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## Shwetha GS

M.Sc. (Hort.), Research Scholar,  
Department of Floriculture and  
Landscape Architecture, KRC  
College of Horticulture, Arabhavi,  
Karnataka, India

## Manjunath DR

Ph.D. Scholar, Department of  
Floriculture and landscape  
architecture, College of  
Horticulture, Bagalkot,  
Karnataka, India

## Nandini GS

Assistant Horticulture Officer,  
Kotturu Horticulture Farm,  
Kotturu, O/o SADH (State sector)  
Vijayanagara, Karnataka, India

## Marriboyina Mahendra

M.Sc Scholar, Department of  
Agriculture Entomology Raja  
Balwant Singh College, Bichpuri  
Agra Uttar Pradesh, India

## Corresponding Author:

### Shwetha GS

M.Sc. (Hort.), Research Scholar,  
Department of Floriculture and  
Landscape Architecture, KRC  
College of Horticulture, Arabhavi,  
Karnataka, India

## Combining ability analysis for flowering and quality parameter in annual chrysanthemum (*Glebionis coronaria* [L.] Cass. ex Spach.)

Shwetha GS, Manjunath DR, Nandini GS and Marriboyina Mahendra

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### Abstract

The study of general and specific combining ability of parents and crosses to identify superior parents and crosses respectively. A line x tester analysis was carried out involving five lines (White Majestine, AACS-3, Sarpan White, Sarpan Yellow and Garden Aids) and three testers (Dharwad White, Dharwad Yellow and Bagalkot Local) to obtain fifteen crosses. The experiment was conducted at the Department of Floriculture and Landscape Architecture, Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka during 2020-21. The parent White Majestine followed by Sarpan White were good general combiners for the majority of the traits. The cross combination Sarpan White x Dharwad White, White Majestine x Dharwad White, Garden Aids x Bagalkot Local, White Majestine x Dharwad Yellow and AACS-3 x Dharwad White are the best specific combining ability for various trait.

**Keywords:** Annual chrysanthemum, general combining ability, specific combining ability

### Introduction

*Glebionis coronaria* (L.) Cass. ex Spach. often known as *Chrysanthemum coronarium* L., is a flowering plant in the Asteraceae family. It is abundant throughout Europe, Northern Africa and Asia and is endemic to the Mediterranean area. Garland chrysanthemum, edible chrysanthemum, crown daisy chrysanthemum, kikuna, mirabeles, shungiku, chop suey green, crown daisy and Japanese green are just a few of common names. The annual chrysanthemum has the potential to appear at any time of the year. They are self-fertile hermaphrodites that reproduce by seed.

It contrasts from the Florist's Chrysanthemum in a number of ways, including its shorter bloom time, lower photosensitivity and ability to grow higher, more vigorously and more hardily. It's a bipinnately lobed leaf herb with yellow ray florets and a tiny fragrant flower head. It is a branching annual with finely cut leaves that may reach a height of one meter. The blooms are 2.5-4 cm in diameter and occur in single or double forms (Desai, 1962) [4] with cream zones in the center (Vishnu swarup, 1967) [14]. India has a total area of 16.63 million hectares under loose flower production, with a production of 179.33 million tonnes. Tamil Nadu, Karnataka, Maharashtra, Rajasthan, Madhya Pradesh and Bihar are some of India's top chrysanthemum-growing states (Anon., 2014) [2].

A lot of variability for flower characters is available in annual chrysanthemum, In the market, importance is given to annual chrysanthemum flowers having a small disc, a greater number of petals with large size, multi-layered whorls of petals with multicolor. Estimation of combining ability is an important tool which can be utilized in the design of successful breeding programs in various ornamental crops (Bayat *et al.*, 2012) [3]; To understand the probable use of any genotype as a good line or tester parent in hybridization, there is a need to evaluate its own performance along with its gca effect and the performance of F1 hybrid derived from it. General combining ability (gca) of genotypes is normally associated with additive gene action, while specific combining ability (sca) governed by dominance and epistasis gene action (Malik *et al.*, 2004) [7]. Parents differing in their combining ability and the use of good general combiners are expected to give useful segregants. In similar way, superior cross combinations can be categorized in respect to their specific combining ability effects.

