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APPLICATION OF THE INDEPENDENT SUBJECTIVE EVALUATION METHOD OF THE HYBRID MATERIAL IN THE BREEDING OF SESAME (*SESAMUM INDICUM* L)

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Abstract

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The study included results from the application of subjective independent method for evaluating the susceptibility of sesame (*Sesamum indicum* L.) for mechanized harvesting. This method tested progeny of different generations of Bulgarian selection resulting from repeated individual selects. It has been shown that the highest seed weight in capsule characterize those progeny who do not possess anatomical peculiarities of the capsule to hold the seeds to entering the threshing mechanism. Such forms are far genetically of the forms that retain the seeds and can be used in a breeding program in which to receive plants with higher yield and mechanisms (strong attached placenta or shape of the capsule), which holds the seeds to entering the threshing.

Key words: sesame; mechanized harvesting; subjective independent method; breeding

Iintroduction

In Bulgaria and in several other countries around the world are actively working on problems related to mechanized harvesting sesame (Langham and Wiemers, 2002; Langham et al, 2004; Uzun et al., 2003). In recent years IPGR – Sadovo has a sesame forms that retain their seeds when ripe (Georgiev et al., 2014; Stamatov et al., 2014). They are characterized by two signs that reduced dispersal of seeds when ripe. One of them is “attached placenta” and the other is the form of fruit capsule and in particular the extent and location of its narrowing. These two signs defined as opportunities for threshing seeds and how that might be by destroying or without destroying the fruit capsule (Ishpekov et al., 2015a). Assessing the susceptibility of sesame capsules for mechanized harvesting seeds is done through specially developed subjectively independent methodology (Ishpekov and Stamatov, 2015b). The introduced indexes allow an assessment of whether and how fruit capsule retains the seeds. Forms high index i_1 release their seeds by gently swirling wind and are not suitable for mechanized harvesting, i.e. called. Dispersion forms. In forms with high index i_2 retention of seeds is due to the narrowing of capsules and their separation is done through its crushing. The tall i_3 shows that the seeds remain in the capsule thanks to the attached placenta, which broke off in inertial effect. Forms high i_2 carry in their genome signs inherited from parent forms are non-shattering capsules that suppress the production of high yield. Attached placenta is controlled by recessive genes and expression and in F2 (Stamatov and Deshev, 2014), which contributes to the preservation and future generations.

Yield in sesame has a complex polygenic character, but most largely depends on number of fruit capsules (Stamatov and Deshev, 2012; Rauf et al., 2004). Engin at al., 2010 re-

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ported that direct positive effect on the yield of seeds have the number of capsules on the central stem and branches and mass of seeds in capsules. The components of yield are also strong relationships between them (Bidgoli et al., 2006). The relationships between signs are measured by the coefficient of correlation, which does not allow determining the relative contribution of each of them on the yield. Factor analysis can be understood as a technique of data reduction through covariance (Brejda, 1998). The analysis shows the percentage shares of signs in each factor (Seiler and Stafford, 1979) and how their expression is inhibited by the interaction of the genes in the genome. The advantage of the component analysis consisted in the demonstration of the genetic composition of each factor (Pandya et al., 1996; Ashkani and Pakniyat, 2003; Ashkani et al., 2007). Aquaah et al. (1992), Bramel et al. (1984), Denis and Adams (1978), and Seiler and Stafford (1979) applied factor analysis in selection programs.

The objective of this study was to assess the capabilities of hybrid progeny to retain their seeds by independent subjective method. One of the main aims is to substantiate relations between the three indices characterizing them and the mass of seeds in a capsule, thereby to determine parental pairs for future hybridization program to produce high-yielding not spillage progeny.

Materials and Methods

Plant material

There were studied 43 hybrid progeny of different generations of selection process of four crossings of Bulgarian selection of sesame in the direction of creating shapes with no spillage his seed capsules. Studied are offspring resulting from a multiple individual choices subjective criteria cross 355 with parental forms ♀ A 8,000,161 x ♂ Victoria cross 361 parents ♀ Nevena x ♂ 3959-3, cross 364 x ♂ ♀ Valia 3959 and cross 365♀ Nevena x ♂ 3959.

- Varieties Nevena and Valia, which are characterized by the presence of placenta attached;
- Victoria variety and selection lines with numbers 3959 and 3959-3 are non-shattering capsules
- Breeding Line with a catalog number A 800 161 has introduced a model of gene-bank in Grifiyn, USA.

