A study on yield and yield components of twenty genotypes of sesame for planting in Southern Kerman Region

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Abstract

The genetic diversity of sesame genotypes was studied by morphological traits in Southern Kerman Agriculture Research and Training Center in an experiment on the basis of a Randomized Complete Block Design including 20 genotypes with three replications. The studied traits were plant height, the height of the first capsule from the ground, capsule length, the number of first-order auxiliary branches, stem diameter at crown, the number of seeds per capsule, the number of capsules per plant, 1000-seed weight, leaf dry weight, stem dry weight, capsule dry weight and seed yield. It was found that the effect of genetic diversity was statistically significant on plant height, the height of the first capsule from the ground, stem diameter at crown, the number of capsules per plant, 1000-seed weight, leaf dry weight, stem dry weight, capsule dry weight and seed yield at the 1% level and on the number of seeds per capsule at the 5% level. The highest number of capsules per plant (78), 1000-seed weight (3.5 g) and seed yield (1020 kg ha^{-1}) was produced by genotype 9. With respect to the yield and yield components, genotypes GL2, GL8,GL13, GL14 ,GH27 ,local dezful ,local behbehan ,local jiroft ,local kahnuj GL11 and darab one were categorized in the same statistical group in terms of the highest number of seeds per capsule, genotypes GL13 ,GL18 ,local dezful ,local kahnuj and varamin 237 were categorized in the same group in terms of the highest number of capsules per plant, genotypes GL2, GL8, GL11, GL18, GH27, local dezful, local behbehan, local kahnuj, local jiroft and varamin 237 were categorized in the same group in terms of 1000-seed weight, and genotypes GL18 ,GH27 ,GL14 and local dezful were categorized in the same group in terms of the highest yield.

Keywords: sesame, genotype, yield, yield components.

Introduction

Sesame (*Sesamum indicum* L.) is a self-pollination annual from the family of Pedaliaceae. Its economical part is seeds which are composed of nearly 75% oil and protein (Khajehpour and Bagherian Naeini, 2001). Sesame is one of the oldest crops and maybe the oldest oilseed in the world. Today, it is used as a source of edible oil (Dadashi and Khajehpour, 2007). Sesame is invaluable oilseed containing 45-65% oil depending on conditions and cultivar. Its oil is well-durable because of containing an antioxidant phenol compound known as sesamol (Dini Torkamani and Karapian, 2007). Sesame is an oilseed occurring in hot and semi-hot regions. However, its new cultivars have been distributed into moderate regions, too. This crop has a lot of local varieties and is produced traditionally by tenants in most countries (Weise, 2000). FAO reports that the cultivation area (ha), yield (kg) and production rate (t) of sesame was 40 000, 700 and 28 000 in Iran and 7 418 230, 477.5 and 3 542 129 in the world in 2008, respectively (FAO, 2008). In a study on genetic diversity among 27 sesame genotypes using cluster analysis on the basis of Euclidean distance and Ward method, Tabatabaei et al. (2009) categorized the studied genotypes in four groups and found that some Iranian sesame genotypes were categorized the same group with foreign genotypes implying their possible kinship. Sesame is essentially a crop for hot and semi-hot regions and breeding allowed its distribution to more moderate regions. It is mainly distributed between the latitudes of 20°S and 25°N. However, it can grow up to the latitude of 40°N in China, former USSR and the US and to the latitude of 30°S in Australia and 35°S in South America. Sesame normally grows in altitudes of <1250 m although some varieties may be adaptable to the altitudes of 1500 m. The types that grow in high altitudes are usually short and fast-growing with relatively no foliage. They mostly bear just one flower next to the leaf and have low seed efficiency (Ozounidouji et al., 2007). Sesame is a thermophile, short-day crop and so, it prefers hot weather and plentiful light and is sensitive to low temperatures. However, very hot temperatures (over 40°C) decrease the formation of capsules (Behdadi et al., 1998). In a study on evaluating genetic diversity in breeding lines from local sesame landraces, Nasiri and Saeedi (2012) assessed 70 genotypes on the basis of a Randomized Complete Block Design and found that the studied genotypes had significant differences in morphological traits and that sesame lines were highly diverse in terms of the number of branches per plant, the number of capsules per plant and seed yield. This diversity can be exploited for genetic improvement of these traits. Navale et al. (2001) studied 50 sesame genotypes collected from different regions and divided them into six groups by cluster analysis. They reported that the genotypes were normal in terms of genetic and geographical diversity. Nasiri and Saeedi (2012) studied the genetic diversity of 27 sesame genotypes and reported that the genotypes were divided into four groups by cluster analysis on the basis of Euclidean distance and Ward method. They stated that some Iranian sesame genotypes were categorized with foreign genotypes implying their possible kinship. According to factor analysis, six factors explained 74.09% of the diversity. According to previous studies, 35 RAPD primers (from the series of operon primers) were selected, out of which 10 primers exhibited clear, replicable bands for the genotypes. Polymorphism for all indicators was 56.3%. The results of morphological and molecular data revealed non-significant correlation between these two series of data. The results of this study can be used in preservation, categorization and breeding of Iranian genotypes of sesame. Southern Kerman region with an area of 40 000 km^2 is located in southeastern Iran with the longitude of 5617 E. and latitude of 2643 N. It is limited to Kerman from the north, Jaz Murian swamp and Hormozgan Province from the south, to Sistan and Baluchestan Province and Bam from the east and Baft and a part of Hormozgan Province from the west. Southern Kerman region has some global records in the production of some crops per unit area.

