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Analysis of Sesame (*Sesamum indicum* L.) Accessions Collected From Different Parts of Turkey Based on Qualitative and Quantitative Traits

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ABSTRACT

An experiment was conducted at the experimental area of Dicle University Faculty of Agriculture, Department of Field Crops in 2014 growing season. A total of 107 diverse sesame accessions collected from Mediterranean, Aegean and Southeastern Anatolia Region of Turkey were sown on 3 May 2014. The experiment was laid out in an augmented experimental design with eleven replications. A total of 25 morphological and agronomical characters of 107 sesame accessions were evaluated following to IPGRI (International Plant Genetic Resources Institute) descriptors of sesame, and the obtained data were evaluated according to their qualitative and quantitative traits. Frequency distribution of qualitative traits and correlation coefficients of quantitative traits were determined. According to the frequency of accessions analyzed, the variability in terms of the qualitative traits examined. Regarding the relationship between quantitative traits, the number of capsules, 1000 seed weight and harvest index were determined significantly affecting the seed yield.

Keywords: Sesame, diversity, accession, correlation, qualitative and quantitative traits

Introduction

Sesame is one of the most important ancient oil seed crops. Though the origin of sesame is not known, archeological remains of sesame dating back to 5500 BC have been found in the Harappa valley in the Indian subcontinent (Bedigian and Harlan, 1986), and it was cultivated and domesticated on the Indian subcontinent during Harrapan and Anatolian eras (Bedigian and Van der Maesen, 2003). Discussion continues about the exact origin of sesame. It is often asserted that sesame has its origin in Africa and spread early through West Asia, China and Japan, which themselves become secondary centers of diversity. With the exception of *Sesamum prostratum* Retz, all the wild *Sesamum* species are found in Africa (Purseglov, 1977).

So far, many countries of the world have sponsored extensive research on breeding methods based on a single and bulk selection of sesame accessions that resulted in the introduction of new varieties. However, sesame breeding studies relative to other crops remains extremely limited, especially in Turkey.

As a result of natural selection for many years , there are numerous varieties and ecotypes of sesame adapted to various ecological conditions of Turkey. But the average seed yield is too low. Low yields are mainly due to absence of non-shattering cultivars suited for mechanical harvest, indeterminate growth, uneven ripening of capsules and biotic and abiotic stresses such as diseases, pests, drought etc. (Venkataramana *et al*., 1999).

Access to a wide range of genetic diversity is critical to the success of any crop breeding programs and the ability to identify genetic variation is indispensable for effective management and use of genetic resources (Varshney *et al*., 2009), and it mainly depends on germplasm characterization (Yogranjan *et al*., 2015).

The above stated constraints to the productivity pose the need for concerted efforts for sesame crop improvement. However, despite, being an ancient but an important oil crop, it is still at an early stage in its breeding history. Characterization of available or existing genetic diversity of crops played a significant role in bringing out a variety with desirable market oriented physio-chemical traits. Information on genetic diversity is noteworthy when working to improve qualitative profile of the crop varieties (Yogranjan *et al*., 2015).

In this context, the aims of the present study were to find out the relationships between the quantitative traits, and to determine varietal difference. Of sesame accessions collected from different regions of Turkey. The study can help breeders better understand the genetic structure of sesame populations which can be used for selection.

Material and Methods

The field experiment was carried out in the experimental area of Field Crops Department, Faculty of Agriculture, Dicle University, Diyarbakır, Turkey (37^0 53^I N and 40^0 16^I E) in 2014. Annual average rainfall in the region is 490 mm, 18%, 44%, 37% and 1% of which falls in autumn, winter, spring and summer, respectively. Water needs of the plant due to lack of rains especially in July-August was met with irrigation water. The soil type was a clay and mid-alkaline. A total of 107 diverse sesame accessions collected from Mediterranean, Aegean and Southeastern Anatolia of Turkey were used as experimental material. The experiment was laid out in an augmented design with 11 replications. Improved cultivars Muganlı 57, Osmanlı 99, and Özberk 82) were repeated as check after every 13 accessions. Each plot had a size of 1.4 x 4 m^2 with two rows (intra-row spacing of 70 cm and inter-row spacing of 10 cm).

Sesame accessions used in the study were examined for qualitative and quantitative traits according to IPGRI (International Plant Genetic Resources Institute) for a total of 25 traits. The frequency distribution of qualitative traits was analyzed. Also, relations between quantitative traits were made through JMP version 11 statistical program according to Jeffers (1967).

Results and Discussion

Morphological descriptors of qualitative traits recorded on 107 sesame accessions are summarized in Table 1.

The frequency distribution of qualitative traits of 107 sesame accessions is summarized in Table 2. Regarding stem hairiness significant differences between accessions were observed, 88 of the total accession being hairless, 18 less hairy and 1 was very hairy (Table 2).