Methods of analysis

Apply method for objectively assessing the susceptibility of and the way of mechanized harvesting of sesame seeds. It is composed in determining the indicators:

$$i_1 = \frac{m_{c1}}{m_{c2} + m_{c3}}, \quad (1)$$

$$i_2 = \frac{m_{c2}}{m_{c1} + m_{c3}}, \quad (2)$$

$$i_3 = \frac{m_{c3}}{m_{c1} + m_{c2}}, \quad (3)$$

where: m_{c1} – share of seeds that are released from the capsules when ripe, [%]. It includes seeds that are released when opening tip in the longitudinal cleavage of the capsules, and those that are released in a smooth rotation of the capsules with the top down; m_{c2} – the share of seeds left in the capsule after the inertial effect [%]; m_{c3} – the proportion of seed left the capsules due to inertial effect [%].

The receipt of partition m_{c2} and m_{c3} is obtained by Pendel apparatus and is defined in detail in (Ishpekov et al., 2015a). The first index i1 is the criterion for dispersal of seeds. The second index i_2 is a criterion for the retention of the seeds in capsul at the time of harvesting, which is due to the peculiarities of its form. i_3 – the third index is a measure of the strength of the relationship between the seeds and placenta. When the value of the first index i_1 is close to 0.05, and the values of i_2 or i_3 are close to 20 it can be considered that the test genotype is perfectly a susceptible to mechanized harvesting. The higher values of i_2 or i_3 showed the most appropriate way to mechanized harvesting – with or without destroying the capsules. Certainly the values of those indices for 43 genotype by two repetitions with four dry capsules. This makes it possible to determine the mass of the seed in capsule.

Statistical methods

For assessing the results and the relationship between the capabilities of capsules to keep seeds and seed weight in capsule using the methods of correlation analysis, multiple regression analysis and Path. For determination of parental couples were used the capabilities of the component analysis (Stamatov and Deshev, 2012). To compile the hybridization program used to work Stamatov et al., 2015; Stamatov, 2015.

Results and Discussion

The results from the measurements (Table 1) show that the greatest mass of the seed capsule i_2 is characterized progeny. One capsule it contain from 0.2 to 0.255 g seeds. The lowest seed weights in the capsule below 0.1 g are 6 progeny that have a mass of 0.04 to 0.098 g. The remaining 25 progeny produced seeds in a capsule with a mass of between 0.1 to 0.19 g. Progenies in which no anatomical mechanisms to retain their seeds and scattered them while shaking are the majority of the studied genotypes. 23 surveyed progeny are at high i_1. Progeny high i_2 are 3 studies. It is striking that these progeny produce capsules very low seed weight. Forms with sesame heights values i_3 characterized by a strong placenta and retain seeds while on them are not being applied inertial effects. 3 surveyed progeny possess strong relationship between the seeds and placenta. The remaining 14 progeny possess similar in value indexes. According to their magnitude, they retain their seeds thanks to the fact that they have a strong relationship between the seeds and placenta or narrowing of the capsule along its length.