In this sense, it is one of the few regions in the world in which potato, onion, cucumber, watermelon, tomato, maize, etc. are planted and harvested twice a growing year. It is an important agriculture region in Iran which controls the projects of continuous supply-demand of potato and onion and out-of-the-season maize. It has a promising future in non-oil exports of Iran. Attempts have started in Agriculture Research Center of Southern Kerman since a few years ago to introduce new adapted, high-yielding cultivars to substitute the local variety currently used by most farmers. As a result, JL13 line was introduced by which mean yield per unit area can be increased. It is necessary to conduct plant improvement studies (e.g. plant density) on this cultivar to introduce a new cultivar. The fact that agronomists are, today, aware that potentially high yield can be produced by supplying optimum environmental conditions (appropriate sowing date and the use of cultivars and lines adapted to regional climate), moisture through irrigation, soil fertility through fertilization and higher genetic capacity by new pure lines only after adjusting environmental conditions shows the necessity for conducting similar studies. The objective of the present study was to evaluate and use different cultivars of sesame in the fields of Southern Kerman.

Materials and Methods

The genetic diversity of sesame genotypes was studied by morphological traits in Southern Kerman Agriculture Research and Training Center in an experiment on the basis of a Randomized Complete Block Design including 20 genotypes with three replications. Soil preparation operation included plowing, disking and leveling. Then, furrows were created with the spacing of 60 cm. Then, they were leveled by workers and were prepared for planting. In addition, the soil was fertilized according to soil test before sowing. The plots were composed of sowing rows 6 m long. Two rows were left unplanted between adjacent main plots and one row was left unplanted between adjacent sub-plots. The seeds were sown by hand on rows with the spacing of 10 cm at the depth of 2-3 cm in July. To accelerate emergence, the second irrigation was carried out immediately after sowing. The irrigation interval was shorter during early growth period and then, it was increased to 7-10 days after the establishment and growth of the plants. The operations of thinning, weeding and fighting with pests and diseases were carried out according to conventional practices. The measured traits included seed yield, plant height, the height of the first capsule from the ground, capsule length, the number of first-order auxiliary branches, stem diameter at crown, the number of seeds per capsule, the number of capsules per plant, 1000-seed weight, leaf dry weight, stem dry weight, capsule dry weight and seed yield. The plants were sampled during growth period to estimate shoot dry weight, plant height, stem diameter, etc. At each sampling, 10 plants were harvested from the second and third rows after eliminating 50 cm as margin effect. Then, they were packaged in plastic bags. The leaves and stems were naturally dried in fresh air and their dry weight was determined by digital scale. Then, leaf area was calculated by area:weight ratio method. The final harvest was done manually when the plants were still green and the seeds inside the capsules were yellow to brown in color. After that, the seeds and whole dry plants were weighed to find out seed yield and biological yield. After recording the intended traits, the data were statistically analyzed by SAS software package and the means were compared by Duncan Test at the 5% level. The graphs were drawn by MS-Excel software package.

