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Introduced sesame accessions as donors of useful qualities for breeding of mechanized harvesting cultivars

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Abstract

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A subjectively independent method for assessing the relevance of introduced sesame genotypes with different geographic origin for mechanized harvesting was applied. Values of numerical indicators that classify accessions according to their suitability for threshing with or without destroying the capsules were obtained. The results show that the introduced genotypes have a narrowing of capsules in physiological ripening which could successfully eliminate some of the disadvantages in the Bulgarian breeding programs. The relationship between individual indexes and mass of seeds per capsule was evaluated. The possibility of crossing between the studied genotypes that could be combined the appropriate architecture of the capsule for mechanized harvesting with high seed yield in the future generations was assessed. The genetic distance of parent pairs, which guarantee the intensification of these features in future generations, was established.

Keywords: sesame; *Sesamum indicum;* mechanized harvesting; genotypes; breeding

Introduction

In recent years Bulgarian and foreign sesame (*Sesamum indicum* L.) cultivars suitable for mechanized harvesting have been created and breeding programs with such a focus has been developed (Langham, 2001, 2007; Georgiev et al., 2013; Deshev, 2015; Stamatov et al., 2016). At the same time, methods for assessing the parent forms and source materials are developed in terms of their suitability for mechanized harvesting and yield potential (Ishpekov et al., 2015; Ishpekov and Stamatov, 2015; Stamatov et al., 2017). The sesame cultivars – Aida, Valya and Nevena, created as a result of the purposeful breeding-improvement activities, are highly productivity and suitable for mechanized harvesting but in them all the disadvantages are not avoided. Bulgarian sesame cultivars are characterized by a strength attached placenta, but in them the requisite specificity of the capsule is not enough combined. The narrowing of the capsule walls, which prevent the scattering of the seeds caused by wind, combine header and cutting mechanism, is demonstrated to be insufficient. The additional narrowing of the capsules through the entire length would prevent seed scattering caused by these reasons.

The exchange of germplasm with different geographic origin and biological status is a reliable source of donors of valuable economic qualities for improvement of crop breeding (Stamatov et al., 2015). As an appropriate example of a successful program in this area could be mentioned the research achievements of the scientists of SESACO (USA). Due to utilization of a diverse of initial material, the breeders created sesame forms, suitable for mechanized harvesting (Langham, 2006).

In order to improve the Bulgarian germplasm collection with donors, which have the ability to shrink their capsules at the maturity, accessions from international catalogues of plant genetic resources are introduced. Such genotypes have a high value of index 2 (*i*2) according to the Bulgarian methodology. However, the genotypes with a high value of *i*2 are

low-productive and after combining their seeds are damaged and with a low germination.

The sesame seed mass per capsule is directly related to the seed yield (Yol et al., 2010). The breeders have to find the right balance between the tightly attached placenta – index 2 (*i*3) and the narrowing of the capsule walls – a high value of *i*2, for obtaining of high-productive forms, which could retained their seeds until they enter in the threshing mechanism.

The aim of the study was to select appropriate donors from introduced foreign genotypes with a high value of *i*2 to be included in hybridization schemes with Bulgarian sesame cultivars.

Material and Methods

Plant material

By the system of the free germplasm exchange 20 sesame accessions with different geographic origin from the International catalogue GRIN (USA) have been received. The main criteria in the genotypes selection were the phenological feature – early maturity and their agro-technical capacity for mechanized harvesting, which are a basic prerequisite for inclusion of the materials in breeding programs in Bulgaria. The accessions are described by descriptor and all belong to ssp. *bicarpellatum*:

The accession **B700070** is with origin from Mexico and is characterized by a plant height of 100 cm. The stem is strong and not-branched. The capsule is long and there are 1-2 capsules per node.

The accession **B700071** (Mexico) is characterized by a plant height of 110 cm. The stem is strong and not-branched. By describing the morphological features, the genotype has medium length of the capsule, average one per node.