In terms of leaf edges 102 of the accession had flat edge, 3 were the saw-toothed and 2 were observed to be comb-toothed. 103 of accession had straight leaves and 4 of them were less pieced regarding leaf fragmentation.

In terms of leaf hairiness in accession 102 had hairlessness, and 5 had little hairiness. Because of the fact that leaf hairiness has positive effect in terms of preventing water loss, it is a desirable trait in breeding. According to the flower color, variation was seen between accessions, 76 of the accession were light pink and 20 are dark pink-shaded white in and 11 were white. In respect to flower hairiness, 74 of the accession had medium hairiness, 19 were observed to have high hairiness and 14 had very low hairiness. Flower hairiness, as well as preventing the loss of water in flower at high temperatures, it is often preferred because it is considered to have a positive impact on the pollination of flowers. Variability was seen in accessions in terms of stigma length. With 74 of the accessions stigma was observed to be under the anther (short), it was at the anther level in 33 (moderate). Stigma length is an important factor in plant pollination, and if stigma is longer than anther, fertilization may not occur or it may lead to cross fertilization. The fact that stigma is shorter than anther is preferable because it provides a timely fertilization and increases self-fertilization. With respect to the number of flowers in the axil, 94 had only flowering and 13 of accessions were determined to have multiple flowers. With regard to this feature it was determined that, though very little, there was some variability among accessions. The number of flowers in the axil affects fertilization, the number of capsules and efficiency. The accessions were studied in terms of capsule locule number and in 103 of the accession the locule number was 4, while in 4 of the accession the number was determined to be 6. Capsule locule number is important in terms of affecting the number of seeds per capsule and thus affecting the seed yield. In terms of the number of nodes in each capsule variability was observed in the accession, 93 of them were with a single capsule, while 14 had multiple capsules. This feature has a positive effect on seed yield per plant and seed yield per hectare. In terms of capsule form variation was observed in the accession, and in 75 of the accession the capsule had narrow rectangular shape, while 30 were large rectangle type and 2 were observed to have conical shape. In terms of capsule hairiness in the accession, variation was recorded. 89 of the accession had little hairiness, 8 of them had medium hairiness, 6 of them were hairless, while 4 of them were very hairy. Capsule hairiness is a desired feature as it increases tolerance against plant diseases, pests and drought. Variation was seen in the accession in terms of capsule-beak shape, and 76 of the accession had long beak, 30 were found to have short beak and 1 had bent beak. In respect to capsule cracking, 96 of the accession was totally cracked, and in 10 of the accession partial cracking was observed, while 1 showed no cracking. Capsule cracking is not preferred because of lack of spillage during harvest for prevention of loss of productivity and compliance with machine harvest. Seed coat color varied from white to various shades of brown grey to black or red. Seed coat color is a feature for determining the direction of the fat and protein content of seeds. Variation in the accession was also determined with respect to Seed coat, and 48 of the accession were light brown, 27 medium brown, 13 dark brown, 12 beiges, 5 olive-black and 2 of them were observed to be matt black (Table 2).

The relations between quantitative traits

Correlation coefficients of quantitative traits of sesame accessions are given in Table 3. A significant and positive relationship was found between the first capsule height and plant height, harvest index and number of capsules, capsule width and length of the capsule, 1000 seed weight and seed yield, 1000 seeds weight and harvest index, and grain yield and harvest index. As for the relation between the first capsule height and the number of capsules, and the first capsule height and harvest index it was found significant but negative. Our results agreed with similar positive correlation observed by, Uzun and Cagirgan (2001) and Sumathi *et al*., (2007).

Principal component analysis(PCA) revealed that 25% or more of the total variation, might be explained by the first two or three-axis. PCA offers reliable cluster analysis (Mohammadi and Prassana, 2003). The number of seeds per capsule contributed highest towards the divergence followed by number of capsules per plant (Sudhakar *et al*., 2006). Seed yield, number of capsules per plant, plant height and 1000 seed weight are the important contributing factors (Solanki and Gupta, 2002). There was a positive relationship between number of seeds per capsule, capsule number per plant and seed yield per plant. Studies by Majumdar *et al.,* (1987) and Reddy and Haripriya (1992) also reported a highly significant positive correlation between number of seeds per capsule, number of capsules per plant and seed yield per plant. This study showed a positive relationship between plant height, number of branches and seed production. These results were in agreement with previous observations by Gupta and Gupta (1977) and Pathak and Dixit (1992) who reported a positive relationship between plant height, capsules per plant and seed yield.

Conclusions

When the frequency of genotypes in the accession was analyzed, it was found that there is variability in terms of the criteria discussed. Regarding the relationship between the quantitative traits, the number of capsules, 1000 seed weight and harvest index were determined to significantly affect the seed yield. Clustering methods are based on a phenotypic characterization of traits on accessions from which the core collection is to be selected (Hintum,1995). Varieties with high yield potential can subsequently be combined with improvements of others traits such as oil content, plant height, synchronous flowering, synchronous ripening and resistance to pests. This study is crucial in terms of having more reliable results.