Results and Discussion

According to the results of analysis of variance, genetic diversity affected plant height significantly at 1% level (Table 1). The studied genotypes exhibited significant differences in plant height so that the highest plant height of 192.7 cm was related to genotype GL29. Genotype 8 had no significant differences with genotypes GL8, GL11, GL13, GL14, GL18, GL27, Local Dezful, Local Kahnuj and oltan. The lowest plant height of 107.2 cm was observed in genotype Borazjan 5 with no significant differences with genotypes GL5 and yeckta (Fig. 1).

Analysis of variance revealed that the influence of genetic diversity was statistically significant on the height of first capsule from the ground at 1% level (Table 1). The studied sesame genotypes showed significant differences in this trait so that the highest height of first capsule (107.2 cm) was seed in genotype GL11. There were no significant differences between genotypes GL11 and GL8 and between genotypes GL8 and GL13. Also, no significant differences were observed amongst genotypes GL13, GL14, GL18, GL29, GL27, Local Dezful, Local Jiroft, Local Kahnuj, Darab one, oltan, Naz manifold, Borazjan 2 and Varamin 237. The lowest height of the first capsule (49.07 cm) was devoted to genotype yeckta which showed no differences with genotypes Local Behbehan and GL5. As analysis of variance indicated, genetic diversity did not impact capsule length significantly (Table 1). The highest capsule length (29.68 mm) was found to be devoted to genotype GL2 and the lowest one to genotype Varamin 237. Genetic diversity, also, did not significantly influence the number of first-order auxiliary branches (Table 1) so that the highest number of first-order auxiliary branches (3.7) was observed in genotype GL13 and the lowest number in genotypes GL8 and Naz manifold. Analysis of variance showed that genetic diversity significantly affected stem diameter at crown at 1% level (Table 1). The studied genotypes of sesame showed significant differences in terms of stem diameter at crown so that the highest stem diameter of 13.45 mm was observed in genotype Local Dezful with no significant differences with genotypes GL29, GL27, Local Dezful and Local Jiroft. As well, genotypes GL13, GL14, GL18, GL29, GL27, Local Behbehan, Local Jiroft and Varamin 237 were categorized in the same statistical group. The lowest stem diameter of 7.9 mm was devoted to genotype GL8 with no significant differences with genotypes GL2, GL5, Local Jiroft, yeckta, oltan, Naz manifold, Borazjan 2 and Borazjan 5. According to the results of analysis of variance, the number of seeds per capsule was significantly influenced by genetic diversity at 1% level (Table 1). Means comparison revealed that genotype GL27 produced the highest number of seeds per capsule (78). It was categorized in the same statistical group with genotypes GL2, GL8, GL11, GL13, GL14, Local Dezful, Local Behbehan, Local Jiroft, Local Kahnuj, Darab one, oltan, Borazjan 2 and Varamin 237. The lowest number of seeds per capsule was observed in genotypes Naz manifold and yeckta (65.67) (Fig. 2). In a study on the number of sunflower seeds per head, Roshdi et al. (2007) stated that the number of the seeds was the highest in genotype Hysun 33 (2166.395) and the lowest in genotype Iroflor (852.791). It can be explained by the fact that although genetics is an important factor causing variations in genotypes in terms of seed number per head (Majid and Schneiter, 1987), the traits responds differently to the effect of year and is affected by the environmental conditions from the period before the initiation of pollination.

As analysis of variance revealed, genetic diversity significantly affected the number of capsules per plant at 1% level (Table 1). According to means comparison, the highest number of capsules per plant (118 capsules) was seed in genotype GL13 with no significant differences with genotypes GL18, Local Dezful, Local Kahnuj and Varamin 237. The lowest number of capsules per plant (43 capsules) was devoted to genotype GL11. Thousand-seed weight was influenced by genetic diversity at 1% level (Table 1). Means comparison revealed that genotype oltan had the highest 1000-seed weight (3.5 g) without exhibiting significant differences with genotypes GL2, GL8, GL11, GL18, GL27, Local Dezful, Local Behbehan, Local Jiroft, Local Kahnuj and Varamin 237. Genotypes GL5, GL29 and yeckta had the lowest 1000-seed weight of 2.9 g (Fig. 3). Seed weight of sunflower is an important component affecting their seed yield whose final status is determined at seed filling period (Roshdi et al., 2010). Therefore, since the seed filling period was not the maximal in genotype oltan in the present study but it had the highest 1000-seed weight (3.5 g), it seems that seed filling rate of this cultivar was more influential on its seed weight than its seed filling duration.