In terms of the growth habit **B700072** from Mexico is characterized by a plant height of 110 cm. The stem is medium-strong and branched. Morphologically, the genotype is distinguished by long capsules and varied number of them per node.

By description of growth habit **B700075** from China is characterized by a plant height of 150 cm. The stem is strong and branched. The genotype is distinguished with medium length of the capsule, average one per node.

The accession **B700076** (China) is characterized by a plant height of 150 cm. The stem is strong and branched. By describing the morphological features, the plant produces long capsules, 2 per node.

By describing the morphological features, Cat. № **B700077** with China origin is characterized by medium-long capsules, one per node. The stem is strong and branched.

The accession **B700080** (local, Turkey) is characterized by a plant height of 160 cm. The stem is medium strong and branched. By describing the morphological features, the genotype produces medium-long capsules, varied number of them per node.

By description of the growth habit **B700087** from Turkey is characterized by a plant height of 70 cm. The stem is strong and branched. Morphologically, the genotype is distinguished by medium-long capsules, one capsule per node.

The accession **B700084** with local origin from India is characterized by a plant height of 140 cm. The stem is strong and branched. By describing the morphological features, the genotype produces average two capsules per node.

The accession **B700085** (India) is characterized by a plant height of 140 cm. The stem is weak and not-branched. By describing the morphological features, the genotype produces medium-long capsules, one capsule per node.

The accession **B700088** (Indian Agricultural Research Institute, New Delhi) is characterized by a plant height of 100 cm. The stem is weak and branched. By describing the morphological features, the genotype produces one capsule per node.

The accession **B700095** with Indian origin is characterized by a plant height of 120 cm. The stem is strong and branched. By describing the morphological features, the genotype produces medium-long capsules, one capsule per node.

Regarding the growth habit **B700089** (Afghanistan) is characterized by a plant height of 150 cm. The stem is strong and branched. Morphologically, the genotype is distinguished by short capsules, one capsule per node.

The accession **B700092** (Afghanistan) is characterized by a plant height of 80 cm. The stem is strong and branched. By describing the morphological features, the genotype produces short capsules, 2 per node.

The accession **B700093** (Afghanistan) is characterized by a plant height of 90 cm, short capsules, one capsule per node. The stem is strong and branched.

Regarding the growth habit **B700094** (Afghanistan) is characterized by a plant height of 70 cm. The stem is strong and branched. Morphologically, the genotype is distinguished by short capsules, one capsule per node.

The accession **B700096** (Afghanistan) is characterized by a plant height of 140-150 cm. The stem is strong and branched. By describing the morphological features, the genotype produces from short to medium-long capsules, one or more per node.

The accession **B700097** (local, Iran) is characterized by a plant height of 140 cm. The stem is strong and branched. By describing the morphological features, the genotype produces one capsule per node.

By description of the growth habit **B700098** – local accession from Iran, is characterized by a plant height of 150 cm. The stem is weak and branched. Morphologically, the genotype is distinguished by medium-long capsules, one per node.

The accession **B700086** (Egypt) is characterized by a plant height of 100 cm. The stem is weak and branched. By describing the morphological features, the genotype produces one capsule per node.

Aida is Bulgarian sesame cultivar with a plant height of 160 cm. It produces one capsule per node. The stem is strong and erect with 3-4 branches. The seeds are large, located in medium-long capsules.

Valya is Bulgarian cultivar with a plant height of 170 cm. The capsules are characterized with medium length, located one capsule per node. The stem is strong with 4-5 branches.

Nevena is Bulgarian cultivar with a plant height of 150 cm. The capsules are medium-long, one capsule per node. The stem is strong with 3-4 branches.

Methods of analysis

Using the subjectively independent method (Ishpekov et al., 2015; Ishpekov and Stamatov, 2015), the capsule ability to retain the seeds until they entered into the threshing mechanism was determined. The indexes which determined the scattering of seeds and the seed mass per capsule were reported. The evaluation was done on 12 capsules, divided into three replications of the experiment.