Table 1
Progeny studied from different generation's sesame

№	Progeny	Mass of seeds of capsule	i_1	i_2	i_3
1	f2/363-12-2	0.175	0.596	0	1.55
2	f3/362-5-1	0.076	1.033	1.033	0.615
3	f3/361-7-3-1	0.235	3.871	0.580	2.642
4	f4/355-9-2	0.040	0.256	6.090	1.510
5	f2/364-15	0.180	4.310	0.335	3.400
6	f2/365-26	0.130	4.110	0.135	1.400
7	f2/365-25	0.208	11.736	0.155	1.866
8	f3/361-6-1	0.188	4.970	0.378	2.180
9	f2/364-18	0.225	1.206	1.493	1.393
10	f2/363-9	0.085	1.246	0.937	0.806
11	f2/364-6	0.145	17.686	0.076	1.196
12	f3/361-7-8-1	0.2	7.020	0.032	2.770
13	f3/361-4-1	0.208	19.270	0.071	1.270
14	f2/363-20-1	0.098	0.346	6.180	1.030
15	f3/361-6-2	0.222	87.010	0.021	1.870
16	f4/355-2-1	0.250	1.560	1.56	2.765
17	f3/361-4-2-1	0.177	3.190	0.523	1.851
18	f3/361-7-6-1	0.167	1.902	0.760	0.760
19	f4/355-6-1	0.080	0.985	1.311	1.688
20	f2/363-13-1	0.156	1.33	1.173	1.462
21	f4/355-3-2-2	0.125	1.003	1.370	1.313
22	f2/364-20	0.187	4.442	0.404	0.471
23	f4/355-6-2	0.217	1.870	1.036	1.433
24	f3/361-3-6	0.220	2.108	0.838	0.966
25	f3/361-6-3	0.182	0.838	2.561	3.694
26	f3/362-2-1	0.220	4.793	0.428	0.500
27	f2/365-27	0.250	3.154	0.605	0.662
28	f3/361-7-2	0.155	5.715	0.267	0.28
29	f3/361-7-9	0.112	3.292	0.380	0.331
30	f2/364-4	0.255	3.801	0.466	0.472
31	f2/364-16-1	0.230	2.560	0.694	0.765
32	f2/364-8	0.055	0.830	1.413	1.413
33	f2/365-28	0.055	0.390	3.423	3.100
34	f3/361-7-1-2	0.192	3.517	0.512	0.618
35	f3/361-7-1-1	0.160	10.47	0.166	0.184
36	f2/365-6	0.185	11.14	0.230	0.304
37	f2/363-14	0.070	1.580	0.746	0.746
38	f2/363-12-1	0.115	2.466	0.463	0.292
39	f2/363-19	0.217	4.292	0.391	0.398
40	f2/365-17-1	0.070	1.538	0.810	1.170
41	f2/365-18	0.102	3.435	0.356	0.302
42	f2/365-20-1	0.160	16.453	0.181	0.274
43	f3/361-7-4-1	0.147	4.241	0.373	0.441

Progeny with high i_2 influencing the ratio of the mass of seeds in a capsule. The results of correlation analysis (Table 2) show the negative impact of narrowing capsule along its length on the table seeds in the capsule. The correlation coefficient r = -0,432 has established highly. From conducted correlation analysis surveyed progeny is apparent that there is a positive linear relationship between i_1 and i_3, which is a demonstration of the results obtained from relatives in value indexes in individual progeny.

Table 2
The correlations between the studied parameters

	Mass of seeds of capsule	i_1	i_2	i_3
Mass of seeds of capsule	1	0.220	-0.432**	0.034
i_1		1	-0.29097	0.360*
i_2			1	-0.049
i_3				1

**Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

The linear model of high sesame seed weight in the capsule is represented by equation (1)

$$Y = 0.175 + 0.0037\, i_1 - 0.018\, i_2 - 0.00037\, i_3$$

It is obvious that high seed weight in one capsule characterize these samples do not have the ability to detain them. Scattered sesame forms are larger capsules and seeds with higher absolute mass. Path – the coefficient analysis enables us to find hidden relationships between studied indices and mass of seeds in a capsule. The results presented in Table 3 show that the possibilities of influencing the mass of seed by i_1 and i_2 are null and void. The direct effect of increasing the mass of the seed by an increase of i_1 is shown with a direct ratio (0.113097). The negative impact of i_2 demonstrated a direct effect coefficient value (-0.40128). In the direct coefficient of i_3 is also negative (-0.02619), but the mass of the seed indirectly, can be increased by the correlation which exists between i_1 and i_3, the value of implicit coefficient of (0.040779) is higher than the direct.

Table 3
Path – the coefficient analysis between the parameters studied

	i_1	i_2	i_3	Phenotype correlations
i_1	**0.113097**	0.116763	-0.00944	0.220
i_2	-0.03291	**-0.40128**	0.001285	-0.432
i_3	0.040779	0.019688	**-0.02619**	0.034

The surveyed signs indicate two significant components with over one explained of 86.5% (Table 4). The first significant component explained of 43.03% includes weight of seed in capsule, i_1 and i_2. The second significant component explained 71% of the included i_3 (Tables 4 and 5). According Stamatov and 2012 Deshev the features of the individual components are transmitted independently in the progeny.

Table 4
Explanation of the total variance

Komponents	Weight	Cumulative, %
1	1.721597	43.03991
2	1.135599	71.42988
3	0.603106	86.50753
4	0.539699	100

Table 5
Component Matrix

Signs	Komponents	
	1	2
Mass of seeds of capsule	0.681199	
i_1	0.724925	
i_2	-0.7312	
i_3		0.767753

The location of the studied parameters in the component plane is shown in Figure 1. It shows that i_1 and mass of seed in capsule refer positively to the two significant factors, i_2 is negative to both components and i_3 is positive to the second main component and negative at first.

