Development of eggplant hybrid cultivar 'BATEM FILIZI' and determination of yield performance

Hatice Filiz BOYACI[1*] Volkan TOPÇU[1]

[1] Batı Akdeniz Agricultural Research Institute, Antalya

Received: 17 October 2014 Accepted: 18 December 2014

Abstract

Eggplant (*Solanum melongena* L.) cultivation is an important part of vegetable production in Turkey. It is highly affected by abiotic stress factors such as low temperatures during growth and development. The present study was aimed to improve new hybrid varieties with high quality and fruit setting under undesirable environmental conditions in eggplant. The 39 inbred lines were developed from eggplant genepool by using pedigree breeding method at the Bati Akdeniz Agricultural Research Institute. They were characterized morphologically and evaluated for phylogenetic relationship among them. Selected seven lines were crossed each other to obtain F1 hybrids. Thirteen hybrids from these crosses were examined for their rate of heterosis and heterobeltiosis. These hybrids were not suitable for market demands although F1 hybrids including P350 as parental line had high heterosis rate. Oval fruit shaped P350 inbred line as female parent showed good performance and crossed with long fruit shaped P599 inbred line. The resultant F1 hybrid cultivar higher yielding, suitable for production under greenhouse and highly adaptable was registered with the name of BATEM FILIZI. It is recommended that this hybrid can be used in greenhouse production especially in single crop season.

Keywords: Breeding, Heterosis, Heterobeltiosis, Greenhouse, Phylogenetic relationship

'BATEM FILIZI' hibrit patlıcan çeşidinin geliştirilmesi ve verim performansının belirlenmesi

Özet

Patlıcan Türkiye'de üretilen önemli sebze türlerinden birisidir. Büyümesi ve gelişmesi sırasında düşük sıcaklık gibi abiyotik stres faktörlerinden oldukça etkilenir. Sunulan çalışmada, patlıcanda olumsuz çevre koşulları altında meyve tutumu ve kalitesi yüksek yeni hibrit çeşitlerin geliştirilmesi amaçlanmıştır. Pedigri ıslah metodu

[*] Sorumlu yazar (Corresponding author): filiz_boyaci@yahoo.com

kullanılarak Batı Akdeniz Tarımsal Araştırma Enstitüsü patlıcan gen havuzundan 39 adet hat geliştirilmiştir. Bu hatlar morfolojik olarak karakterize edilmiş ve aralarındaki filogenetik ilişki değerlendirilmiştir. F1 hibrit elde etmek için seçilen 7 hat arasında melezlemeler yapılmıştır. Bu melezlemelerden elde edilen 13 adet hibritin heterozis ve heterobelitiosis oranları incelenmiştir. P350 hattının da ebeveyn olarak yer aldığı F1 hibritler yüksek heterozis oranlarına sahip olmasına rağmen, bu hibritler pazar taleplerine uygun bulunmamıştır. Ana ebeveyn olarak iyi bir performans gösteren oval meyveli P350 ile uzun meyveli P599 melezlenmiştir. Sonuç olarak, elde edilen yüksek verimli, serada yetiştirilmeye uygun adaptasyon kabiliyeti yüksek bu hibrit BATEM FİLİZİ olarak tescile alınmıştır. Bu çalışmada geliştirilen hibrit özellikle tek ürün döneminde örtüaltı yetiştiriciliğinde kullanılabilir.

Anahtar kelimeler: Islah, Heterozis, Heterobeltiosis, Sera, Filogenetik ilişki

1. Introduction

Eggplant (*Solanum melongena* L.) is an annual and herbaceous plant that has large diversity for fruit color, shape and size etc. (Sidhu et al., 2005). It is grown in Asia, Africa, and the subtropics, including southern USA and the Mediterranean region (Daunay, 2008; Mutlu et al., 2008). They showed a wide variation according to their morphological structure (Cerciola et al., 2013). A large number of cultivars have been cultivated throughout the world according to market needs and consumer demands (Sidhu et al., 2005). In the last thirty years, many different commercial F1 hybrids have been developed and offered to the market (Sekara et al., 2007).

