



The Phenotypic Performances of Gerbera Local Bali X Rubby Red Hybrids

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ABSTRACT

Gerbera is one of important cut flowers in floriculture industries. It can substitute of chrysanthemum. The novelty of cultivar and superiority of characteristic of gerbera are necessary in the floriculture markets. New cultivars can be created through hybridization between cultivars. This study aimed to find out the phenotypic performances of gerbera hybrids of Local Bali x Rubby Red. The research was conducted in Indonesian Ornamental Crops Research Institute, West Java, Indonesia from January 2014 to September 2015. Eight progenies of F1 hybrids and their parents (Local Bali and Rubby Red) were used as materials. In the hybridization process Local Bali and Rubby Red were used as female and male parents respectively. Genetic variabilities of Gerbera were achieved through this hybridization. Gerbera progeny no. 20.009 had the longest inflorescence diameter, the biggest outer sepal and the highest number of sepals compared to the others. The flower vase life of this progeny was not significantly difference to the male parent. Qualitative characters observation showed that the hybrids were classified into two groups based on flower type, four groups of outer ray florets and two-disc groups of petal color.

INTRODUCTION

Gerbera (*Gerbera jamesonii* H.Bolus ex. Hooker) is an important ornamental plant in floriculture industries. It has a wide applicability as cut flower and potted plants (Rogers & Tjia, 1990; Parthasarathy & Nagaraju, 1999; Kanwar & Kumar, 2008). Gerbera was the member of *Asteraceae* (Tourjee, Harding & Byrne, 1994). The flower is one of the leading of cut flowers and ranks among the top ten cut flowers of the world. Recently, Gerbera is in fifth rank after rose, carnation, chrysanthemum and tulip (Bhatia, Singh, Jhang, & Sharma, 2009; Teeri, Elomaa, Kotilainen, & Albert, 2006). Trend of gerbera is also increase every year in Indonesia. The production of gerbera flower was 9.693.487 stalks in 2010 and 17.057.909 stalks in 2015 (Directorate General of Horticulture, 2014).

There were many gerbera cultivars has been released, both for cutting and potted flowers. It was about 1150 cultivars released from Netherlands (Gong & Deng, 2010). Breeding programs of gerbera were focusing on color improvement, flower types and disease resistance. Based on market demand, this program always produces new

cultivars of gerbera. The most favorite gerbera was double and thickly petals. Some countries such as Netherlands, Denmark, Germany, USA and Japan focus on gerbera breeding programs for industries and floriculture markets in Equador and Columbia (Rogers & Tjia, 1990; Kloos, George, & Sorge, 2005; Shoub, 2012).

Gerbera was introduced from temperate countries and it grew well in Indonesia. Most of gerbera cultivars grown in Indonesia were imported. According this condition, Indonesia has the opportunities to develop and create some new cultivars. Breeding program is one of solutions to increase productivity and quality of gerbera and it gave alternative of choices. The genetic constitution of gerbera is heterozygous; it causes gerbera hybridization to produce high variation of progenies. The genetic diversity and variability of F1 in breeding population was tested by observing the phenotypic characters (Kustanto, Basuki, Sugiharto, & Kasno, 2012). The objective of the research was to obtain the performance of F1 hybrids of gerbera and their parents (Local Bali and Rubby Red).

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MATERIALS AND METHODS

The experiment was conducted from January 2014 to September 2015 in Indonesian Ornamental Crop Research Institute. Local Bali (LB) and Ruby Red (RR) as female and male parents for hybridization. There were 17 survival progenies obtained from this hybridization. Eight of 17 progenies were selected as research materials i.e.: 20.001; 20.004; 20.006; 20.009; 20.011; 20.012; 20.013 and 20.017. The selection of clones was based on survival and healthy plants. Random Completely Block Design (RCBD) was used as experimental design. Every progeny was planted into mixed media (organic fertilizer: charcoal: soil = 5 : 3 : 1) in 40x40 cm pot and maintained by watering every day for 1-2 week after planting, and after the second week as usual irrigation. Fertilizer was given twice a week. First fertilization was used 10 g per block of NPK (15:15:15). Two weeks later, the mixture of 5 g NPK (15:15:15) and 5 g KNO₃ was applied. Liquid fertilizer (micro elements) was applied once a week.