It also provides necessary information on nature and magnitude of gene effects for growth traits

### Material and methods

The present study was conducted in the research field of the Department of Floriculture and Landscape Architecture of Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka during 2020-21. The experimental material comprised eight genotypes of the annual chrysanthemum. Five lines namely White Majestine, AACS-3, Sarpan White, Sarpan Yellow and Garden Aids were crossed with three testers namely Dharwad White, Dharwad Yellow and Bagalkot Local in line  $\times$  tester mating design to develop ten  $F_1$  hybrids. Hand pollination of five lines was done with three testers in fifteen combinations. The lines, testers and hybrids were planted in a randomized complete block design (RCBD) with two replications at a spacing of 60 cm  $\times$  30 cm. Uniform cultural practices were followed in all the hybrids, lines and testers.

The observations were recorded for namely days to first flowering, days to 50 per cent flowering, duration of flowering, flower diameter and shelf life of flower. The data generated was used to estimate general combining ability of parents and specific combining ability of cross combinations using appropriate formulae and statistical package WINDOSTAT version 8.6.

### Result and Discussion

The variances of general combining ability (GCA) and specific combining ability (SCA) of fifteen characters studied are presented in Table 1. Results of the investigation revealed that, days for first flowering and shelf life reported higher SCA variance and for the trait Days to 50% flowering, duration of flowering and flower diameter GCA variance was maximum.

General combining ability (*gca*) and Specific combining ability (*sca*) effects for flowering and quality parameters in annual chrysanthemum were furnished in Table 2 to Table 5

White Majestine recorded the highest significant negative *gca* effect hence, was a good general combiner for getting early flowering. Cross combination White Majestine  $\times$  Dharwad White recorded the highest significant negative *sca* effect and has a female parent with low *gca* and male parent with high *gca* indicating additive  $\times$  dominance type of gene action, which can be exploited by heterosis breeding and recurrent selection. The mean sum of squares exhibited a significant difference for the line  $\times$  tester effect. SCA variance was of a higher order than GCA variance indicating the major role of non-additive gene action in the expression of this trait. Similar findings were reported by Sureshkumar *et al.* (2004a) [13], Anjali (2015) [1] and Mrutyunjaya (2021) [8] in China aster.

Five parents reported significant *gca* effects for this character. White Majestine (-2.29) and Dharwad White (-0.75) were negatively significant and AACS-3 (1.61), Sarpan White (1.67) and Bagalkot Local (1.31) were reported positive significant *gca* effects.

Eight crosses reported negative and seven crosses reported positive *sca* effects. six crosses showed significant *sca* effects *viz.*, White Majestine  $\times$  Dharwad White (-2.45), AACS-3  $\times$  Dharwad Yellow (-1.45) and Garden Aids  $\times$  Bagalkot Local (-1.97) in negative and White Majestine  $\times$  Dharwad Yellow (1.95), AACS-3  $\times$  Bagalkot Local (2.69) and Garden Aids  $\times$  Dharwad White (2.09) in a negative direction.

For days to 50 per cent flowering Sarpan Yellow was the best general combiners as shown significant negative *gca* effects and hence, possesses additive genes for the trait, similar result reported by Anjali (2015) [1] and Mrutyunjaya (2021) [8] in China aster. None of the crosses had significant values for the *sca* effect in a negative direction. Sarpan Yellow  $\times$  Dharwad White

showed the highest values for the *sca* effect. In this cross, the female parent was with higher *gca* and the male parent was with lower *gca* hence indicating additive  $\times$  dominant type of gene action and can be exploited by heterosis breeding and recurrent selection.

AACS-3 (2.13) reported the highest *gca* effect whereas, the lowest was reported by Sarpan Yellow (-2.53). AACS-3 (2.13) and Sarpan Yellow (-2.53) parents exhibited significant *gca* effects and the rest of the six were non-significant. Among fifteen crosses, eight crosses showed negative *sca* effects while the other seven crosses exhibited positive *sca* effects. None of the crosses showed a significant *sca* effect in both directions.

An increase in flower duration helps in the continuous harvest of the flowers for longer days. The mean sum of squares was significant for the line effect and line  $\times$  tester effect. Compared to SCA variance, GCA variance was maximum showing the role of additive gene action in the expression of this trait. The results are also in agreement with the findings of Namita *et al.* (2011) [9] in marigold. White Majestine followed by Dharwad White was the best general combiners for this trait which showed the highest positive *gca* effects. The best specific cross combination for the trait was AACS-3  $\times$  Dharwad White which had the highest positive significant *sca* effect. This cross has both the parents with high *gca* showing dominance gene action, which can be exploited by heterosis breeding and recurrent selection.

