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Morphological Characteristics and Genetic Variation of Gerbera (*Gerbera hybrida* Hort)

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Abstract

This study was conducted to analyze the morphological characteristics such as flower color, flower type, flower diameter and flower stalk, and the main annual production yield, and genetic similarity of twenty four *Gerbera* species growing in Korea. Most of flower colors were pink. The numerical order of flower color was pink, orange, red, double-colored, and milk-white. Majority of flower types were single or semidouble flowers. A few species were double flowers. Flower diameters were from 7 cm to 12 cm, showed significant differences compared to other characteristics. Flower stalks were ranged from 55 cm to 65 cm. Only one species was the shortest as 55 cm. The others were similar size as about 65 cm. Main annual production yields were between 190 and 400 blossoms. Fifty seven reproducible polymorphic bands from eighty primers were used for analyses of genetic similarity. The genetic similarity of 24 collected *Gerberas* was largely classified into five groups. The average similarity coefficient was 0.72 ranged from 0.50 to 0.90. The highest similarity coefficient was shown between 'Sardana' with red/white flower color and double flower type, and 'Tamara' with orange flower color and double flower type as 0.90.

Introduction

Gerbera is a perennial which belongs to the composite family. There are about forty *Gerbera* varieties. Their original homes are temperate Asia, tropical Asia and Africa (Yoon et al., 1996). Jamesonii which has become the pivot of today's horticultural cultivars, has been found originally in Transvaal, South Africa in 1878 (Dole and Wilkins, 1999).

The *Gerbera* was introduced into England as novelty in 1886. By 1910, the *Gerbera* was well established in commerce as a garden or cut flower in France, and by the 1930s, as a cut flower in North America (Grifing, 1959). The *Gerbera* was cultivated in Korea in 1983. In Korea, the *Gerbera* took 2.7% of the cultivated area of the total cut flower as 62.4 ha in 1995. The production value in 1995 was extended as 44 times as that in 1983 as 5.1% of the total cut flower production value, and the market production value was 11.6 billion Korean won (Kim et al., 1999).

Gerbera is mainly consumed for events and flower arrangements. The colors of pink, violet, white, yellow and red are in the order of preference. *Gerbera* on the increasing trend because of the diversity of flower colors is newly presented more than 300 varieties in foreign special breeding company every year. In Korea, however, the development of plant breeding itself is very few and depends on the imports which results in weakening of the international competition by the increase of a royalty (Yang, 1994).

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Accordingly, it is thought to be inevitable to develop a new species suitable to the Korean climate by the method of genetic engineering. It is required to satisfy the needs of diverse flower colors, types and preference of consumers, but the fundamental research on this trend has not been carried out systematically.

Many researches for *Gerbera* have been carried out for agronomic analyses such as ridge height, organic materials and chemicals on the cut flower productivity, seasonal fluctuation of yield and quality of cut flowers in *Gerbera* Hybrids, *in vitro* rapid propagation of *Gerbera* (Kim, 1991), the relationships between morphological characteristics as scape deformation of cut *Gerberas* (Park and Yang, 1992), or the dry storage and recovery after storage of cut *Gerberas* (Shin et al., 1994). However there have been reported a few studies of *Gerbera* using the biotechnological methods.

Randomly amplified polymorphic DNA (RAPD) schemed out by Mullis et al. (1983) is being used for several researches; 1) the classification and relationship of species (Karihaloo et al., 1995), 2) the evaluation of genetic resources, 3) the confirmation of introduced exotic genes (Tsutomu, 1985; Welsh and McClelland, 1990), 4) the quantitative characteristic analysis of population genetics (Williams et al., 1990), 5) the development of marker genes to detect a useful genetic character (Michelmore et al., 1991), or 6) the making of genetic linkage maps (Rowland and Levi, 1994; Chaparro et al., 1994).

Considering these studies in view, we have made an attempt to analyses the morphological characteristics and morphological relationships, and the genetic relationships between genetic markers and phenotype data of 24 *Gerbera* species cultivated in Korea.