Leaf dry weight was significantly influenced by genetic diversity at 1% level (Table 1). Sesame genotypes showed significant differences in terms of leaf dry weight so that the highest leaf dry weight of Borazjan 5 g was observed in genotype GL29. There were no significant differences in leaf dry weight of genotypes GL13, GL18, Local Dezful, Local Kahnuj, Darab one and Borazjan 5. The lowest leaf dry weight of 2 g was related to genotype GL5. However, it was categorized in the same statistical group with genotypes GL2, GL8, GL11, Local Behbehan and Naz manifold. Stem dry weight was affected by genetic diversity at 1% level (Table 1). Sesame genotypes had significant differences in stem dry weight so that the highest stem dry weight (38.33 g) was related to genotype Local Dezful. It had no significant differences with genotypes GL29, GL27, GL13, Local Kahnuj, Varamin 237 and Borazjan 5. The lowest stem dry weight (11.47 g) was produced by genotype Local Jiroft which showed no significant differences with genotypes GL2, GL5, GL8, GL11, GL14, Darab one, yeckta, oltan, Naz manifold and Borazjan 2. Capsule dry weight was affected by genetic diversity at the 1% level (Table 1). Means comparison showed that the highest capsule dry weight (18.67) was observed in genotype GL18. It did not have significant differences with genotypes GL13, GL29, GL27, Local Dezful, Local Behbehan, oltan, Varamin 237 and Borazjan 5. The lowest capsule dry weight (5.47 g) was related to genotype Varamin 237. No significant differences were observed among genotypes Varamin 237, GL2, GL5, GL8, GL11 and Darab one. Seed yield was significantly impacted by genetic diversity at the 1% level (Table 1). Sesame genotypes had significant different seed yield so that the highest seed yield of (1020 kg) was related to genotype GL27. Genotype GL27 had no significant difference in seed yield with genotypes GL14, GL18 and Local Dezful. The lowest seed yield (200 kg) was produced by genotype yeckta with no significant differences with genotypes GL2, GL5 and Borazjan 5 (Fig. 4). In studies on sunflower, Khalilvand-Behroozyar et al. (2010) and Roshdi et al. (2010) showed the superiority of the cultivar Record and found that the genotype Iroflor produced the lowest yield (240.160 g m^{-2}) which could be related to the yield differences of the genotypes.

The study on genetic diversity among 20 sesame genotypes by cluster analysis on the basis of Euclidean distance and Ward method categorized the studied genotypes in 8 groups implying their kinship.

Conclusion

It was found out that sesame genotypes had significant differences in plant height so that the highest plant height (192.7 cm) was observed in genotype GL29 which did not have significant differences with genotypes GL8, GL11, GL13, GL14, GL18, GL27, Local Dezful, Local Kahnuj and oltan. The lowest plant height (107.2 cm) was related to genotype Borazjan 5. However, this genotype had no significant differences with genotypes GL5 and yeckta. Sesame genotypes exhibited significant differences in terms of the height of the first capsule from the ground so that genotype GL11 had the highest height of the first capsule from the ground (107.2 cm) with no significant difference with genotype GL8. Genotype GL8 had no significant difference with genotype GL13, either. No significant difference was found between genotypes GL13, GL14, GL18, GL29, GL27, Local Dezful, Local Jiroft, Local Kahnuj, Darab one, oltan, Naz manifold, Borazjan 2 and Varamin 237. The lowest height of the first capsule from the ground