Although eggplant is a warm climate crop, it is grown in greenhouse conditions during all year in the Mediterranean region (Abak and Guler, 1994). The yield and quality losses are one of the important problems faced in greenhouse production of eggplant. The low temperatures have unfavorable effect on plant growth, pollen viability, pollen quantity and fertility and fruit setting on eggplant especially in winter seasons (Acciarri et al., 2002). The high yielding hybrid cultivars have been developed specifically to overcome problems derived from out of season production under adverse environmental conditions in Mediterranean climate areas (Prohens et al., 2005). These commercial hybrids are usually less affected by adverse weather conditions (Rodríguez et al., 2008) and some of them are parthenocarpic cultivars (Rotino et al., 1997; Donzella et al., 2000; Spena and Rotino 2001; Kikuchi et al., 2008; Saito et al., 2009). However, some parthenocarpic eggplant cultivars have not given sufficient yield during the winter growth period. Therefore, it has been reported by Acciarri et al.

(2002), that they need to be applied phytohormones. Some researchers have tried to solve yield and quality loss problems with using rootstock (Schwarz et al., 2010). This solution is expensive for growers because they have to pay fees both cultivar and rootstock. Also, there is a need a good knowledge and experience for using of grafted plants in the eggplant production. The best solution for overcoming these problems is to develop fruitfully hybrids under lower temperature.

This study aimed to improve a new F1 hybrid eggplant cultivar having high productivity, good quality, adaptability under unfavorable environmental conditions.

2. Materials and Methods

The study was carried out at Batı Akdeniz Agricultural Research Institute (BATEM) in Antalya, Turkey, between 2003 and 2011.

2.1. Materials

BATEM eggplant genepool including inbred lines and population was used.

2.2. Methods

The pedigree breeding method was used and following steps were carried out. At the beginning of the study, a large F_2 population was derived from crosses of different genetic materials for exploiting variation within the eggplant genepool and then single plant selection was performed on the basis of phenotypic performance (plant growth vigor, earliness, hairiness, prickles, fruit color, fruit shape and size, yield, seeds, etc.). The selection was continued up to F_{7-9} generation until a high degree of homozygosis was achieved. A total of 39 homozygous lines were obtained. The phenotypic characterization was performed and the phylogenetic relationship was investigated on these inbred lines according to 26 morphological traits chosen among the International Union for the Protection of New Varieties of Plants (UPOV), the International Board for Plant Genetic Resources Institute (IBPGRI) descriptors and breeder's own criteria. Their genetic similarity was analyzed by the UPGMA (Unweighted pair-group method, arithmetic average) clustering procedure of the software NTSYS (Numerical Taxonomy

Multivariate Analysis System) pc 2.2 versions (Rohlf, 1998) by using morphological descriptors between these lines. Traits and descriptors used in this study were given in Table 1.