Observed variables were phenotypic characters of flower, there were 12 quantitative characters (vase life, Inflorescence length, inflorescence diameter, diameter of outer flower/ first flower, second flower diameter, third flower diameter, flower height, total of flower, total of petal in first flower, second flower and third flower) and

three qualitative characters (type of flower, color of flower, and color of petal). All of variables were measured and observed when the flower reached full blooming.

Quantative characters data were analyzed using RCBD (Random Completely Block Design) based on equation 1 (Gaspersz, 1991).

$$Y_{ij} = \mu + \sigma_i + \beta_j + \epsilon_{ij} \dots\dots\dots(1)$$

where: Y_{ij} = observation value from treatment I in block j; μ= population mean; σ_i= additive effect from treatment i; β_j = additive effect from block j; ε_{ij}= treatment error effect from treatment i in block j

The software of SPSS 16.0 was used for data analysis.

RESULTS AND DISCUSSION

Gerbera is an ornamental plant which is produced exclusively for aesthetic values. Gerbera belongs to the family *Asteraceae*, with composite flower (Kanwar& Kumar, 2008). The important phenotypic characters of gerbera are determined by (1) flower color (petal and disc floret), (2) shape (single, semi double and double), (3) flower diameter, and (4) inflorescence flower. The flower diameter, flower stalk length and stalk diameter are also very important as they determine the quality of cut flower in gerbera (Kumar, 2013).

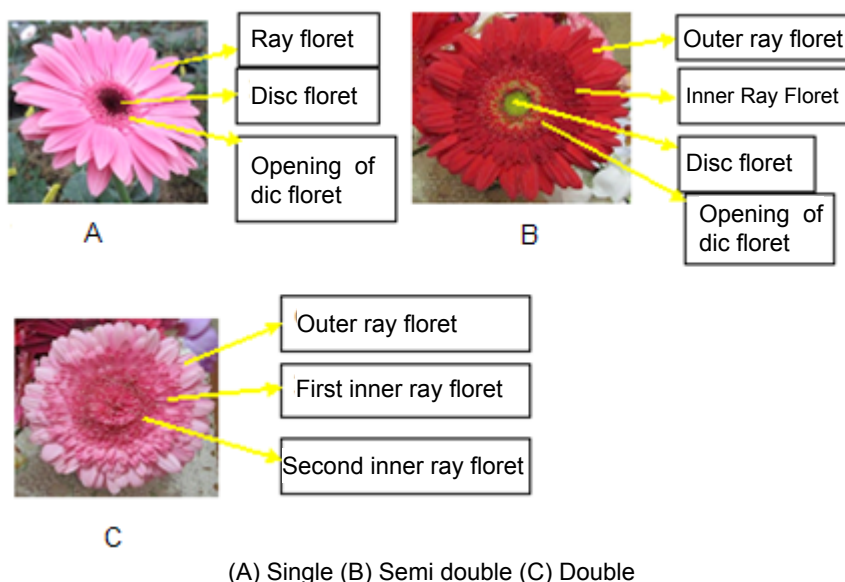


Fig. 1. Morphological type of Gerbera Flower

Based on petal structure of flower, gerbera is divided in 3 types. There are (1) One-layer petal, with single layer, (2) Two-layers petal, with two layers and many colors of petal and (3) Three-layers petal, with three layers and many colors (Yusup, 1999). Based on UPOV (2000), single gerbera has one layer of petal flower, semi double with two layers of petal and double type has three layers of petal. Single and semi double types have disk floret (Fig. 1.)

Analysis of 12 qualitative characters showed that there were genetic variabilities among progenies. Out of 12 characters observed, 9 characters were significantly different and 3 characters were not. The characters which were not significantly different were peduncle (Table 1), third flower diameter (Table 2) and flower height (Table 3).