(49.07) was observed in genotype yeckta. It had no significant difference with genotypes Local Behbehan and GL5. Sesame genotypes showed significant differences in stem diameter at crown so that the highest stem diameter at crown (13.45 mm) was related to genotype Local Dezful with no significant difference with genotypes GL29, GL27, Local Dezful and Local Jiroft. In addition, genotypes GL13, GL14, GL18, GL29, GL27, Local Behbehan, Local Jiroft and Varamin 237 were categorized in the same statistical group. The lowest stem diameter at crown (7.9 mm) was observed in genotype GL8. This genotype had no significant difference with genotypes GL2, GL5, Local Jiroft, yeckta, oltan, Naz manifold, Borazjan 2 and Borazjan 5. Analysis of variance indicated that the effect of genetic diversity was significant on the number of seeds per capsule. Means comparison revealed that the highest number of seeds per capsule (78) was produced by genotype GL27. It was categorized in the same statistical group with genotypes GL2, GL8, GL11, GL13, GL14, Local Dezful, Local Behbehan, Local Jiroft, Local Kahnuj, Darab one, oltan, Borazjan 2 and Varamin 237. The lowest number of seeds per capsule (65.67) was produced by genotypes Naz manifold and yeckta. It was revealed that genetic diversity significantly impacted the number of capsules per plant. According to means comparison, genotype GL13 produced the greatest number of capsules per plant (118) but it had no significant difference with genotypes GL18, Local Dezful, Local Kahnuj and Varamin 237. Genotype GL11 produced the lowest number of capsules per plant (43)

According to the results, genotype GL27 had the highest number of capsules per plant (78), 1000-seed weight (3.5 g) and seed yield (1020 kg ha^{-1}). In terms of yield and yield components, genotypes GL27, GL2, GL8, GL11, GL13, GL14, Local Dezful, Local Behbehan, Local Jiroft, Local Kahnuj and Darab one were categorized in the same statistical group in terms of the highest number of seeds per capsule, genotypes GL13, GL18, Local Dezful, Local Kahnuj and Varamin 237 were categorized in the same statistical group in terms of the number of capsules per plant, genotypes oltan, GL2, GL8, GL11, GL18, 9, Local Dezful, Local Behbehan, Local Jiroft, Local Kahnuj and Varamin 237 were categorized in the same statistical group in terms of the highest 1000-seed weight, and genotypes GH27, GL14, GL18 and Local Dezful were categorized in the same statistical group in terms of the highest yield.

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Table 1. Analysis of variance of the studied traits of sesame

Sources of variation	df	Means of squares (MS)					
		Plant height	Height of first capsule from ground	Capsule length	Number of first-order auxiliary branches	Stem diameter at crown	Seed number per capsule
Replication	2	101.233	34.135	24.436**	0.867	3.279	125.117**
Genotype	19	1995.625**	603.693**	1.124	1.238	6.012**	42.821*
Experimental error	38	217.923	88.959	1.115	1.025	1.521	21.082
Coefficient of variations (%)		9.38	12.48	3.8	37.26	11.8	6.42

Sources of variation	df	Means of squares (MS)					
		Capsule no./plant	1000-seed weight	Leaf dry weight	Stem dry weight	Capsule dry weight	Seed yield
Replication	2	256.267	0.032	2.971	83.101	13.322	5532.35
Genotype	19	1280.59**	0.131**	43.601**	172.735**	40.969**	136111.666**
Experimental error	38	193.951	0.031	3.232	33.931	7.575	15882.929
Coefficient of variations (%)		17.4	5.48	25.58	24.44	21.01	19.69