Table 1. Traits and descriptors used in morphological observation of pure lines

	Traits	Description
1	Plant habit	Score range (1=Open, 3=Bushy, 5=Semi open)
2	Plant height	Score range (1=Long, 3=Intermediate, 5=Short)
3	Stem thickness	Score range (1=Thick, 3=Intermediate, 5=Thin)
4	Stem hairiness	Score range (1=Dense, 3=Intermediate, 5=Tenuous)
5	Stem color	Score range (1=Grayish, 3=Green, 5=Green-purple, 7=Grayish-green-purple, 9=Grayish-green, 11= Grayish-purple, 13=Purple)
6	Shoot tip color	Score range (1=Grayish, 3=Green, 5=Green-purple, 7=Grayish-green-purple, 9=Grayish-green, 11=Grayish-purple, 13=Purple)
7	Length of internodes	Score range (1=Long, 3=Intermediate, 5=Short)
8	Leaf color	Score range (1=Light green, 3=Green, 5= Dark green)
9	Leaf size	Score range (1=Large, 3=Intermediate, 5=Small)
10	Leaf hairiness	Score range (1=Dense, 3=Intermediate, 5=Tenuous)
11	Presence of spine on petiole	Score range (1=Many, 3=Intermediate, 5=Few, 7=Absent)
12	Bud size	Score range (1=Large, 3=Intermediate, 5=Small)
13	Bud hairiness	Score range (1=Dense, 3=Intermediate, 5=Tenuous)
14	Presence of spine on bud	Score range (1=Many, 3=Intermediate, 5=Few, 7=Absent)
15	Flower color	Score range (1=Light purple, 3=Purple, 5= Dark
16	Flower size	Score range (1=Large, 3=Intermediate, 5=Small)
17	Calyx size	Score range (1=Large, 3=Intermediate, 5=Small)
18	Fruit shape	Score range (1=Long, 3=Intermediate, 5=Short, 7=Ovoid, 9=Pear shaped)
19	Fruit color	Score range (1=White, 3= Green, 5=Purple, 7=Black)
20	Fruit stalk length	Score range (1=Long, 3=Intermediate, 5=Short)
21	Presence of spine on fruit stalk	Score range (1=Few, 3=Intermediate, 5=Many, 7=Absent)
22	Fruit end shape	Score range (1=Flat, 3= Pointed, 5=Round)
23	Fruit end button size	Score range (1=Large, 3= Intermediate, 5=Small)
24	Fruit length (cm)	The average measurement of ten fruits
25	Fruit diameter (cm)	The average measurement of ten fruits
26	Av. fruit weight (g)	The average measurement of ten fruits

The seven inbred lines (P350, P1673, P1693, P1121, P1752, E231 and E232) were selected to obtain F1 hybrid with good characters. These lines and thirteen hybrids among them were grown in single crop season. The experiment was arranged according to the randomized block designed (RCBD) with two replicate and 10 plants in each replicate. Fruit weight and fruit number were recorded in each harvest. Their rate of heterosis and heterobeltiosis were determined. Heterosis (H%) and heterobeltiosis (HB%) were estimated in both yield and fruit number by formulae described by Matzinger et al. (1962) and Fonseca and Patterson (1968) respectively.

H% (Heterosis over mid parent) = [(F1-MP)/MP X 100]

HB% (Heterosis over better parent) = [(F1-BP)/BP X 100]

P350 inbred line had good heterosis and heterobeltiosis when it was used female parent. Therefore, it was crossed with P599 inbred line. The hybrid obtained from this cross had good characters and suitable market demands. It was identified morphologically and called "BATEM FILIZI".

The BATEM FILIZI was compared with several commercial cultivars. The experiment was conducted to measure the effect of environmental factors on yield and quality in the 2010 fall growth season in an unheated glasshouse that had low minimum temperature. The soil tests were performed before the planting by Plant Nutrition Department of BATEM. The sowing and transplanting dates were, respectively, August 3 and September 20, 2010. Fertilizing program was applied according to the soil test results (Table 2).

Table 2. Fertilizer program used in the 2010 fall season trial performed in a greenhouse

Development period	Fertilizer	Content	Dose (g da^{-1})
Seedling period	Potassium nitrate	(% 13 N, % 46 K2O)	400
	Mono Ammonium Phosphate	(% 12 N, % 61 P2O5)	250
	Ammonium nitrate	(% 33 N)	350
Development period	Potassium nitrate	(% 13 N, % 46 K2O)	600
	Mono Ammonium Phosphate	(% 12 N, % 61 P2O5)	250
	Ammonium nitrate	(% 33 N)	550
Harvest period	Potassium nitrate	(% 13 N, % 46 K2O)	700
	Mono Ammonium Phosphate	(% 12 N, % 61 P2O5)	250
	Ammonium nitrate	(% 33 N)	500