The character of peduncle length was not significantly different. This character had narrow

variability (LB x RR). Rate of peduncle length was 33.00 – 64.05 cm, and the average was 54.51cm. The longest peduncle, 64.05 cm, was achieved by the progeny no. 20.011. Contrary, RR cultivar had the shortest flower peduncle. Previous research was done by Mahmood, Ahmad, & Khan (2013), the average of flower peduncle was 40.6 – 60.3 cm. Based on the Directorate of Floriculture and Postharvest (2014), peduncle length was an important variable to determine quality of cutting flower. The minimum standard of peduncle length was 40 cm. The advantage of longer peduncle is the many sources of nutrients and it causes longer vase life (Mahmood, Ahmad, & Khan, 2013). The major reasons for shorter vase life of cut flowers are nutrient deficiency, bacterial and fungal contaminations, water stress-induced wilting and vascular blockage (Safa, Hashemabadi, & Kaviani, 2012).

Table 1. Average of peduncle-length, diameter of peduncle, diameter of outer ray floret, and diameter of first inner ray floret

Clone Number	Peduncle-length (cm)		Diameter of peduncle (cm)		Diameter of outer ray floret (cm)		Diameter of first inner ray floret (cm)	
	Mean	Significance	Mean	Significance	Mean	Significance	Mean	Significance
20.001	56.40	cd	0.47	b	6.80	a	0.00	a
20.004	56.30	c	0.62	d	9.66	fg	7.05	c
20.006	54.60	ac	0.50	b	9.54	ef	0.00	a
20.009	59.10	f	0.64	d	10.86	gh	0.00	a
20.011	64.05	g	0.47	b	7.51	a	0.00	a
20.012	53.85	b	0.55	c	8.74	cd	0.00	a
20.013	58.80	f	0.48	b	8.60	ab	0.00	a
20.017	57.50	de	0.48	b	8.69	bc	0.00	a
Local Bali	51.50	b	0.36	a	9.08	de	6.15	b
Rubby Red	33.00	a	0.49	b	7.73	a	0.00	a

Remarks: Means followed by the same letter are not significantly different according to the Duncan's Multiple Range Test at $p < 0.05$

Table 2. Average of second inner ray floret diameter, height of flower, disc floret diameter and vase life

Clone Number	Second inner ray floret diameter (cm)		Height of flower (cm)		Disc floret diameter (cm)		Vase Life (day)	
	Mean	Significance	Mean	Significance	Mean	Significance	Mean	Significance
20.001	0.00	a	2.84	bc	1.47	de	12.00	ab
20.004	3.02	ab	2.20	a	0.00	a	13.00	bc
20.006	0.00	a	3.15	cd	1.05	b	9.50	a
20.009	0.00	a	3.59	ef	2.32	i	14.00	cd
20.011	0.00	a	2.55	a	1.38	cd	12.00	ab
20.012	0.00	a	1.84	a	1.53	ef	8.00	a
20.013	0.00	a	2.81	ab	1.79	gh	9.00	a
20.017	0.00	a	3.62	fg	1.20	bc	7.00	a
Local Bali	2.69	a	3.93	gh	0.00	a	8.50	a
Rubby Red	0.00	a	3.17	de	1.61	fg	18.50	c

Remarks: Means followed by the same letter are not significantly different according to the Duncan's Multiple Range Test at $p < 0.05$

Table 3. Average of total number of outer ray floret, total number of first inner ray floret, total number of second inner ray floret and total number of disc floret

Clone Number	Total number of outer ray floret	Total number of first inner ray floret	Total number of second inner ray floret	Total number of disc floret
20.001	54.50 gh	0.00 a	0.00 a	265.00 fg
20.004	53.00 fg	142.50 c	325.50 c	0.00 a
20.006	48.00 bc	0.00 a	0.00 a	125.00 b
20.009	83.00 j	0.00 a	0.00 a	402.00 i
20.011	47.00 b	0.00 a	0.00 a	211.00 cd
20.012	49.00 cd	0.00 a	0.00 a	257.00 ef
20.013	50.50 de	0.00 a	0.00 a	209.50 c
20.017	50.50 ef	0.00 a	0.00 a	217.50 de
Local Bali	33.50 a	94.50 b	130.50 b	0.00 a
Rubby Red	55.00 hi	0.00 a	0.00 a	311.50 gh