Table 2. Coefficient of correlation between the studied traits of sesame

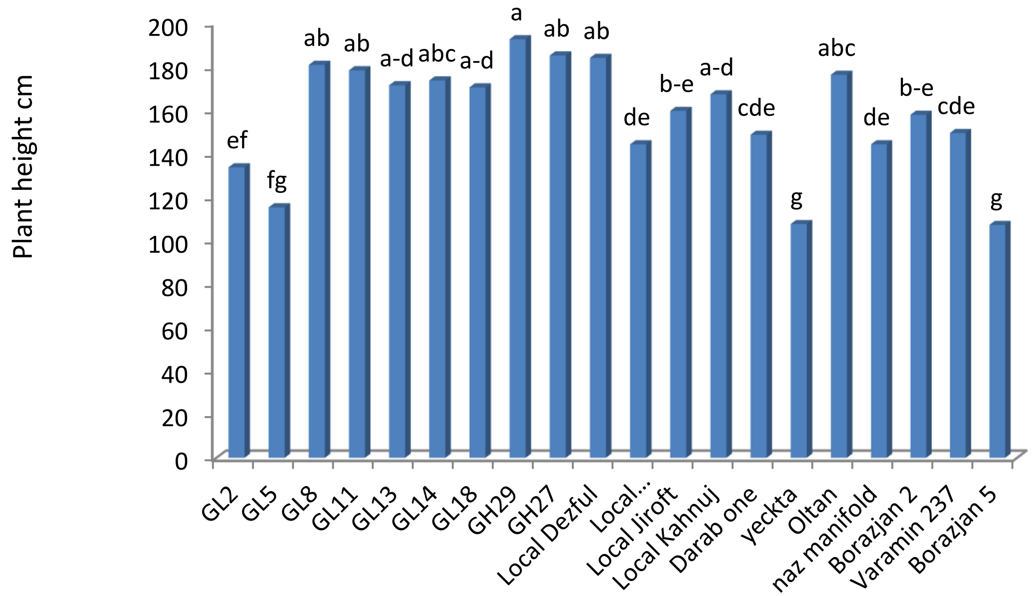
Traits	Plant height	Height of first capsule from ground	Capsule length	Number of first-order auxiliary branches	Stem diameter at crown	Seed number per capsule	Capsule no./plant	1000-seed weight	Leaf dry weight	Stem dry weight	Capsule dry weight
Plant height	1										
Height of first capsule from ground	0.733**	1									
Capsule length	0.323	0456*	1								
Number of first-order auxiliary branches	0.087	0.062	0.155	1							
Stem diameter at crown	0.555*	0.278	0.113	0.728**	1						
Seed number per capsule	0.517*	0.530*	0.552*	0.323	0.501*	1					
Capsule no./plant	0.223	0.025	-0.024	0.794**	0.691**	0.277	1				
1000-seed weight	0.319	0.413	0.452*	0.315	0.306	0.615**	0.234	1			
Leaf dry weight	0.398	0.004	0.236	0.293	0.464*	0.022	0.446*	0.111	1		
Stem dry weight	0.420	0.163	0.075	0.654**	0.758**	0.331	0.663**	0.072	0.528*	1	
Capsule dry weight	0.342	0.024	0.029	0.728**	0.734**	0.262	0.722**	0.152	0.488*	0.740**	1
Seed yield	0.833**	0.570**	0.318	0.298	0.755**	0.521*	0.390	0.385	0.269	0.521*	0.408

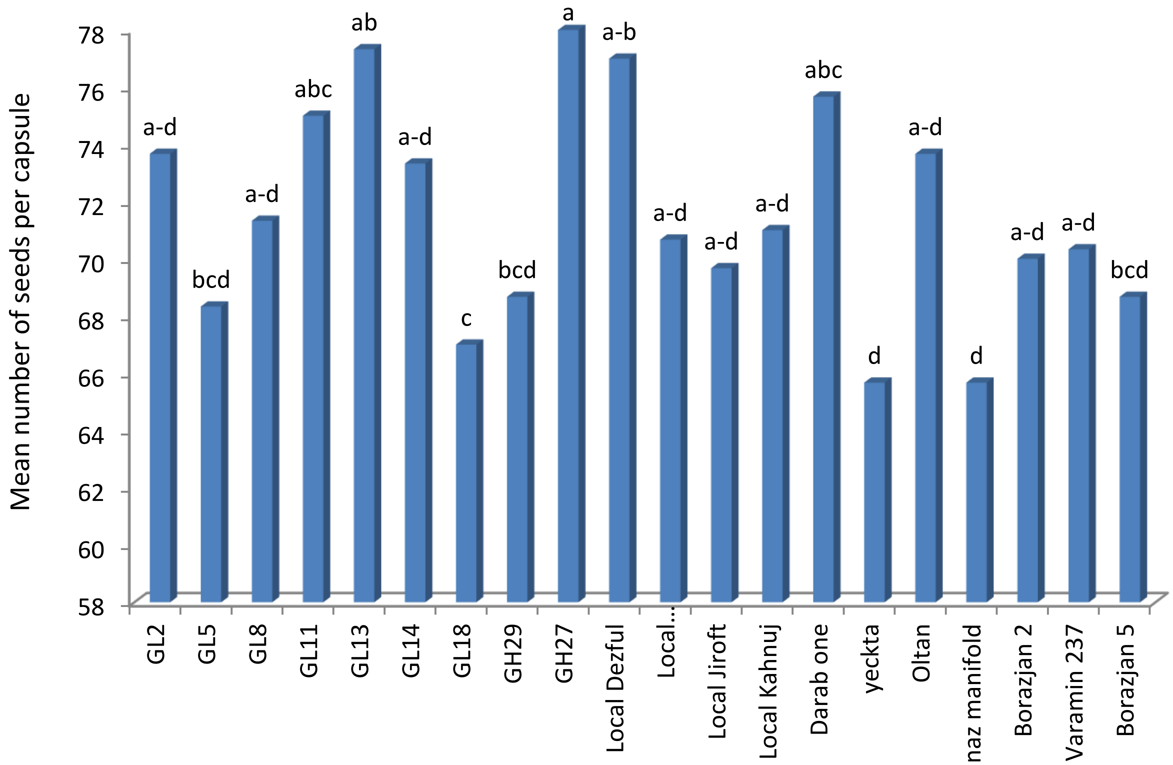
Fig. 1. Mean plant height of the studied genotypes of sesame