The trial of F1 hybrid cultivars was arranged in a randomized complete block design (RCBD) with three replications. Twenty plants were used from each genotype per replicate. Plants were planted in strips, which were 100 cm apart with a distance of 50 cm between rows and in-row plant spacing of 60 cm. The plants were pruned to three shoots. For each plot, nine commercially ripe fruits for fruit width (mm), fruit length (mm), and fruit weight (g), and average fruit size were measured. For yield estimation, the total number of fruits and total weight of marketable eggplant fruits in per plot were recorded at each harvest date and calculated. Harvests continued through the winter and were finalized by the end of the February 2011. The yield data obtained from the harvest were analyzed by analysis of variance (ANOVA). Means were separated using the least significant difference (LSD) test.

3. Results and Discussion

The phylogenetic relationships were examined among the total 39 homozygous lines with using 26 basic morphological descriptors. Dendrogram showing phylogenetic relationships of lines are presented in Figure 1. The Eigen value was found 87%. Two-way Mantel test (Mantel, 1967) method was also performed. The matrix correlation (r) was found 0.86. The genetic similarity rates according to the coefficient similarity of lines ranged from 0.61 to 0.99. Two major groups were revealed by the dendrogram generated with UPGMA method using morphological data. First group (Group A) consisted of only two lines (E283 and P1673). This group exhibited highly genetic differences from the Group B. Second group was divided into two subgroups. E451 showed genetic differences among the other lines in Group B. The highest genetic similarity was observed in between P1482 and P1483. The average genetic similarity cultivated eggplants by using SSR markers was found in 82% in other study performed by Stàgel et al. (2008). In addition, Tumbilen et al. (2011) reported that the genetic similarity in the Turkish national collection of 67 *S. melongena* accessions ranged from 0.68 to 0.95. Therefore, our result revealed the inbred lines used in this study had high genetic diversity.

