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Investigation on some seed characteristics among sunflower lines and hybrids

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Abstract. *Sunflower, being one of the main oil seed crops in the world, is of special economic importance in East Europe. In sunflower breeding the heterosis effect is primarily used. The high yield and the quality properties of seeds depend on the indices of the lines in their pedigree and require the developing of lines with good bio-chemical and technological indices. This investigation involved 5 fertility restorer lines produced by using pollination technique with high gamma-irradiation doses and subsequent embryo cultivation, 4 cm lines obtained through selfing, and their hybrid combinations. Applying various mathematical models, the correlation between the individual indices (1000 seed weight, percent of kernel, percent of husk, oil content in kernel, oil content in seed and protein content) was demonstrated. The performed analysis revealed negative correlation between the two main quality traits: oil content and protein content. Oil content in kernel correlated insignificantly negatively with the trait 1000 seed weight, while protein content in kernel was in a significant positive correlation with the 1000 seed weight. The established correlations can be directly used at the initial stages of investigation on the breeding materials.*

Keywords: sunflower, seeds, oil content, protein content, 1000 seed weight, correlations

Introduction

Sunflower is among the most important technical crops in Bulgaria used mainly for oil production. Oil content in the seeds of the modern commercial hybrids reaches a mean value of 55 % and the tendency is toward higher percent in the next hybrid generations. Sunflower seeds are also important as sources of protein. The kernel contains an average of 23 % protein (Ivanov, 1980). The protein type of sunflower varieties and hybrids are used in different branches of food industry, as well as for poultry feed.

Protein and oil content are main characteristics of the sunflower seeds which determine its usage. Oil content in seeds is conditioned by the genotype and the agro-ecological environment, the effect of which is especially strong at stage seed filling (Stanojevic et al., 1992). Bedov and Škorić (1981) have found significant variation also with regard to the trait "protein content in kernel" (16-29 %) when investigating breeding materials of diverse genotypic origin. The greater part of the scientific researches (Pačenko and Djakov, 1968; Ivanov and Stoyanova, 1978; Jovanović, 1995; Joksimović, 1999) focuses on the correlation of protein and oil content with other qualitative and quantitative traits of sunflower seeds. Some authors point out the negative correlation between the main quality indices – oil content and protein content (Poustavoyt and Dyakov, 1972; Radić, et al., 2009). Later Dyakov (1986) did not confirm the antagonism of these traits, and Stanojevic et al. (1992) determined a positive correlation between them in some of the investigated breeding lines.

For efficient selection, the knowledge on the correlations between the individual breeding traits is an important prerequisite. The aim of this investigation was to study the correlations between some main qualitative and quantitative traits in new sunflower lines and their hybrid combinations with a view of their further improvement and use in breeding programs.

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Material and methods

The investigation was carried out during 2009-2010 at Dobrudzha Agricultural Institute, General Toshevo. The investigation involved 5 fertility restorer lines produced by using the selfing technique with high gamma irradiation doses and subsequent embryo cultivation, 4 cm lines developed through selfing and 14 of their hybrid combinations. In the initial materials oil content in kernel varied from 43.2 % to 64.4 %, and protein in kernel – from 18.2 % to 34.8 %. A thousand seed weight was from 26.0 to 102.0 g.

The following traits were analyzed: 1000 seed weight, % of kernel, % of husk, % of oil in kernel, % of oil in seed, protein content in kernel (%) and protein content in defatted kernel (%). Thousand seed weight and the value of kernel, respectively husk, were determined by analyzing two samples, each of 50 seeds. Oil percent was determined by the method of Roushkovsky, and protein content – by Kjeldahl's method. Data were analyzed by correlation and regression analyses. The statistical software Biostat version 7.0 and MS Excel were used.

Results and discussion

A positive correlation was confirmed of 1000 seed weight with protein content in defatted kernel (Table 1). The correlation of the above index with percent of oil in kernel was negative but not significantly. The index % of kernel correlated negatively with % of husk and positively with oil percent in seed, and the index % of husk was in negative correlation with % of oil in seed. Oil content in kernel was in direct correlation with oil content in seed and in negative correlation with protein content in kernel. Logically, the indices protein in defatted kernel and protein content in kernel were in linear correlation. It is interesting to note the negative correlations between

the two main quality traits: oil and protein content, as well as the correlation of each of these traits with the trait 1000 seed weight. The specified correlations can be directly used at the initial stages of investigation on the breeding materials.