Materials and Methods

Plant materials

Total twenty four species such as 'Beauty', 'Climax', 'Estelle', 'Fashion', 'Florense', 'Fredigor', 'Marita', 'Maya', 'Nevada', 'Ramboginii', 'Rava', 'Rosamette', 'Rosula', 'Salina', 'Sangria', 'Sardana', 'Sunset', 'Tamara', 'Temptation', 'Ventury', 'Wizzard', 'Ximena', 'Michele', 'Sunspot' were planted in unreplicated single-row plots at the greenhouse of Changwon Greenhouse Floricultural Experiment Station, Kyongnam Provincial R.D.A., with 80 cm bed width and 40×30 cm distance by two rows, in the spring of 1998. These species were investigated for the flower color, flower type, flower diameter, flower stalk and mean production yield per m^2.

RAPD analysis

Genomic DNA from 1 g of cultivated *Gerbera* leaflet was isolated with the CTAB buffer as described by Lee (1996).

The total volume for PCR was adjusted as 25 μL with 50 ng genomic DNA, 25 mM $MgCl_2$, 10× PCR buffer, 10 mM dNTPs, 50 pM random primer (Operon Technologies Inc.), and 1.5 units Taq DNA polymerase.

The optimum reaction for the RAPD was carried out at 72℃ for five minutes and 4℃ for infinite time after denaturation at 94℃ for one minute, annealing at 39℃ for 1 minute, extension at 72℃ for two minutes, and 40 cycles with Perkinelmer PTC-100. The amplified DNA was electrophoresed to 50 V in 1.5% agarose gel with ethidium bromide. A total 80 random primers (OPA 1~20, OPB 1~20, OPK 1~20, OPL 1~20) were used.

Data analysis

The reproducible bands from 36 primers showed polymorphic bands were used for analysis of genetic similarity. The genetic similarity was calculated based on Nei and Li's (1979) formula using NTSYS-pc software (Roy et al., 1992). The cluster analysis was carried out using the unweighted pair group method with arithmetic mean (UPGMA).

Results and Discussion

The morphological characteristics

The morphological characteristics of twenty four *Gerbera* species were investigated for flower color, flower type, flower diameter, flower stalk and main annual production yield.

As showed in Figure 1, 2 and Table 1, in case of flower color, most of colors were pink as nine species of 'Estelle', 'Fredigor', 'Marita', 'Maya', 'Rosamette', 'Rosula', 'Salina', 'Temptation', 'Wizzard'. Orange color was second rank as six species of 'Climax', 'Sunset', 'Tamara', 'Ventury', 'Michele', 'Sunspot'. Five species were red color; 'Beauty', 'Fashion', 'Ramboginii', 'Sangria', 'Ximena'. Three species of 'Florense', 'Rava', 'Sardana' were double-colored, and milk-white color was the only one, 'Nevada'. In case of flower type, single flowers were ten species of Beauty, Florense, Rava, Rosamette, Rosula, Salina, Ventury, Ximena, Michele, Sunspot. Semidouble flowers were eleven species of Climax, Estelle, Fashion, Fredigor, Marita, Maya, Nevada, Ramboginii, Sangria, Sunset, Temptation. Double flowers were three species of Sardana, Tamara,

Table 1. Morphological characteristics of 24 *Gerbera* species.

No	Variety	Flower color	Flowertype	Flower diameter (cm)	Flower stalk(cm)	Flowers/ m2/year
1	Beauty	red	sf	11.5	65	220
2	Climax	orange	sdf	11.5	65	220
3	Estelle	pink	sdf	11.0	65	220
4	Fashion	red	sdf	11.5	65	220
5	Florense	red/white	sf	11.5	65	220
6	Fredigor	pink	sdf	11.5	65	220
7	Marita	pink	sdf	11.5	65	220
8	Maya	pink	sdf	11.5	65	220
9	Nevada	milk-white	sdf	11.0	55	210
10	Ramboginii	red	sdf	11.5	65	250
11	Rava	red/white	sf	11.0	65	200
12	Rosamette	pink	sf	11.0	65	220
13	Rosula	pink	sf	11.0	65	200
14	Salina	pink	sf	11.5	65	220
15	Sangria	red	sdf	12.0	65	190
16	Sardana	red/white	df	7.0	65	400
17	Sunset	orange	sdf	11.0	60	230
18	Tamara	orange	df	11.5	65	220
19	Temptation	pink	sdf	11.0	65	200
20	Ventury	orange	sf	11.0	65	230
21	Wizzard	pink	df	11.0	65	220
22	Ximena	red	sf	11.5	60	200
23	Michele	orange	sf	11.0	60	220
24	Sunspot	orange	sf	11.5	60	230

sf; single flower, sdf; semidouble flower, df; double flower.