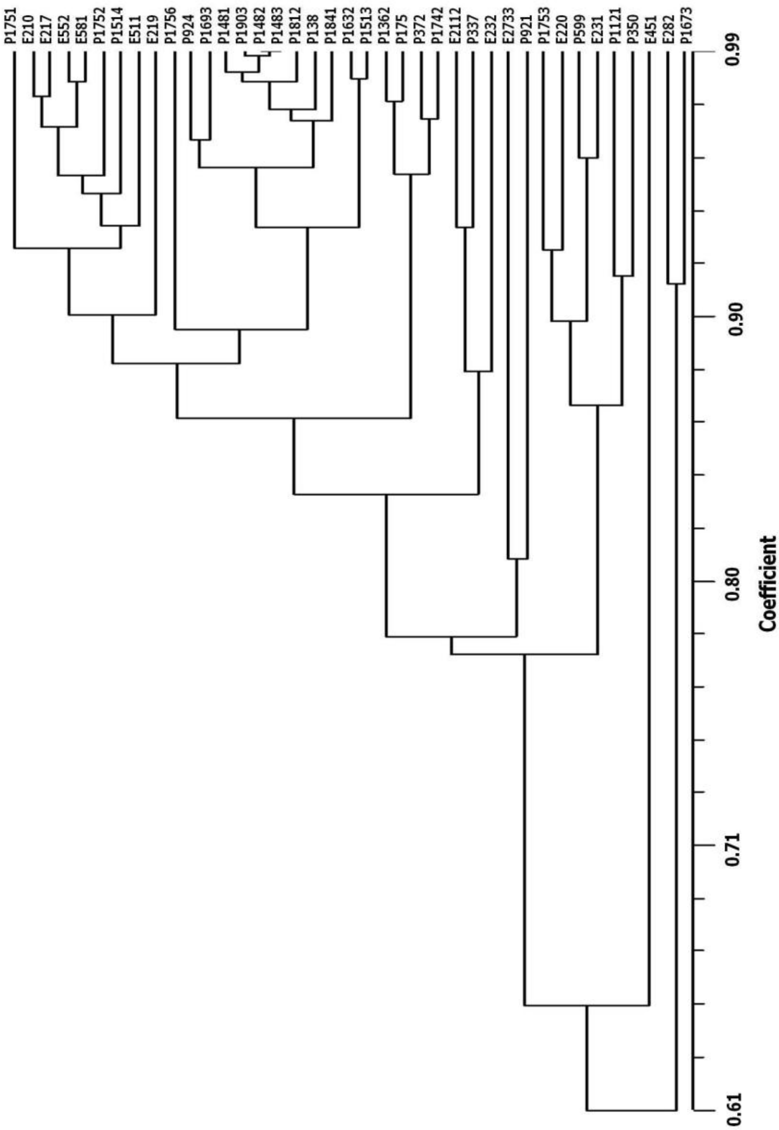

Figure 1. Dendrogram showing phylogenetic relationships of eggplant inbred lines using UPGMA method on the morphological data

The heterosis rates of the thirteen F1 hybrids obtained by crossing seven inbred lines (P350, P1673, P1693, P1121, P1752, E231 and E232) ranged from 134 to -6 according to first quality fruit number. Second quality fruit number ranged from 83 to -12 and total fruit number ranged from 57 to -24. The heterobeltiosis rates ranged from 81 to -40, from 80 to -19, from 47 to -30 according to the first class fruit number, second class fruit number and total fruit number, respectively. The heterosis rates according to the yield ranged from 93 to -14, from 79 to -44 and from 66 to -15 in the first and second quality fruits and total fruit yield, respectively. Heterobeltiosis rate ranged from 51 to -20 in the total yield. The results of the present study for fruit number and yield revealed that significant positive heterosis (H) and heterobeltiosis (HB) was recorded in the crosses of P350 and E232 inbred lines both among themselves and other lines (Table 3).

Table 3. Rates of heterosis and heterobeltiosis for fruit yield and number in eggplant (%)

Hybrids	First quality fruit number		Second quality fruit number		Total fruit number		Yield of first quality fruit		Yield of second quality fruit		Total fruit yield	
	H	HB	H	HB	H	HB	H	HB	H	HB	H	HB
P350 x P1121	71	55	20	6	42	37	78	52	27	13	52	49
P350 x PE231	17	-4	83	80	57	47	16	-6	79	72	55	42
P350 x E232	89	46	8	-5	39	38	86	55	22	6	52	51
P1673 x P350	65	65	25	15	44	36	44	42	21	13	34	29
P1693 x P1673	40	16	31	31	35	23	49	30	52	19	50	25
P1693 x P1121	30	-1	10	7	20	6	81	72	51	13	66	45
E232 x P350	54	19	7	-6	25	24	56	30	15	0	34	33
E232XP1673	134	81	5	-1	50	40	93	58	18	8	52	45
E232 x P1121	61	35	0	-1	20	14	67	62	-1	-3	26	24
E231 x E231	92	75	33	19	51	43	15	11	11	0	12	3
P1752 x P1121	5	-26	-10	-18	-2	-22	16	-9	-9	-21	4	-3
P1752 x E232	-6	-40	-12	-19	-	-30	14	-12	-	-52	-	-20

Eggplant heterosis can be exploited for the development of F1 hybrids, as maximum hybrid vigor effects are seen in the first filial hybrid generation (Viswanathan, 1973; Chattopadhyay et al., 2012). While the heterosis rate in the hybrids has been reported for yield ranging from 33% to 97% for commercial eggplant breeding programs (Wehner, 1999), in this study the highest heterosis rate for first quality and total fruit yield of hybrids were found in 93% and 51%, respectively.