Fig. 2. Mean number of seeds per capsule of the studied genotypes of sesame

Fig. 3. Mean 1000-seed weight of the studied genotypes of sesame

Fig. 4. Mean seed yield of the studied genotypes of sesame


Plant height cm
200
180
160
140
120
100
80
60
40
20
0
ef
fg
ab
ab
a-d
abc
a-d
a
ab
ab
de
b-e
a-d
cde
g
abc
de
b-e
cde
g
GL2
GL5
GL8
GL11
GL13
GL14
GL18
GH29
GH27
Local Dezful
Local…
Local Jiroft
Local Kahnuj
Darab one
yeckta
Oltan
naz manifold
Borazjan 2
Varamin 237
Borazjan 5


Mean number of seeds per capsule
78
76
74
72
70
68
66
64
62
60
58
a-d
bcd
a-d
abc
ab
a-d
c
bcd
a
a-b
a-d
a-d
a-d
abc
d
a-d
d
a-d
a-d
bcd
GL2
GL5
GL8
GL11
GL13
GL14
GL18
GH29
GH27
Local Dezful
Local...
Local Jiroft
Local Kahnuj
Darab one
yeckta
Oltan
naz manifold
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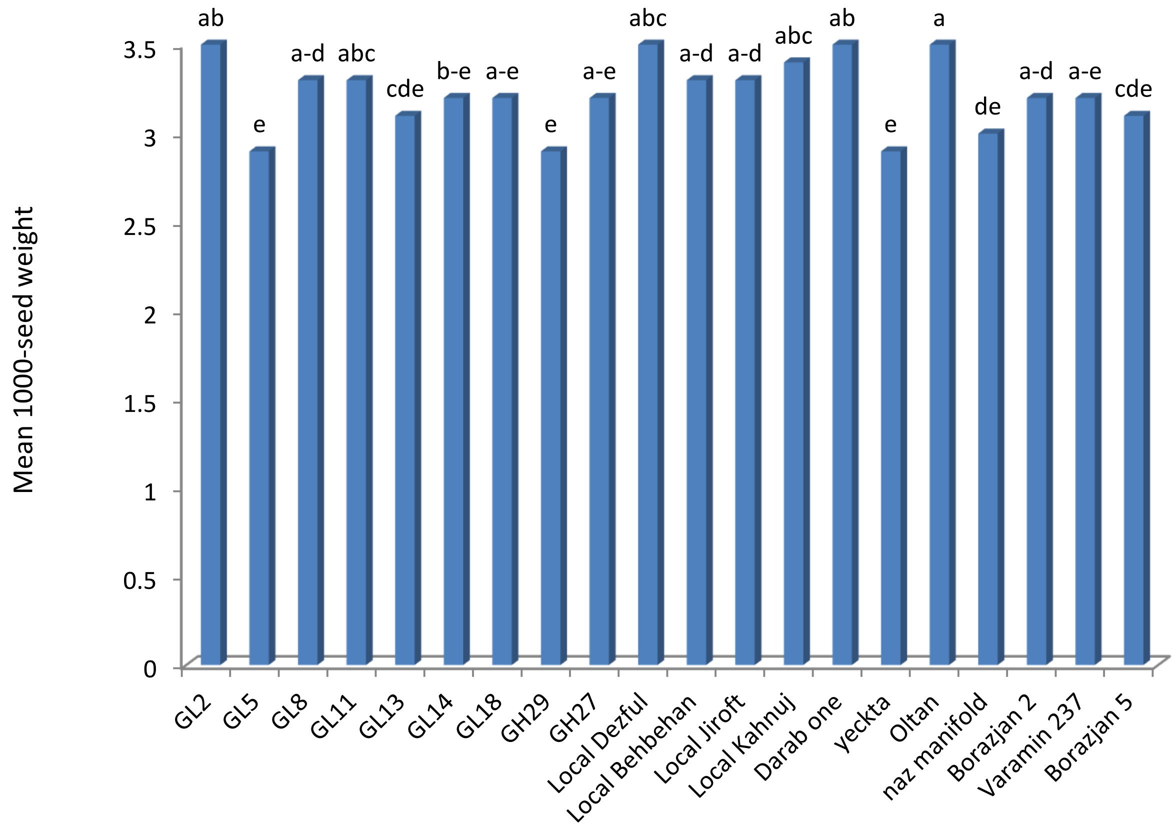
Varamin 237
Borazjan 5