The regression models describing the correlation of oil percent in kernel with the investigated indices were also evaluated (Table 2):

$Y = aX + b$

The obtained results demonstrated the positive correlation of the index percent of oil in kernel with percent of kernel and percent of oil in seed. There was a strong negative correlation with the indices protein in kernel and 1000 seed weight. The graphic expression of the regression model of oil percent in kernel and 1000 seed weight is given in Figures 1 and 2 shows the model type of oil percent in kernel and protein content in kernel.

The results from the regression analysis confirmed the data from the correlation analysis. The main indices determining quality in the investigated materials were in negative correlation. An explanation for this negative correlation can be found in the studies of Canvin (1965) on oil and protein biosynthesis in sunflower seeds indicating that the two processes are antagonistic, i.e. the conditions which favor oil synthesis are unfavorable for protein synthesis. The results obtained by Poustovoyt and Dyakov (1972) and Radić, et al. (2009) give additional confirmation in this respect. These results, however, are in contrast with the investigations of Dyakov (1986) and Stanojevic et al. (1992), who found positive correlation between these two main traits in some of the studied genotypes. The determining role of the genotype for higher protein in sunflower kernel has also been pointed out by Marinković et al. (2003).

The regression equations between the other important quality index, protein content in kernel, and the other indices were also investigated. The results are given in Table 3. The index protein content in kernel correlated positively with 1000 seed weight and %

Table 1. Correlation coefficients of the investigated indices

	x1	x2	x3	x4	x5	*x6*
x1	1					
x2	–0.187	1				
x3	0.187	–1	1			
x4	–0.075	0.279	–0.279	1		
x5	–0.128	0.607**	–0.607**	0.931***	1	
x6	0.414*	0.054	–0.054	–0.299	–0.238	1
x7	0.280	–0.151	0.151	–0.866***	–0.778***	0.728***

Key: x1 – 1000 seed weight, x2 – % of kernel, x3 – % of husk, x4 – % of oil in kernel, x5 – % of oil in seed, x6 – protein content in defatted kernel and x7 – protein content in kernel

Table 2. Regression coefficients a and b for the correlation of oil % in kernel with the investigated indices

Index	a	b
% kernel	0.42	19.5
% husk	–0.42	61.7
1000 seed weight (g)	–0.02	52.3
% of oil in seed	1.02	11.9
% of protein in defatted kernel	–0.32	70.8
% of protein in kernel	–1.04	80.2

Table 3. Regression coefficients for the correlation of protein content in kernel with the investigated indices

Index	a	b
% kermel	–0.19	44.0
% husk	0.19	25.1
1000 seed weight (g)	0.06	26.2
% of oil in kernel	–0.72	66.6
% of oil in seed	–0.71	57.0
% of protein in kernel	0.65	–9.8

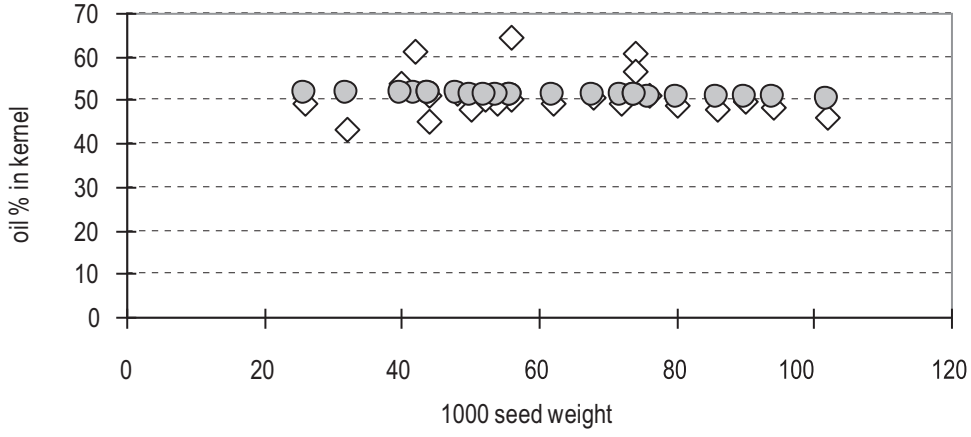

Figure 1. Graphic representation of the regression model between oil % in kernel and 1000 seed weight