In the breeding programs, the genetic distance is important in the gene pool for heterosis. However, it was revealed with results of crosses in this study that there was no directly relation between distance in phylogenetic relationship and expected heterosis and heterobeltiosis. Although some hybrids showed good heterosis and heterobeltiosis, they were not suitable in order to the market demands. These results gave good information for the next crosses program. The oval fruiting P350 inbred line as female parent was chosen to develop oval hybrid variety. Thus, the F1 hybrid was obtained from the cross between P350 and P599. This hybrid showed good performance and called as 'BATEM FILIZI'.

Some of the morphological characteristics were described as follows. The stems, leaf and calyx color of the plant of hybrid 'BATEM FILIZI' are green. No anthocyanin coloration is present on the stem. The leaf blade size is large and intensity of green color on leaf blade is medium. The number of flowers at the inflorescence is generally from one to three. The flowers are functionally hermaphroditic and the corolla is pink. The length of the fruit peduncle is intermediate and the fruits are pear shaped. The fruit flesh is greenish and firm. The average fruit length, diameter and weight are 135-145 mm, 80-90 mm and 320 g, respectively. The color of skin at harvest maturity is dark purple. The size of the calyx is intermediate and calyx prickles are few and small. This hybrid presented was different in some plant and fruit characteristics.

The results of its performance experiment with commercial cultivars showed that there was a statistically significant difference for marketable yields among the tested genotypes in the 2010 fall growth season. Data obtained from the trial concerning fruit yield and fruit observations are presented in Table 4. The highest yield was obtained from BATEM FILIZI (28.720 kg $plot^{-1}$) and Fantastic (28.303 kg $plot^{-1}$) genotypes, while Vezir (23.847 kg $plot^{-1}$) and Amadeo (23.590 kg $plot^{-1}$) genotypes were placed in the second group. The fruit width in the tested genotypes ranged between 81.67 mm and 99 mm, fruit length between 135 mm and 170 mm and fruit weight between 248.4 mm and 264.5 mm (Table 4).

Table 4. Trial results of 'BATEM FILIZI' and three commercial cultivars performed in 2010 fall growth season

Cultivars	Fruit width (mm)	Fruit length (mm)	Fruit weight (g)	Yield (kg $plot^{-1}$)
BATEM FILIZI	81.67	141.67	249.7	28.720 a
Fantastic (Rito Seeds)	86.67	170.00	264.5	28.303 a
Vezir (Yüksel Seeds)	99.00	135.00	248.4	23.847 b
Amadeo (AG Seeds)	85.00	138.33	262.1	23.590 b

LSD (5%) for yield=3.353 CV (%) = 6.43

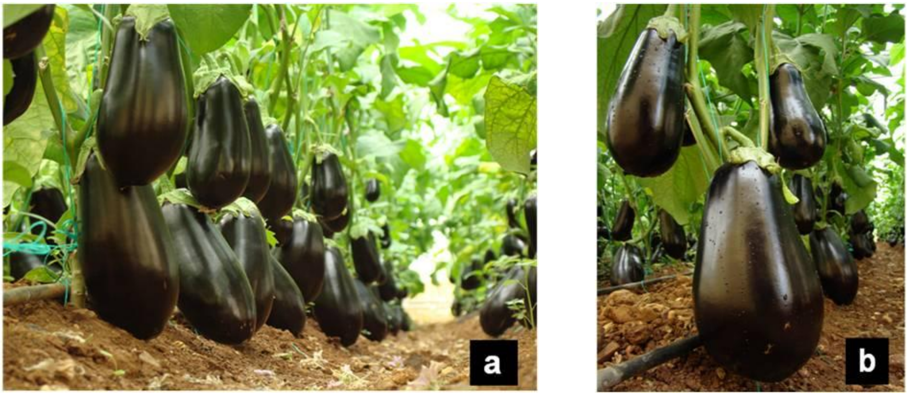

Figure 2. Overall appearance from the greenhouse (a) and fruits (b) of the BATEM FILIZI eggplant cultivar

Fruits of commercial genotypes used as control in the experiment had lower quality than that of BATEM FILIZI during the harvesting period in cold days. Appearance of BATEM FILIZI produced in the greenhouse is shown Figure 2a, b.