Mean 1000-seed weight
0
0.5
1
1.5
2
2.5
3
3.5
ab
e
a-d
abc
cde
b-e
a-e
e
a-e
abc
a-d
a-d
abc
ab
e
a
de
a-d
a-e
cde
GL2
GL5
GL8
GL11
GL13
GL14
GL18
GH29
GH27
Local Dezful
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Local Kahnuj
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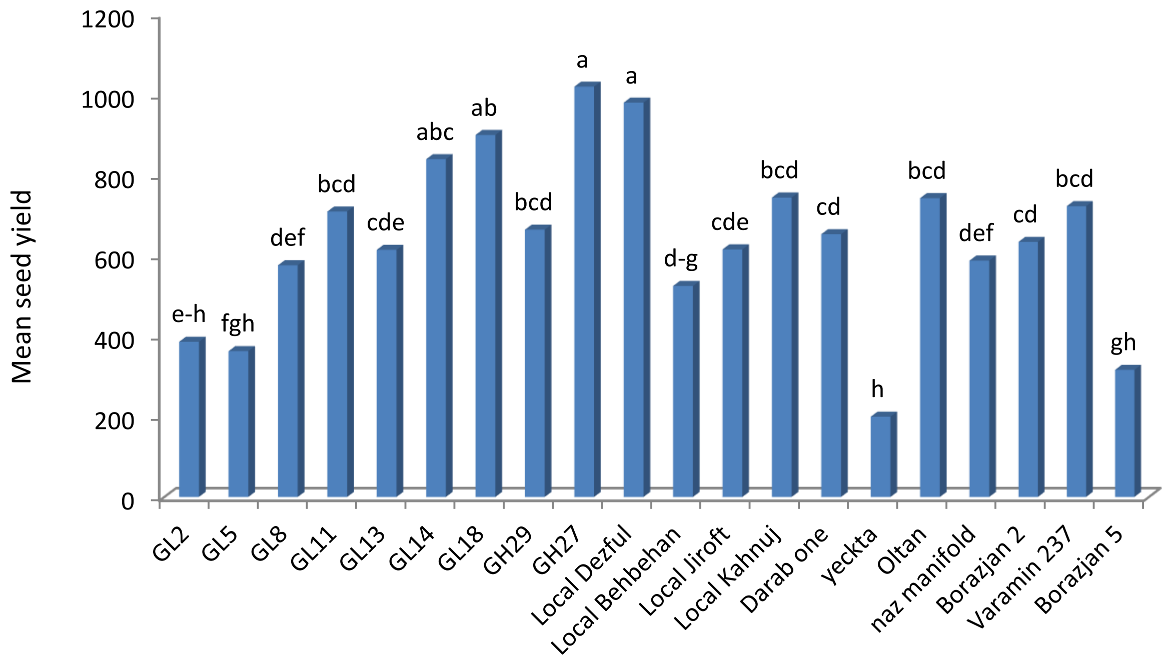
yeckta
Oltan
naz manifold
Borazjan 2
Varamin 237
Borazjan 5


Mean seed yield
0
200
400
600
800
1000
1200
e-h
fgh
def
bcd
cde
abc
ab
bcd
a
a
d-g
cde
bcd
cd
h
bcd
def
cd
bcd
gh
GL2
GL5
GL8
GL11
GL13
GL14
GL18
GH29
GH27
Local Dezful
Local Behbehan
Local Jiroft
Local Kahnuj
Darab one
yeckta
Oltan
naz manifold
Borazjan 2
Varamin 237
Borazjan 5