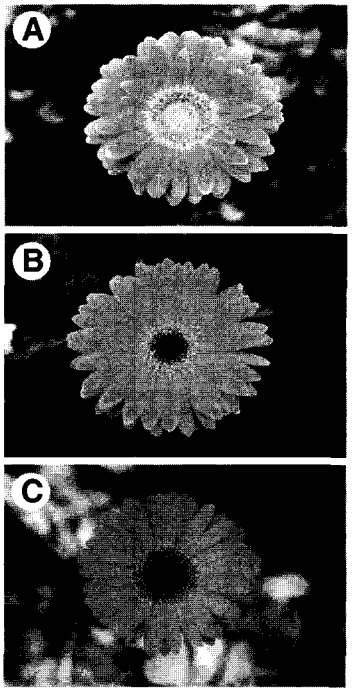

Figure 1. Flower colors of *Gerberas*. A; Pink color, B; Orange color C; Red color. Most of flower colors were pink. The numerical order of flower color was pink, orange, red, double-colored, and milk-white.

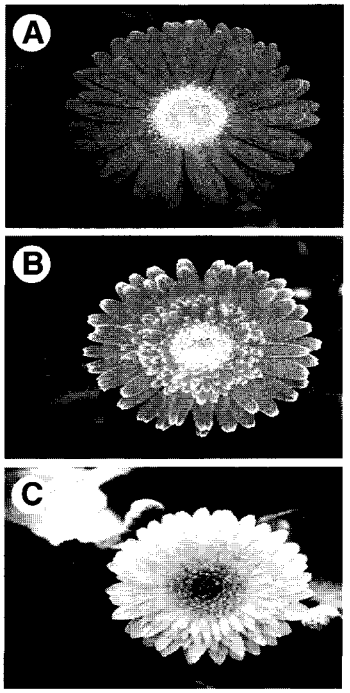

Figure 2. Flower types of *Gerbera*. A; Single flower type, B; Semi-double flower type, C; Double flower type. Most of flower types were single or semidouble flowers. A few species were double.