Remarks: Means followed by the same letter are not significantly different according to the Duncan's Multiple Range Test at $p < 0.05$

The peduncle diameter was about 0.36 - 0.64 cm with the average of 0.51 cm. The progenies with more than 0.60 cm of peduncle diameter were progenies no. 20.009 and 20.004, and the smallest one 0.36 cm, was LB cultivar. The diameter of peduncle influences the cutting flower freshness. Flower with big diameter of inflorescence, suppose to have stem strengthness. But, it was not limited for diameter of gerbera as optimal diameter in gerbera. It was different from chrysanthemum, the optimal peduncle diameter was more than 0.41 cm (A grade) (Directorate General of Horticulture, Directorate of Fruit and Floriculture, 2016). From this study there were 9 progenies had more than 0.41 cm of peduncle diameter.

The diameter of first inner ray floret among tested gerbera progenies were 6.80 – 10.86 cm. The progeny no. 20.009 had the biggest diameter of outer flower. On the other hand, the progeny no. 20.001 was the smallest. Based on the consumers preference, they prefer gerbera with outer flower more than 8 cm (Directorate of Floriculture and Postharvest, 2014). According to this standard, there were six progenies (20.004, 20.006, 20.009, 20.012, 20.013 and 20.017) with outer flower diameter more than 8 cm.

The first and second inner ray florets were just on no. 20.004 and Local Bali. The result based on flower type, both progeny no.20.004 and Local Bali were double type and the others were single type. Diameter of first inner and outer ray floret, the progeny no. 20.004 was bigger than than Local Bali cultivar. Flower height of ten gerbera genotypes tested were not significantly different. The average

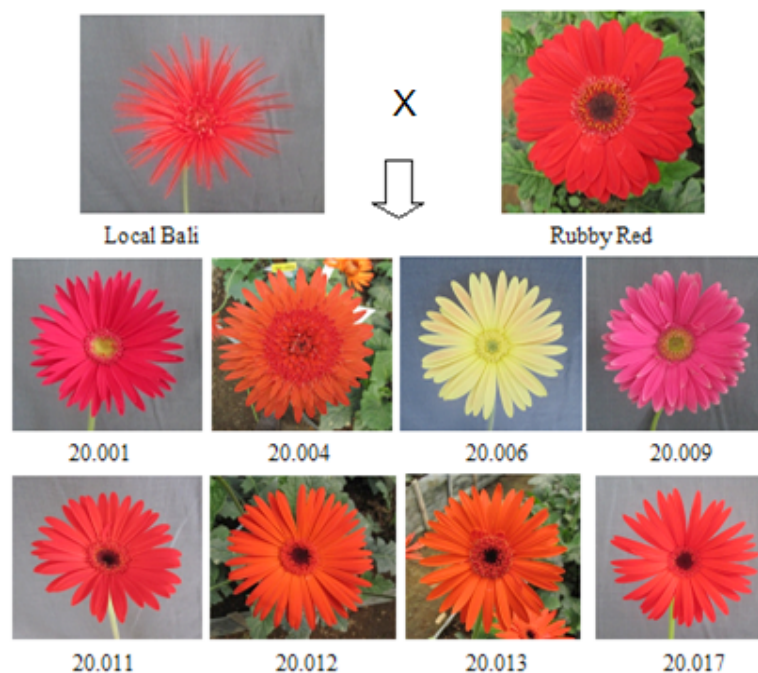
of flower height was about 2.97 cm. The progeny no. 20.012 has the highest flower and the shortest flower was Local Bali cultivar.

The progeny no. 20.004 and Local Bali were double type, so both did not have disc floret diameter and total number of disc floret. The biggest diameter of disc floret was 2.32 cm (progeny no. 20.009), and this character was significantly different with the others. This value (2.32 cm) was related to the total number of disc floret. Progeny no. 20.009 has the most disc floret (402). Total number of ray florets are indicated by the thickness of gerbera petal. If gerbera has a large number of ray florets, it will be indicated by its thickness petal. Progeny no. 20.009 has the total number of outer ray florets more than the others, there was 83.0 and it showed a significant different to the others. Local Bali cultivar has the least total number of outer ray florets (33.5) among 10 tested gerbera genotypes. It can be concluded that progeny no.20.009 has the thickest petal than the others.