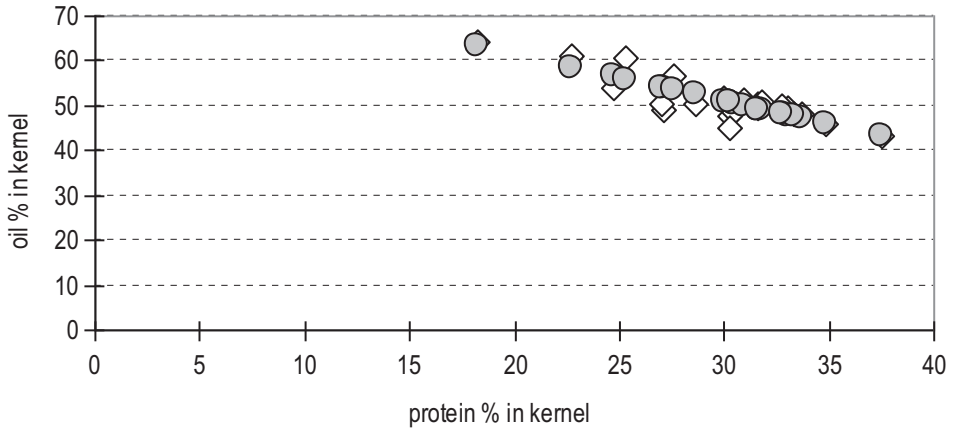

Figure 2. Graphic representation of the regression model between oil % in kernel and protein % in kernel

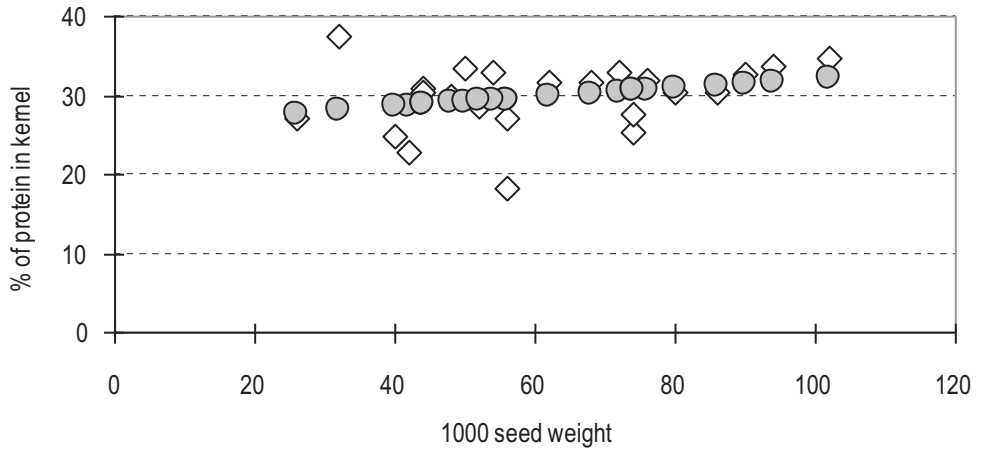

Figure 3. Graphic representation of the regression model between % of protein in kernel and 1000 seed weight

of husk, and negatively with oil in kernel and seed. The regression analysis confirmed the results from the correlation analysis. The graphic expression of the regression model between protein % in seed and 1000 seed weight is given in Figure 3.

Based on the applied correlation and regression analyses, the following conclusions can be made. Oil content and protein content in kernel are in negative correlation. Oil content in kernel shows insignificant negative correlation with 1000 seed weight. Protein content in kernel has a significant positive correlation with 1000 seed weight.

Summarizing these correlations we can assume that the index 1000 seed weight, a trait which can be determined relatively easily without special laboratory equipment, contains preliminary tentative information about the relative protein content in the seeds of the breeding materials.

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Thesis:

Penkov D, 2008. Estimation of metabolic energy and true digestibility of amino acids of some feeds in experiments with muscus duck (Carina moshata, L). Thesis for DSc. Agrarian University, Plovdiv, 314 pp.

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