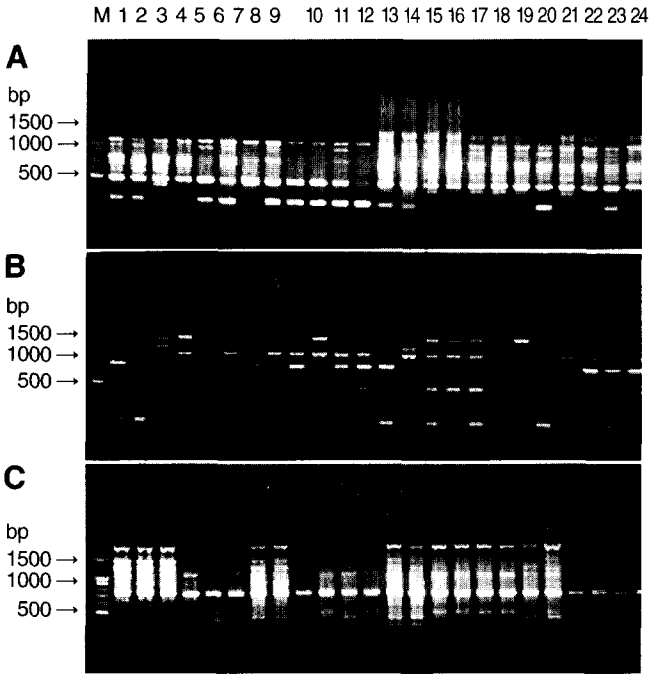

Figure 3. Amplified DNA fragments of 24 *Gerbera* lines as given in Table 1 and 4 primers (A: OPK-07; B: OPK-16; C: OPL-11). M: lambda DNA/*Eco*RI + *Hin*dIII; line 1. Beauty; 2. Climax; 3. Estelle; 4. Fashion; 5. Florense; 6. Fredigor; 7. Marita; 8. Maya; 9. Nevada; 10. Ramboginii; 11. Rava; 12. Rosamette; 13. Rosula; 14. Salina; 15. Sangria; 16. Sardana; 17. Sunset; 18. Tamara; 19. Temptation; 20. Ventury; 21. Wizzard; 22. Ximena; 23. Michele; 24. Sunspot.

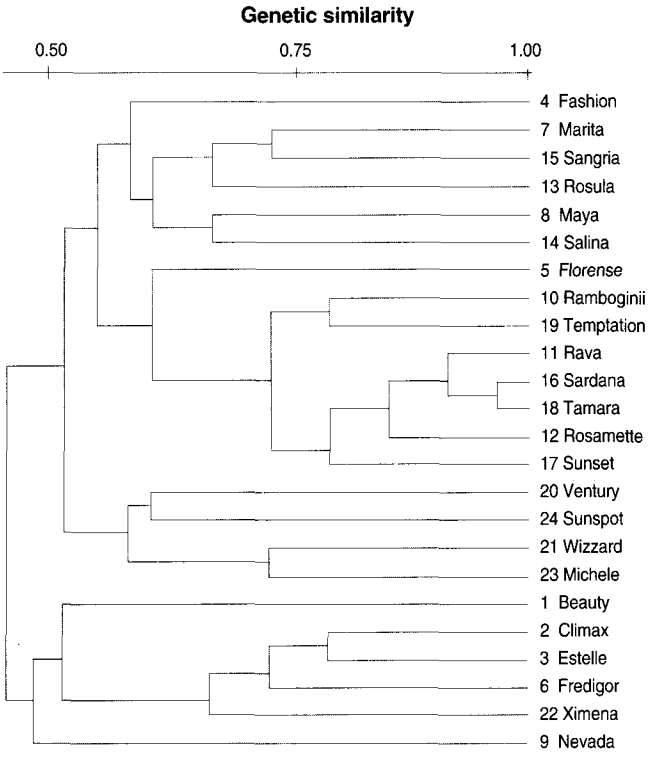

Figure 4. Genetic similarity of 24 *Gerbera* accessions based on RAPD analysis using 57 polymorphic DNA fragments.

Wizzard. Flower diameters were from 7 cm in Sardana to 12 cm in Sangria, showed significant differences compared to other characteristics. Flower stalks were between 55 cm and 65 cm, and Nevada was the shortest as 55 cm. The others were similar size.

Main annual production yields were between 190 and 400 blossoms. Sangria with the longest flower diameter was the smallest yield as 190 blossoms, and Sardana with the shortest flower diameter was the largest as 400 blossoms.

Genetic diversity of *Gerbera* species by the RAPD analysis

Eighty primers were used for RAPD analysis of 24 *Gerbera* species. A total 57 polymorphic bands were generated by 36 primers. Twenty four *Gerbera* species were classified by their morphological characteristics and RAPD banding patterns. Figure 3 showed polymorphic bands among 24 species. The size of DNA fragments amplified by the PCR was between 200 bp-1500 bp. Even many polymorphic bands were produced among different species, there did not show any polymorphic bands linked with flower colors, or types. It might be many genes to affect flower color in *Gerbera* like petunia. Wiering and de-Vlaming (1984) showed that at least 35 genes were known to affect flower color in petunia.