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Table 1. Morphological descriptors of qualitative traits recorded on 107 sesame accessions.

Qualitative traits

Trait	**Definition**
Stem hairiness	0: Hairless. 3: Little Hairy. 5: Medium Hairy. 7: Shaggy
Basal leaf margin	1: Flat. 2: Sawtooth. 3: Toothed Comb
Lobe incision of basal leaf	1:Flat. 2: Few Pieces. 3: Medium Pieces. 4: Three or More Lobe
Leaf hairiness	0: Hairless. 3: Little hairy. 5: Medium Hairy. 7: Shaggy
Flower color	1: White. 2: White Light Pink Shaded. 3: Dark pink shaded white. 4: Pink. 5: Open Violet. 6:Dark Violet. 7: Purple. 8: Red. 9: Maroon. 99: (Other)
Flower hairiness	0: Hairless. 3: Little Hairy. 5: Medium Hairy. 7: Shaggy
Stigma length	1: Short (stigma below anthers). 2: Medium (stigma anther level). 3: Long (stigma anther above)
Number flower per leaf axil	1: One. 2: More than one
Number of lobe capsule	Capsule On the main stem; 1: Four. 2: Six. 3: Eight. 4: Mix
Number capsule of per axil	1: single Capsule. 2: Very Capsules
Capsule shape	1: conic. 2: Narrow Rectangle. 3: Large Rectangle. 4: Square
Capsule hairiness	0: Hairless. 3: Little hairy. 5: Medium Hairy. 7: Shaggy
Type of capsule beak	1: Short. 2: Long. 3: Inclined. 4: Separate. 99: Other
Capsule dehiscence at ripening	Maturation period; 1: No Cracking. 2: Partly Cracking. 3: Fully Cracking
Seed coat color	1: White. 2: Cream. 3: Dark Cream 4: Light Brown. 5: Medium Brown. 6: dark Brown. 7: Brick Red. 8: Bronze. 9: Olive color Black. 10: Grey. 11: Matte Black. 12: Bright Black. 99: Other

Table 2. The frequency distribution of qualitative traits of 107 sesame accessions.

Qualitative traits	Index	Number	Frequency (%)
Stem hairiness	0	88	0.82
	3	18	0.17
	5	1	0.01
Basal leaf margin	1	102	0.95
	2	3	0.03
	3	2	0.02
Lobe incision of basal leaf	1	103	0.96
	2	4	0.04
Leaf hairiness	0	102	0.95
	3	5	0.05
Flower color	1	11	0.10
	2	76	0.71
	3	20	0.19
Flower hairiness	3	14	0.13
	5	74	0.69
	7	19	0.18
Stigma length	1	74	0.69
	2	33	0.31
Number of flowers per leaf axil	1	94	0.88
	2	13	0.12
Number of carpels per capsule	1	103	0.96
	2	4	0.04
Number capsules per leaf axil	1	93	0.87
	2	14	0.13
Capsule shape	1	2	0.02
	2	75	0.70
	3	30	0.28
Capsule hairiness	0	6	0.06
	3	89	0.83
	5	8	0.07
	7	4	0.04
Type of capsule beak	1	30	0.28
	2	76	0.71
	3	1	0.01
Capsule dehiscence at ripening	1	1	0.01
	2	10	0.09
	3	96	0.89
Seed coat color	3	12	0.11
	4	48	0.45
	5	27	0.25
	6	13	0.12
	9	5	0.05
	11	2	0.02

Table 3. Correlation coefficients among 10 quantitative traits in sesame accessions.

	PH	FCH	NPB	NC	CL	CW	SN	1000 SW	HI
FCH	**0.6746**								
NPB	-0.1142	0.0285							
NC	-0.2779	**-0.3260**	-0.0495						
CL	0.1489	0.0419	-0.1008	0.0981					
CW	0.2212	0.1782	-0.0349	0.0427	**0.3811**				
SN	-0.0388	-0.0956	0.0026	0.0826	-0.1016	-0.1194			
1000 SW	0.0888	-0.1554	-0.0637	0.1569	0.0933	-0.0011	-0.0014		
HI	-0.0022	**-0.2620**	-0.0765	**0.3541**	0.1990	-0.0689	0.0862	**0.5471**	
SY	0.2040	-0.1489	0.2105	0.1198	0.2176	0.0382	-0.0118	**0.3270**	**0.471**

PH: Plant Height, **FCH:** First Capsule Height, **NPB:** Number of Primary Branches, **NC:** Number of Capsules, **CL:** Capsule Length, **CW:** Capsule Width, **SN:** Seed of Number, 1000 **SW:** 1000 Seed Weight, **HI:** Harvest Index, **SY:** Seed yield

* significant at P < 0.05, ** - significant at P < 0.01. For quantitative traits, Pearson pairwise correlation coefficients were calculated.

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