Figure 2 demonstrated the attitude of studied progeny to significant components in factorial plane. It is apparent that

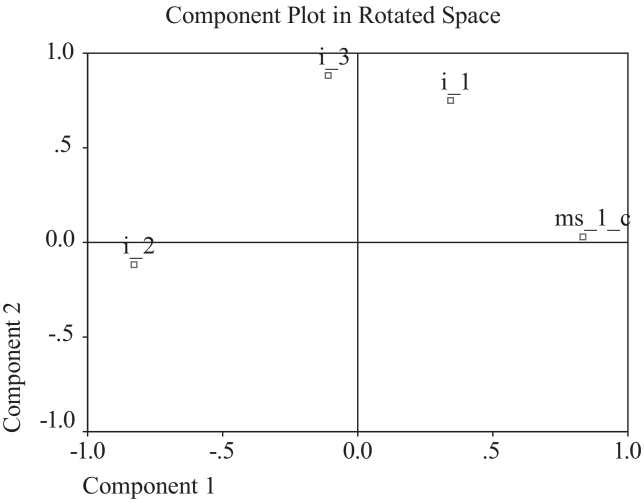

Fig. 1. Location of studied signs in component plane

progeny that disperse their seeds and are characterized by high yield seeds refer positively to two major factors. Progeny numbers 5, 6 and 33 refer positively to factor 2 and a negative factor to 1. These progeny have enough a strong placenta attached. Progeny 33 owns anatomical features of the capsule that allow you to retain your seeds, that seed is approximate in factorial plane to progeny whose shape determines the retention of seeds.

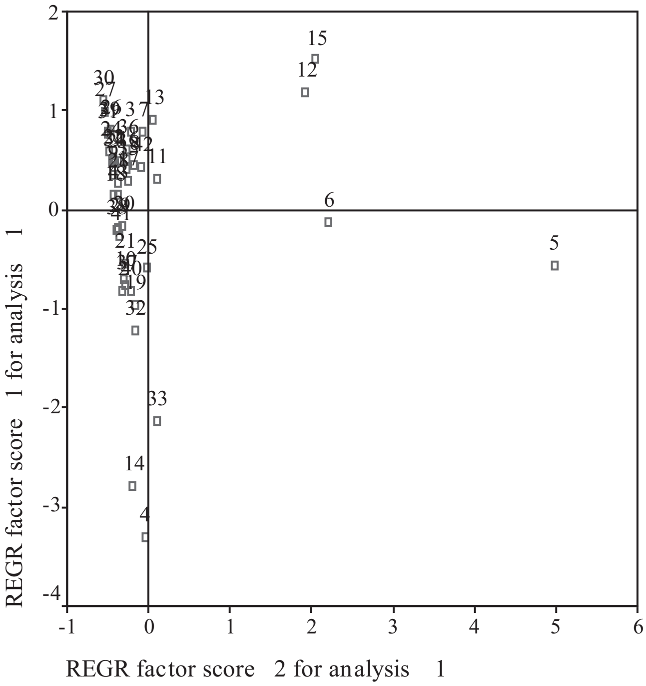

Fig. 2. Location of studied progeny in component plane

In order fasten the and increase the strength of the attached placenta without reducing the mass of seeds in capsule in future breeding work should use direct negative relationship that exists between i_2 with her on one side and hidden relationship that exists between i_1 and i_3. In this sense, for future cross progeny should use the right half of the factorial plane. Success should expect if we do make and reciprocal crosses between 33 and 12 progeny and progeny 5 and 15 (Table 6). These are progeny from different crosses, which guarantees their genetic distance.

Table 6
Plan of hybridization

1	♀ 5 x ♂ 15
2	♀ 15 x ♂ 5
3	♀ 12 x ♂ 33
4	♀ 33 x ♂ 12

Conclusions

The most multiple individual team subjective (by sight) signs is less effective in the selection of sesame, so applies subjective independent method that allows to improve and accelerate the assessment of hybrid materials through share (percentage) of the scattered seed capsules due to inertial effect . This share is determined easily and quickly with a small number of capsules in technological maturity by simply arranged pendelov apparatus, which generates and adds inertia impact on capsules.