The Bulgarian cultivars suitable for mechanized harvesting – Aida, Valya and Nevena, were used as standards in the conducted study.

Statistical methods

Using the correlation analysis, the relationships between the resulting indexes and the seed yield was established. Path-coefficient analysis revealed the hidden relationships that exist between *i*2 and studied parameters. The potential of component analysis to determine parent pairs was used (Biabani and Pakniyat, 2008). For the compilation of hybridization program the research work of Stamatov et al. (2015) and Langham (2014) were applied.

Results and Discussion

From the studied sesame genotypes group, the three Bulgarian cultivars are characterized with highest mass of seeds per capsule (Table 1). The seed mass is 0.094 g for Valya, 0,085 g for Aida, and 0,075 g for Nevena. The lowest mass of seeds per capsule produces the foreign genotypes B700070 (0.031 g), B700097 (0.038 g) and B700072 (0.038 g). The other genotypes of the group have a seed mass per capsule in the range of 0.044 to 0.081 g. Two genotypes are with an absence of capsule anatomical architecture to retain the seeds and scatter them in shaking. With the highest value of *i*1 is B700080, followed by B700096. The accession B700070 reacts with high values of *i*1 and *i*2. This genotype has a narrowing of the walls in the middle through the capsule length and the seeds over this narrowing are freely scattered. The capable of retaining their seeds under wind shaking, combine header

Table 1
Seed mass per capsule and indexes of seeds scattering of the studied genotypes

№	Cat. №	Mass of seeds per capsule (g)	*i*1	*i*2	*i*3
1	B700088	0.081	0.000	0.667	0.353
2	B700094	0.050	0.000	0.500	0.400
3	B700084	0.069	0.000	0.833	0.375
4	B700086	0.063	0.000	1.000	0.167
5	B700080	0.056	1.000	0.000	0.286
6	B700089	0.069	0.075	0.667	0.371
7	B700085	0.044	0.000	0.500	0.250
8	B700097	0.038	0.000	0.333	0.429
9	B700087	0.056	0.000	0.750	0.333
10	B700095	0.044	0.190	0.250	0.444
11	B700075	0.069	0.071	0.200	0.397
12	B700093	0.056	0.064	0.250	0.381
13	B700076	0.050	0.154	0.500	0.186
14	B700077	0.075	0.000	1.000	0.333
15	B700070	0.031	1.000	1.000	0.000
16	B700071	0.050	0.000	0.333	0.333
17	B700092	0.050	0.132	0.500	0.355
18	B700098	0.050	0.250	0.250	0.375
19	B700096	0.044	0.667	0.250	0.154
20	B700072	0.038	0.000	0.333	0.429
21	Aida	0.085	0.116	0.110	0.433
22	Nevena	0.075	0.095	0.259	0.499
23	Valya	0.094	0.159	0.295	0.380

Table 2
Correlational relationships between studied indicators

Parameters	Mass of seeds per capsule	*i*1	*i*2	*i*3
Mass of seeds per capsule	1	-0.307	-0.004	0.378*
*i*1		1	-0.144	-0.589*
*i*2			1	-0.471*
*i*3				1

Table 3
Path-coefficient analysis between the studied parameters

Parameters	Mass of seeds per capsule	i1	i3	Phenotypic correlation
Mass of seeds per capsule	0.141	0.193	-0.339	-0.0043
i1	-0.0434	-0.628	0.527	-0.1445
i3	0.0535	0.370	-0.895	-0.4716

Table 4
Explanation of total scattering

Components	Significance	Cumulative %
1	1.918875	47.97186642
2	1.189377	77.70628269
3	0.730224	95.96187115
4	0.161525	100.00000000

Table 5
Component matrix

Parameters	Components	
	1	2
Mass of seeds per capsule	0.022	
*i*1	-0.295	
*i*2		0.292
*i*3	0.078	