Intensive eggplant breeding programs have been carried out in various countries (Western Europe, Turkey, India, China and Japan) where production is more (Sekera et al., 2007). The eggplant germplasm and the pedigree of hybrid cultivars are of great importance for the breeders (Ali et al., 2011). One of the important strategies to obtain high yielding and uniform varieties has been hybrids development (Daunay, 2008). Highly adaptable and high yielding commercial F1 hybrids in eggplant have been developed for greenhouse (Munoz et al., 2008). F1 hybrids vary greatly among growing systems like the out of season cultivation under protected conditions etc. (Prohens et al., 2005). BATEM FILIZI is suitable cultivar for out of season cultivation under protected conditions and less affected by low temperature.

4. Conclusions

The breeding studies should have a variable structure to respond the current demands of producers and consumers because market demands and consumer needs are rapidly changeable. BATEM FILIZI is an eggplant hybrid variety suitable for the current market demands. This variety was transferred to a seed company in May 2013 in order to satisfy the demands of both Turkish and foreign growers. This hybrid developed in this study can be used in greenhouse production especially in single crop season.

Acknowledgements

This research was financially supported by grants from the General Directorate of Agricultural Research and Policy, Republic of Turkey Ministry of Food, Agriculture and Livestock under BBSS-10-12 project number. Special thanks to Ahmet EREN for supporting preparation of this manuscript by authors.

Availability of cultivar

Seeds of 'BATEM FILIZI' for commercial use are available from Mars Seeds, Turkey. (Phone: +90 242 724 5616, Fax: +90 242 724 5596, web site: http://marstohum.com.tr, e-mail: info@marstohum.com). Small samples for research studies are available from the author.

References

Abak, K., & Guler, H.Y. (1994). Pollen fertility and the vegetative growth of various eggplant genotypes under low temperature greenhouse conditions. *Acta Horticulturae*, 366:85–91.

Acciarri, N., Restaino, F., Vitelli, G., Perrone, D., Zottini, M., Pandolfini, T., Spena, A., & Rotino, G.L. (2002). Genetically modified parthenocarpic eggplants: improved fruit productivity under both greenhouse and open field cultivation. *BMC Biotechnology*, 2(1):4.

Ali, Z., Xu, Z.L., Zhang, D.Y., He, X.L., Bahadur, S., & Yi, J.X. (2011). Molecular diversity analysis of eggplant (*Solanum melongena*) genetic resources. *Genetics and Molecular Research,* 10(2):1141–1155.

Cericola, F., Portis, E., Toppino, L., Barchi, L., Acciarri, N., Ciriaci, T., Sala, T., Rotino, G.L., & Lanteri, S. (2013). The population structure and diversity of eggplant from Asia and the Mediterranean basin. *PloS one*, 8(9), e73702.

Chattopadhyay, A., Seth, T., Dutta, S., Ghosh, P.P., Chattopadhyay, S.B., Majumder, D., & Hazra, P. (2012). Breeding eggplant for higher productivity and bacterial wilt tolerance. *International Journal of Vegetable Science*, 18(4):376-392.

Daunay, M.C. (2008). Eggplant, p. 163–220. *In*: Prohens, J.; Nuez, F. eds. Handbook of plant breeding: vegetables II. Springer, New York.

Donzella, G., Spena, A., & Rotino, G.L. (2000). Transgenic parthenocarpic eggplants: superior germplasm for increased winter production. *Molecular Breeding*, 6:79-86.

Fonseca, S., & Patterson, F.L. (1968). Hybrid vigor in a seven-parent diallel cross in common winter wheat (*Triticum aestivum* L.). *Crop Science,* 8(1): 85-88.

Kikuchi, K., Honda, I., Matsuo, S., Fukuda, M., & Saito, T. (2008). Stability of fruit set of newly selected parthenocarpic eggplant lines. *Scientia Horticulture*, 115(2):111–116.