43 selected progeny only 6 are definitely not spillage

Of the returnees correlations and regressions show that high seed weight in capsule feature spillage forms sesame. Possibility of increasing the mass of seeds in forms with a strong placenta attached there through the hidden relationship between the indexes i_1 and i_2.

Using parental forms on the right half of the factorial plane can be expected to produce not spillage forms sesame seeds with high index i_3, which produce capsules with high seed weight.

References

Ashkani, J. and H. Pakniyat, 2003. Evaluation of seed yield-related characters in spring safflower (*Carthamus tinctorius* L.) using factor analysis. *Iran Agric. Res.*, 22: 179-189.

Aquaah, G., M. W. Adams and J. D. Kelly, 1992. A factor analysis of plant variables associated with architecture and seed size in dry bean. *Euphytica*, 60: 171-177.

Bidgoli, A. M., G. A. Akbari, M. J. Mirhadi, E. Zand and S. Soufizadeh, 2006. Path analysis of the relationships between seed yield and some morphological and phenological traits in safflower (*Carthamus tinctorius* L.). *Euphytica*, 148: 261-268.

Brejda, J. J., 1998. Factor analysis of nutrient distribution patterns under shrub live-oak two contrasting soils. *Soil Sci. Am. J.*, 62: 805-809.

Denis, J. C. and M. W. Adams, 1978. A factor analysis of plant variables related to yield in dry beans. I. Morphological traits. *Crop Sci.*, 18: 74-78.

Engin, Y., E. Karaman, S. Furat and B. Uzun, 2010. Assessment of selection criteria in sesame by using corelation coefficients, path and factor analyses. *AJCS*, **4** (8): 598-602.

Georgiev, C., S. Stamatov and M. Deshev, 2014. Selection of parent pairs in hybridization of sesame to create varieties for mechanical harvesting by applying quantitative and comprehensive evaluation of source material. *Agrarian Studies*, 16: 39-46.

Ishpekov, S. and St. Stamatov, 2015b. Method for assessment the susceptibility of sesame genotypes for mechanized harvesting of the seed. *Bulgarian Journal of Agricultural Science*, **21** (6): 1230-1233.

Ishpekov, S., R. Zajkov and V. Chervenkov, 2015a. Inertial detachment of sesame seeds from non-squander genotypes. *Agric Eng Int: CIGR Journal*, **1** (3) ISSN 1682-1130.

Langham, D. R. and T. Wiemers, 2002. Progress in Mechanizing Sesame in the US through Breeding. *ASHS Press*, Alexandria, VA, pp. 157-173.

Langham, D. R., G. Smith, T. Wiemers and M. Wetzel, 2004. Southwest Sesame Grower's Pamphlet Sesaco Corporation. www.sesaco.net

Pandya, N. K., S. C. Gupta and A. K. Negda, 1996. Path analysis of some yield contributing traits in safflower. *Crop Sci.*, 36: 982-986.

Rauf, S., M. T. Khan, H. A. Sadaqat and A. I. Khan, 2004. Correlation and path coefficient analysis of yield components in cotton (*Gossypium hirsutum* L.). *Int. J. Agr. Biol.,* 6: 686-688.

Seiler, G. J. and R. E. Stafford, 1979. Factor analysis of components of yield in guar. *Crop Sci.*, 25: 905-908.

Stamatov, S., 2015. Selection program in peanuts choice of parents. *Agrarian Studies*, 17: 43-49.

Stamatov, S. and M. Deshev, 2012. Evaluation of the opportunities for increasing the number of fruit capsules in sesame (*Sesamum indicum* L.) using factor analysis. *Plant Science*, 6: 81-84.

Stamatov, S. and M. Deshev, 2014. Selection approaches for the sesame forms suitable for mechanized harvesting. *Bulgarian Journal of Agricultural Science*, 6: 1435-1438.

Stamatov, C., N. Velcheva and M. Deshev, Use of genetic resources in selection and improvement in peanuts in Bulgaria. International Conference, Banja Luka, May, 2015. http://www.agrores.org/wp-content/uploads/2015/03/PROGRAM_RADA_KONACNO_2015.pdf

Uzun, B., D. Lee, P. Donini and M. İ. Çağirgan, 2003. Identification of a molecular marker linked to the closed capsule mutant trait in sesame using AFLP. *Plant Breeding*, **122** (1): 95-97. www.ni.com/labview/www.usdigital.com/products/interfaces/pc/usb/QSB

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