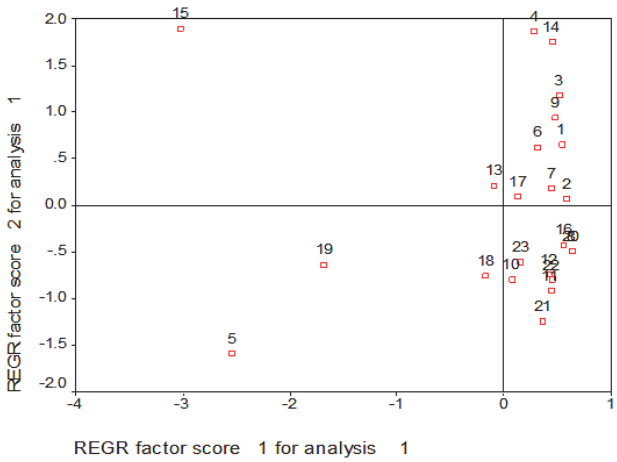

Fig. 1. Location of the studied genotypes in the component plane

or cutting mechanism impact are 16 genotypes. The high value of *i*2 contributes retaining the seeds by shrinking the capsule walls. The seeds could be released only by impact of striking or friction. In the other genotypes the seeds are retained only by the attached placenta and could be separated by application of inertial loading on them.

The future generations have to retain their seeds when the plants are in physiological ripening on the field under negative influences – storms and winds, impact of combine header and inertial cutting mechanism. At the same time, future generations have to combine these characteristics with high seed yield.

There are negative correlations between *i*1, *i*2 and *i*3. Correlation coefficients (-0.89) and (-0.471) are proven at a degree of freedom 0.05 (Table 2). It is established that with a high mass of seeds per capsule are characterized those genotypes, which are retaining their seeds due to the attached placenta (a high value of *i*3).

Path-coefficient analysis allows to detect hidden relationships existing between *i*2, the other indexes and the seed mass per capsule. The results presented in Table 3 indicate that indirectly on the increasing of *i*2 could be effect by reducing the strength of the attached placenta (*i*3), instead of looking for possibility to increase the seed mass per capsule. In this case, the indirect coefficient (-0.339) is higher than the direct path-coefficient (0.141). In future generations reduction of *i*3 have to be searched, thus increasing the seed mass per capsule.

The studied parameters indicated two components with significance over the unit, explained to 95.96%. The first significant component explained at 47.97% includes the seed mass per capsule, *i*1 and *i*3. The second significant component explained at 77.7% includes *i*2 (Tables 4 and 5). According to Biabani and Pakniyat (2008), the parameters from the individual components are transmitted independently from each other.

In Fig. 1 the ratio of the studied genotypes to the significant components in the factorial plane is shown. It is established that genotypes which are retaining their seeds due to the attached placenta and are characterized by high seed yield are positively related to Factor 1 and negatively related to Factor 2. Genotypes, which are positively related to Factor 2, could transfer to future generations the high value of index 2. Introduced accessions No. 4 (B700086), No. 14 (B700077) and No. 15 (B700070) are suitable for hybridization with Bulgarian cultivars Aida, Nevena and Valya. The selected parent pairs are located at a large Euclidean distance, which indicate their genetic difference and provides the expression and magnification of the existing features (Fig. 2).