Mantel, N.A. (1967). The detection of disease clustering and a generalized regression approach. *Cancer Research*, 27:209–220.

Matzinger, D.F., Mann, T.J., & Cockerham, C.C. (1962). Diallel crosses in *Nicotiana tabacum*. *Crop Science,* 2(5):383-386.

Muñoz-Falcón, J.E., Prohens, J., Rodríguez-Burruezo, A., & Nuez, F. (2008). Potential of local varieties and their hybrids for the improvement of eggplant production in the open field and greenhouse cultivation. *Journal of Food Agriculture and Environment*, 6(1):83.

Mutlu, N., Boyaci, F.H., Göçmen, M., & Abak, K. (2008). Development of SRAP, SRAP-RGA, RAPD and SCAR markers linked with a Fusarium wilt resistance gene in eggplant. *Theoretical and Applied Genetics,* 117:1303–1312.

Prohens, J., Muñoz, J.E., Rodríguez-Burruezo, A., & Nuez, F. (2005). Recent advances in the genetic improvement of eggplant. (In Spanish). *Vida Rural*, 217:52–56.

Rodríguez-Burruezo, A., Prohens, J., & Nuez, F. (2008). Performance of hybrids between local varieties of eggplant (*Solanum melongena*) and its relation to the mean of parents and to morphological and genetic distances among parents. *European Journal of Horticultural Science*, 73(2):76–83.

Rohlf, F.J. (1998). NTSYS-PC: Numerical Taxonomy and Multivariate Analysis System. Release 2.20j. Exeter Software, Setauket, N.Y.

Rotino, G.L., Perri, E., Zottini, M., Sommer, H., & Spena, A. (1997). Genetic engineering of parthenocarpic plants. *Nature Biotechnology*, 15(13):1398-1401.

Saito, T., Yoshida, T., Monma, S., Matsunaga, H., Sato, T., Saito, A., & Yamada, T. (2009). Development of the parthenocarpic eggplant cultivar 'Anominori'. *Japan Agricultural Research Quarterly*, 43(2):123–127.

Schwarz, D., Rouphael, Y., Colla, G., & Venema, J.H. (2010). Grafting as a tool to improve tolerance of vegetables to abiotic stresses: Thermal stress, water stress and organic pollutants. *Scientia Horticulture,* 127(2):162–171.

Sekara, A., Cebula, S., & Kunicki, E. (2007). Cultivated eggplants – origin, breeding objectives and genetic resources, a review. *Folia Horticulturae Ann.,* 19(1):97-114.

Sidhu, A.S.; Bal, S.S.; Behera, T.K.; & Rani, M. 2005. An outlook in hybrid eggplant breeding. *Journal of New Seeds*, 6(2-3):15-29.

Spena, A., & Rotino, G.L. (2001). Parthenocarpy, p. 435-450. *In*: Bhojwani, S.S.; Soh, W.Y. eds. Current Trends in the Embryology of Angiosperms.

Stàgel, A., Portis, E., Toppino, L., Rotino, G.L., & Lanteri, S. (2008). Gene-based microsatellite development for mapping and phylogeny studies in eggplant. *BMC Genomics*, 9(1):357.

Tümbilen, Y., Frary, A., Mutlu, S., & Doganlar, S. (2011). Genetic diversity in Turkish eggplant (*Solanum melongena*) varieties as determined by morphological and molecular analyses. *International Research Journal of Biotechnology,* 2:16-25.

Wehner, T.C. (1999). Heterosis in Vegetable Crops. *In*: Coors, J.; Pandey, S. (Eds.). The genetics and exploitation of heterosis. p. 387-397, American Society of Agronomy, Madison, WI.

Viswanathan, T.V. (1973). Hybrid vigour in brinjal. *Proceedings of the Indian Academy of Sciences* - Section B, 77(4):176-180.