13.2	0.020	15.6	-0.079	16.5	-0.007	5.6
FP	0.095	43.0	-0.143	22.4	0.638	79.8	0.066	53.1	0.267	55.6	-0.018	14.0
PM	0.001	0.1	0.001	0.1	0.002	0.2	0.015	11.7	-0.001	0.3	-0.002	1.9
PH	-0.033	15.1	0.020	3.2	-0.050	6.2	0.010	8.3	-0.119	24.9	-0.014	10.8
HD	-0.003	1.5	-0.001	0.2	-0.002	0.3	-0.014	10.8	0.010	2.0	0.084	67.2

Table 13: Correlation values of sunflower hybrids in 2005.

	S. Yield	Oil Cont.	1000 SW	Flowering	Phy Mat	Plant Height	Head Diam.
Seed Yield	1,000						
Oil Cont	0,007ns	1,000					
1000 S W	0,290**	0,245**	1,000				
F. period	0,282**	0,003ns	0,032ns	1,000			
Phy. Mat.	0,438**	0,137**	0,021ns	0,362**	1,000		
Plant Hght	0,189**	0,027ns	0,096ns	0,242**	0,179**	1,000	
Head Dim	0,153**	-0,053ns	0,118*	0,022ns	0,123*	0,002ns	1,000

The data further indicated that the positive effect of TSW on seed yield was realized generally directly both in dry and rainy seasons and TSW has the highest contribution on formating of SY among yield components. TSW was utilized also from the positive and indirect effects mostly of PH. Plant height and head diameter were other contributing traits on the setting up of SY in the research. The positive direct effects of TSW, PH and HD established in this study supports the statements of Kaya and Atakisi (2003), Kaya *et al*. (2003), Vidhyavathi, *et al.* (2005), Göksoy and Turan (2007) that breeding for increased SY seems to the most effective method to get higher sunflower yields.

Table 14: The path (p) coefficients and percentages (%) in the seed yields of hybrids in 2005.

	Oil Cont.		1000 SW		Flowering		Phy Mat		Plant Height		Head Diam.	
	P	%	P	%	P	%	P	%	p	%	P	%
OC	-0.116	47.2	-0.028	8.2	0.000	0.1	-0.016	3.4	-0.003	1.6	0.006	4.0
TSW	0.072	29.1	0.293	84.4	0.009	3.3	0.006	1.3	0.028	14.4	0.034	22.5
FP	0.000	0.1	0.004	1.1	0.115	40.8	0.042	8.9	0.028	14.3	0.003	1.7
PM	0.053	21.5	0.008	2.3	0.140	49.5	0.386	82.2	0.069	35.3	0.048	31.1
PH	0.002	0.1	0.006	1.9	0.016	5.7	0.012	2.5	0.067	34.2	0.000	0.1
HD	-0.003	1.3	0.007	2.1	0.001	0.5	0.008	1.6	0.000	0.1	0.062	40.5

Conclusion

By comparing the correlation coefficient values of six independent variables against the seed yield, significant differences became evident. TSW had a highly significant association with plant yield. By partitioning the mutual relationship among the independent variables into direct and indirect effects on yield, it became apparent that TSW, PH and HD were the main characteristics that

exhibited the highest direct effect on seed yield both in dry and rainy growing seasons. Therefore, both these traits seem to be good selection criteria to improve sunflower seed yield.

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SAULESPUĶU (*Helianthus annuus* L) RAŽAS PAZĪMJU KORELĀCIJU ANALĪZE

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Saulespuķu selekcionāriem jāzina, ka pazīmes, kuras galvenokārt nosaka sēklu ražu, ir kvantitatīvas un tās ietekmē vide, kā arī vides un pazīmes mijiedarbība. Korelācijas koeficientu analīze palīdz selekcionāram izskaidrot tiešās un netiešās ietekmes, tādejādi šī metode plaši tiek izmantota selekcijas darbā. Pētījums veikts, izmantojot ražas datus un korelāciju analīzes Nacionālā Saulespuķu pētījumu projekta izmēģinājumā iekļautajiem hibrīdiem. Projekts notiek Edirne provincē, kurā ražo 20 % no Turcijas saulespuķu produkcijas. Kopumā 2932 saulespuķu hibrīdi tika pētīti 118 izmēģinājumos šī pētījuma gaitā. Augstražīgu hibrīdu selekcijā pazīmei - 1000 graudu svars - bija būtiskākā nozīme. Ziedkopas diametrs un auga garums gan sausos, gan lietainos augšanas apstākļos bija nākamie nozīmīgākie, balstoties uz vienkāršām korelācijas analīzēm.

MOLECULAR MARKER-BASED CHARACTERIZATION OF BARLEY POWDERY MILDEW *MLO* RESISTANCE LOCUS IN EUROPEAN VARIETIES AND BREEDING LINES

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Abstract

Powdery mildew is an economically important barley disease, caused by a fungal pathogen *Blumeria* (*Erysiphe*) *graminis* f.sp. *hordei*. While the pathogen is relatively easily controlled by fungicides, it may represent a serious threat for barley produced in low input and organic agriculture. Alternatively, the disease can be controlled using resistance genes that are either specific for certain fungal pathotypes or confer resistance to a broad range of pathotypes. Naturally occurring and induced recessive mutations in the *Mlo* gene provide race nonspecific resistance that has been effective against almost all powdery mildew pathotypes. The *Mlo* gene has been cloned and several resistance allele have been characterized at the DNA sequence level. Here we report the