Reproducible polymorphic bands were used for analyses of genetic similarity. Indices of the similarity values among 24 genotypes were calculated based on the 57 polymorphic DNA fragments. The genetic similarity of 24 accessions of *Gerbera* showed in Figure 4. The average similarity coefficient was 0.72 ranged from 0.50 to 0.90. The highest similarity coefficient was shown between Sardana with red/white flower color and double flower type, and 'Tamara' with orange flower color and double flower type as 0.90. The genetic similarity of 24 collected *Gerberas* was largely classified into five groups. Nevada with milk-white flower color and semidouble flower type was distant genetic similarity from other groups. Six varieties including Fashion, Marita, Sangria, Rosula, Maya, and Salina were the group I. Eight species like Florense, Ramboginii, Temptation, Rava, Sardana, Tamara, Rosamette, and Sunset belonged to the group II. Four accessions including Ventury, Sunspot, Wizzard, and Michele included into the group III. Five species of Beauty, Climax, Estelle, Fredigor,

and Ximena belonged into the group IV. Nevada was separated into the group V. The genetic relationship among morphological characteristics was not found in this study. It is thought that there are several reasons for this inconsistency of the relationship between molecular markers and morphological characteristics. The first assumption is that it is impossible to identify specific genes related with morphological characteristics since the *Gerbera* species used in this study are genetic mixture. The genetic dissimilarity was twenty five percent. The other possibility is that many genes located in different chromosomes might be responsible for the flower morphological characters of *Gerbera* such as flower colors or flower types.

Acknowledgements

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References

Chaparro JX, Werner DJ, Mallery DO, Sederoff RR (1994) Targeted mapping linkage analysis of morphological, isozyme, and RAPD markers in peach, Theor Appl Genet 87: 805-815.

Dole JM, Wilkins HF (1999) Florticulture principles and species, Prentice Hall, pp 356-361.

Karihaloo JL, Brauner S, Gottlieb LD (1995) Random amplified polymorphic DNA variation in the eggplant, Solanum melongrna L. (Solanaceae). Theor Appl Genet 90: 767-770.

Kim JY, Jeong MI, Kim BH, Ko JY, Kang JY (1999) Right land and optimum cropping type in the production of ornamental plants: production status and distribution. Kor J Hort Sci Technol 17: 407-420.

Lee Y-K (1996) Analysis of genetic relationship by RAPD technique in *allium Sativum* L. Department of Agronomy Graduate School, Kyungpook National University.

Michelmore RW, Paran I, Kessli RV (1991) Identication of markers linked to diseasersis-tance genes by bulked segregant analysis. A rapid method to detect markers in specificg-enomic regions by using segregation populations. Proc Nat'l Acad Sci USA 88: 9828-9832.

Nei M, Li WH (1979) Mathematical model for studying genetic in terms of restriction endonucleases. Proc Natl Acad Soc USA 76: 5269-5273.

Rowland LJ, Levi A (1994) RAPD-based genetic linkage map of blue berry derived from a cross between diploid species(Vaccium darrowi and V. elliotti), Theor Appl Genet 87: 863-868.

Roy AN, Frascaria J, Mackay J, Bousquet (1992) Segregating random amplified polymorphic DNAs(RAPDs) in Betula alleghaniensis, Theor Appl Genet 85: 173-180.

Shin HS, Kim JY, Shin RW, Ko JY (1994) Seasonal fluctuation of yield and quality of cutflowers in *Gerbera* hybrids. RDA J Agri Sci 36: 444-452.

Tsutomu Y (1985) Amphidiploids between Iris iaevigate Fisch. and I. ensata Thunb. Induced through *in vitro* Culture of Embryo Treated with Colchicin. Japan J Breed 35: 136-144.

Welsh J, McClelland M (1990) Fingerprinting genomes using PCR with arbitrare primer. Nucl Acids Res 18: 7213-7218.

Wiering H, de Vlaming P (1984) Genetics of flower and pollen colours. In Petunia, K. C. Sink ed. Berlin, Springer-Verlag, pp 49-75.

Williams JGK, Kubelic AR, Livak KJ, Rafaalski JA, Tingey SV (1990) DNA polymorphism amplified by arbitary primers are useful as genetic markers. Nucl Acids Res 18: 6531-6535.

Yang Jung-in (1994) Studies for the dry storage and recovery after storage of cut *Gerberas*, Department of Horticulture graduate school, Hyosung Women's university.

Yoon HS, Sang CK, Choi BJ (1996) The relationship between morphological characteristics scape deformation of cut *Gerberas*. J Kor Soc Hort Sci 37: 593-597.