

CONTRIBUTION OF BREEDING TO INCREASING SOYBEAN GRAIN YIELD AND GRAIN QUALITY

Aleksandra SUDARIC¹ - Marija VRATARIC¹ - Sonja GRLJUSIC¹ - Sanja SIKORA²

¹Agricultural Institute Osijek, Juzno predgradje 17, 31000 Osijek, Croatia
e-mail: aleksandra.sudaric@poljinos.hr

²Faculty of Agriculture, University of Zagreb, Svetosimunska 25,
10000 Zagreb, Croatia

Abstract

The objective of this research was to determine the genetic gain in grain yield and grain quality accomplished by recently developed domestic soybean elite lines and to determine ways to improve these traits further. Realized gains were estimated by comparing recently developed most promising domestic soybean lines of maturity groups (MGs) 00, 0 and I with commercial cultivars (standards) in comparative field tests during three consecutive years (2002-2004) in Osijek, Croatia. Mean values, broad-sense heritability, genetic gain and relative genetic gain from selection were calculated for grain yield, protein and oil content in grain. The obtained results of biometrical analysis showed genetic improvement in productivity and quality of new domestic soybean elite lines within MGs 00, 0 and I. The high agronomic performances of this breeding material will considerably contribute to the increasing and improving soybean production in our region as well as genetic improvement of domestic soybean cultivars further.

Key-words: soybean, grain yield, grain quality, heritability, genetic gain

Introduction

Classical and emergent breeding technologies have had impact role in soybean (*Glycine max* (L.) Merr.) productivity and quality increasing as well as improving nutritional and functional quality of the soybean seed. Estimates of soybean quantity and quality yield increasing due to breeding (genetic progress) are the objective of many studies (Voldeng et al, 1997; St. Martin and Futi, 2000; Wilcox, 2001; Orf et al. 2004).

In Croatia, the current soybean production has had a positive trend in both, area (35000-50000 ha) and yield units (3-5 t ha⁻¹), particularly during the last six years. This positive trend is attributed to genetic improved cultivars, advances in cultural practices and general management, respectively. The contribution of the soybean breeding program of the Agricultural Institute Osijek to the development, stability and improvement of soybean production in Croatia has been fundamental and invaluable primarily because of permanently development cultivars with superior agronomic performance. As a result of this continuous, intensive and conventional breeding work is 32 released cultivars MGs 00-II (two of them released in Hungary) in the period from 1976 to 2005. These cultivars are sown at the most areas in the large-scale production of Croatia. Currently, about 10 Institute's cultivars cover more than 65% of total area under soybean in Croatia (OS-cultivar 'Ika' is leading in both, hectares and yield). The objective of this research was to determine the genetic gain in grain yield and grain quality accomplished by recently developed domestic soybean elite lines and to determine ways to improve these traits further.

Materials and methods

This research was conducted at the experimental field of the Agricultural Institute Osijek at three consecutive years (2002 to 2004). Total 86 soybean elite breeding lines were evaluated in relation to standards within MGs 00, 0 and I. Tested elite breeding lines were developed by numerous crosses within the Institute's soybean breeding program and derived from previously cycles of selection on the basis of their agronomic performance. Commercial cultivars were used as standards. Field trials were designed as a randomized complete block design with four replications using plots of 9 m². Standard cultural conditions were applied each year in trial. Harvest was done at full maturity by small plot combine. Grain yield was measured from each plot and converted to 13% seed moisture and tha⁻¹. Protein and oil contents in grain were determined per plot by Infratec 1241 Analyzer and expressed in a percentage of absolutely dry matter of grain (ADM). The summarized experimental data were processed by analysis of variance and the means were tested using an LSD-test. The following parameters were used to estimate grain yield and grain quality gain: mean value of trait, broad-sense heritability (%; Singh et al., 1993), genetic gain (Allard, 1960) and relative genetic gain from selection (%; relationship between the genetic gain from selection and mean value of the trait).

Results and discussion

The analysis of variance showed significant differences among both, tested elite breeding lines and standards across all maturity groups in the phenotypic expression of grain yield and grain quality traits (Tab.1). It suggests that genetic basis of experimental material within each maturity group was broad. At the average, elite breeding lines within each maturity group had statistical significant increased grain yield, protein content and oil content in seed relative to standards. These results indicate that important agronomic traits might be improved by conventional breeding procedure.

Table 1: Range and means for grain yield and grain quality traits of tested soybean genotypes MGs 00, 0, I; 2002-2004; Osijek (Croatia)

Maturity group	Standards		Elite breeding lines		LSD _{genotypes}	
	Range	Mean	Range	Mean	0.05	0.01
Grain yield (tha ⁻¹)						
00	2.90-3.60	3.15	3.14-4.10	3.65	0.386	0.490
0	3.47-4.22	3.80	3.80-4.73	4.36	0.398	0.512
I	3.65-5.06	4.22	3.87-5.30	4.68	0.372	0.453
Protein content in grain (% in ADM)						
00	35.87-38.35	37.33	35.96-38.92	38.05	0.522	0.712
0	36.28-38.62	38.20	36.58-39.80	38.92	0.463	0.422
I	39.38-40.35	39.78	38.66-42.49	40.31	0.417	0.510
Oil content in grain (% in ADM)						
00	21.44-22.92	22.10	22.24-23.42	22.86	0.435	0.556
0	21.25-22.75	21.95	22.30-23.30	22.80	0.393	0.509
I	21.40-22.17	21.77	21.18-23.17	22.12	0.376	0.416

According to presented results in Table 2, obviously that studied traits differed in the estimations of broad-sense heritability. Within each maturity group, traits with very high heritability were: protein content (71.65-74.14%) and oil content (69.45-73.18%), while grain yield had low heritability (30.26-34.40%). This result indicates that about 65-70% of phenotypic expression of grain yield and 30% for both protein and oil content may be explained by nongenetic (nonheritable) effects.

Table 2: Broad-sense heritability (%) and genetic gain for grain yield and quality of tested soybean genotypes MGs 00, 0, I; 2002-2004, Osijek (Croatia)

Maturity group	Genetic parameters			
	Mean value	Heritability (%)	Genetic gain	Relative genetic gain (%)
Grain yield (kg ha ⁻¹)				
00	3650	32.14	14.28	0.39
0	4360	30.26	13.44	0.31
I	4680	34.40	18.60	0.40
Protein content in grain (% in ADM)				
00	38.05	74.14	2.64	6.94
0	38.92	73.44	2.87	7.37
I	40.31	71.65	2.63	6.52
Oil content in grain (% in ADM)				
00	22.86	73.18	2.05	8.97
0	22.80	70.27	1.93	8.46
I	22.12	69.45	1.87	8.45

There are evidently that protein and oil content are more reliable traits than grain yield as selection criteria. Hence, genetic gain from selection was larger at both, protein and oil content in grain in relation on grain yield (Table 2). It implies that soybean grain quality may be enhanced faster by selection than grain yield. Similar findings have been reported by Voldeng et al. (1997), St. Martin and Futi (2000), Wilcox (2001), Orf et al. (2004), Sudaric et al. (2004), Vratarić et al. (2005).

Conclusions

The obtained data indicate on achieved genetic progress in soybean grain yield and grain quality. New developed superior domestic elite lines will considerably contribute to improving and increasing of soybean production in our region as well as improving nutritional and functional quality of the soybean seed. From the breeding aspect, recent breeding material represents good genetic background for future hybridizations aimed to advance quantity and quality of grain yield in soybean genetically.

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