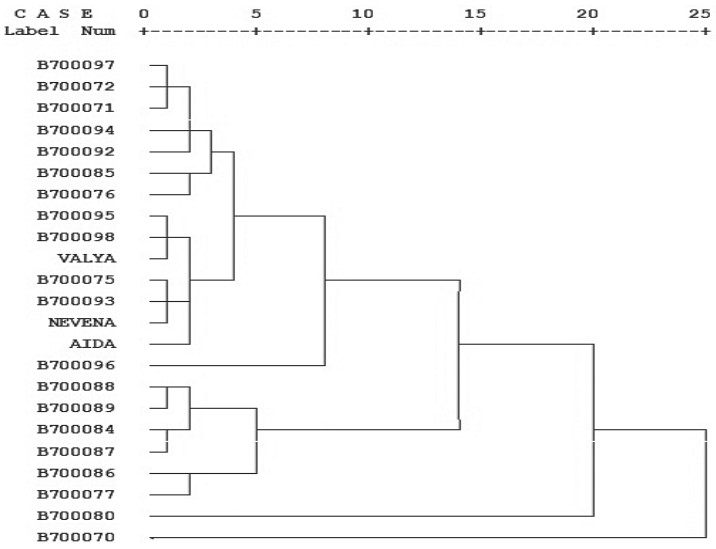

Fig. 2. Dendrogram of cluster analysis

Conclusions

Genotypes have been identified from the studied *Sesamum indicum* L. germplasm collection with different geographic origin, which could be successfully used in hybridization program with Bulgarian breeding materials for obtaining high productivity and suitable for mechanized harvesting.

For increasing the value of *i*2 without to reduce of the sesame seed yield it is recommended crossing of Bulgarian cultivars Aida, Nevena and Valya with genotypes which are falling into the second factorial plane and are characterized with higher values of *i*2 – B700086, B700077 and B700070.

References

Biabani, A. R., & Pakniyat, H. (2008). Evaluation of seed yield-related characters in sesame (*Sesamum indicum* L.) using factor and path analysis. *Pakistan Journal of Biological Sciences*, *11*(8), 1157-1160.

Deshev, M. (2015). Possibilities for increasing the efficiency of the sesame (*Sesamum indicum* L.) breeding for mechanized harvesting. PhD Thesis, Sadovo.

Georgiev, S., Stamatov, S., Deshev, M., Ishpekov, S., Trifonov, A., Petrov, P. & Kolev, B. (2013). *Technology for mechanized cultivation and harvesting of sesame on large flat areas*. IPGR "K. Malkov". Sadovo.

Ishpekov S., Zajkov, R. & Chervenkov, V. (2015). Inertial detachment of sesame seeds from non-squander genotypes. Inertial detachment of sesame seeds from non-squander genotypes. *Agricultural Engineering International: CIGR Journal*, *17*(3), 83-91.

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

Langham, D. R. (2001). Shatter resistance in sesame. In: *Sesame improvements by induced mutations*. Proc. Final FAO/IAEA Coordination Research Meeting, IAEA-TECDOC, No. 1195, 51-61.

Langham, D. R. (2006). Mining for Genes in the NPGS Sesame Collection. In: ASA-CSSA-SSSA Annual meeting, Indianapolis, India.

Langham, D. R. (2007). Phenology of sesame. In: *Issues in New Crops and New Uses,* Janick & Whipkey, eds., ASHS Press, Alexandria, VA, 144-182.

Langham, D. R. (2014). *U.S. Patent No. 8656692 B2*. Washington, DC: U.S. Patent and Trademark Office.

Stamatov, S., Velcheva, N., & Deshev, M. (2016). Utilization of plant genetic resources in peanut breeding program of Bulgaria. *АГРОЗНАЊЕ* /Agro-knowledge Journal, Republic of Srpska/, *16*(3), 289-300.

Stamatov, S., Deshev, M., Ishpekov, S., & Zaykov, R. (2016). Application of the subjective independent method for evaluation of hybrid materials sesame (*Sesamum indicum* L.) in the direction of mechanized harvesting. *Bulgarian Journal of Agricultural Science*, *22*(6), 982-986.

Stamatov, S., Ishpekov, S., Deshev, M., & Zajakov, R. (2017). Application of the independent subjective evaluation method of the hybrid material in the breeding of sesame (*Sesamum indicum* L.). *Bulgarian Journal of Agricultural Science*, *23*(4), 584-588.

Yol, E., Karaman, E., Furat, S., & Uzun, B. (2010). Assessment of selection criteria in sesame by using correlation coefficients, path and factor analyses. *Australian Journal of Crop Science*, *4*(8), 598-602.