One of the best quality of cutting flower depends on vase life. The vase life of gerbera evaluated ranged from 7.00 – 18.50 days. Rubby Red cultivar has the longest vase life (18.50 days), this vase life is not significantly different with the progeny no. 20.009 (14 days). The shortest of vase life was owned by the progeny no. 20.017 i.e. 7 days. Previous result (Nurmalinda & Yani, 2009), based on market preferences of gerbera there were some factors influence the quality of gerbera, i.e. color, flower freshness and vase life. The survey of respondent resulted that 63.0% of respondents chose the longest vase life (more than 5 days).

Table 4. Type of flower, color of outer ray florets and disc floret

Clone Number	Flower Type	Color of outer ray florets	Color of disc florets
20.001	Single	Red Group 46 C	Yellow Green Group N. 144 B
20.004	Double	Orange Red Group N. 30 A	-
20.006	Single	Basic: Yellow Group 7B, secondary : Orange Red Group 30C	Yellow Green Group 151 A
20.009	Single	Red Purple Group 68 A	Yellow Green Group 144 C
20.011	Single	Orange Red Group N. 30 A	Greyed Purple Group 187 B
20.012	Single	Orange Red Group N. 30 A	Greyed Purple Group 187 B
20.013	Single	Orange Red Group N. 30 A	Greyed Purple Group 187 A
20.017	Single	Red Group 40 A	Greyed Purple Group 187 A
Local Bali	Single	Orange Red Group 33 A	-
Rubby Red	Single	Red Group 45 B	Greyed Purple Group 187 A

**Fig. 2.** Phenotypic and flower morphology of 10 gerbera's clones

The qualitative characters, anatomy and biochemical of pigments were factors which have role in the variation of flower color in gerbera (Hatamzadeh, Akbari, Sariri, & Bakhshi, 2012). The qualitative characters were consisted flower type, color of outer ray floret, and color of disc florets. The influence of different light intensities also showed significant variations on growth and flower characteristics (Uddin, Das, Shammy, Foysal, & Islam, 2012).

There were two types of gerbera. First type was single and the other was double type. Progeny no. 20.004 and Local Bali were double type, and the others were single type. The performance of outer ray florets were vary. There were yellow group, red

group, orange red group, and red purple group. The disc florets were yellow green group and grayed purple group (Table 4).

Parents (male and female) had different type of flowers. Female parent (Local Bali) was double type and male parent (Ruby Red) was single type. The progeny no. 20.004 was double type, but it was not similar to Local Bali. The petals structure was closer and wider than the petals belong to Local Bali. The color of outer ray floret (female) was orange red group (33 A) and the male color was red group (45 B). Two progenies were red group, 4 progenies were orange red group, and the others were different with their parents (yellow group and red purple group) (Table 4).

Gerbera is heterozygous with the total number of somatic chromosomes are $2n = 50$ (Kumari, Patel, & Choudhary, 2011). Based on the heterozygosity, the probability of obtaining variability in the filial is very high, through the crossing of Local Bali (female) and Ruby Red (male) (Fig. 2). Beside genetic factors, the physiological status of the donor plant influenced the phenotypic performance. The physiological status of the donor is determined by environmental conditions such as temperature, light intensity, day-length and light wavelength (Hasbullah, Taha, & Awal, 2008).

CONCLUSION AND SUGGESTION

There were significant differences for characters of peduncle diameter, outer ray floret diameter, inner ray floret diameter, disc floret diameter, total number of disc floret, total number of outer ray floret, total number of second inner ray floret and vase life. The progeny no. 20.009 had the longest diameter of peduncle, biggest diameter of outer ray floret, and highest total number of outer ray florets. The longest vase life was Ruby Red cultivar.

There were two types of flower, first was single type (20.001, 20.006, 20.009, 20.011, 20.012, 20.013, 20.017, Ruby Red) and second was double type (20.004 and Local Bali). The color of outer ray floret was divided in 4 groups, there were yellow group, red group, orange red group and red purple group. The color of disc floret was divided in 2 groups, there were yellow green group and grayed purple group.

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