The magnitude of the *gca* effect ranged from -4.75 to 3.52 and five parents exhibited significant *gca* effects. White Majestine (3.52), Dharwad White (3.37) and Dharwad Yellow (1.37) showed positive significance whereas, Sarpan Yellow (-3.28) and Bagalkot Local (-4.75) showed negative significant *gca* effects. Six crosses exhibited significant *sca* effects in both directions. The magnitude of the *sca* effect ranged from -8.59 (AACS-3  $\times$  Bagalkot Local) to 5.29 (AACS-3  $\times$  Dharwad White).

For flower diameter Sarpan White and Sarpan Yellow were the two parents that had positive significant *gca* effects, hence, have additive genes for the trait. White Majestine  $\times$  Dharwad Yellow was the best specific cross combination showing positive significant *sca* effect and had low  $\times$  high *gca* combination indicating dominant  $\times$  additive gene action and can be exploited by heterosis breeding and recurrent selection. The mean sum of squares was found significant for the line  $\times$  tester effect. The maximum variance was reported by GCA compared to SCA indicating the major role of additive gene action for the trait as reported by Raghava (1984) [11], Raghava and Negi (1993) [10] and Sureshkumar (2003) [12] in China aster, Kattera *et al.* (2014) [5] in annual chrysanthemum, Bayat *et al.* (2012) [3] in petunia.

The top two parents that resulted in maximum *gca* effects were Sarpan White (0.63) and Sarpan Yellow (0.28) five parents exhibited significant *gca* effects while, three parents were non-significant. Four crosses among fifteen reported significant *sca* effects while, eleven crosses were non-significant. Positive significant *sca* effects were exhibited by White Majestine  $\times$  Dharwad Yellow (0.42) and Garden Aids  $\times$  Dharwad White (0.30).

For shelf life, Sarpan White was the best general combiner for this trait which reported the highest significant positive *gca* effect. They seem to have additive genes for this trait. White Majestine  $\times$  Dharwad White reported maximum positive significant *sca* effects. Thus, the crosses for the *gca* combination were of high  $\times$  high type indicating the dominant type of gene action. Twelve crosses over the mid parent, eight crosses over the better parent and five crosses over standard check reported significant positive heterosis. White Majestine  $\times$  Dharwad White and Sarpan White  $\times$  Dharwad Yellow showed maximum heterosis over a standard check and also positive significant heterosis over the mid and better parent.

Five parents had a positive *gca* effect whereas three parents reported a negative *gca* effect for shelf life. The range of the *gca* effect varied from -2.50 to 2.00. Sarpan White (2.00) was the parent that had positive and Sarpan Yellow (-2.50) and Bagalkot Local (-0.93) parents had negative significant *gca* effects. Among fifteen crosses, six crosses reported negative *sca* effects

and the rest of the crosses reported positive *sca* effects. White Majestine × Dharwad White (2.63) and AAC3-3 × Bagalkot Local (2.10) and Sarpan Yellow × Dharwad White (2.30) crosses showed positive significant *sca* effects and AAC3-3 × Dharwad White (-2.20) cross showed negative significance for shelf life.

**Table 1:** Variance due to general and specific combining ability and their ratio for flowering and quality parameters in annual chrysanthemum

Sl. No.	Sources Degrees of freedom	Mean sum of squares			Component of variance		
		Line effect	Tester effect	L × T effect	GCA	SCA	VA/VD
		4	2	8			
1	Days for first flowering	16.71	12.91	8.23 **	3.51	3.72	0.94
2	Days for 50% flowering	19.62	13.30	5.22 **	3.29	0.96	3.42
3	Duration of flowering (days)	35.27	178.98	53.61 **	26.00	25.24	1.03
4	Flower diameter (cm)	1.32 **	0.06	0.16 *	0.17	0.07	2.50
5	Shelf life (hours)	16.58	6.63	8.51 **	2.57	3.60	0.72

\*Significant at 5 per cent level \*\*Significant at 1 per cent level GCA - General combining ability

SCA - Specific combining ability

**Table 2:** General combining ability (*gca*) effects for flowering parameters in annual chrysanthemum

Sl. No.	Parents	Days to first flowering	Days to 50% flowering	Duration of flowering (days)
1	White Majestine	-2.29 **	-0.53	3.52 **
2	AACS-3	1.61 **	2.13 *	0.39
3	Sarpan White	1.67 **	1.3	-0.41
4	Sarpan Yellow	-0.56	-2.53 **	-3.28 **
5	Garden Aids	-0.43	-0.37	-0.21
	S.Esij	0.36	0.74	0.72
	C.D. at 5%	0.77	1.59	1.55
	C.D. at 1%	1.07	2.21	2.15
<b>Tester</b>				
6	Dharwad White	-0.75 *	1.1	3.37 **
7	Dharwad Yellow	-0.55	0.1	1.37 *
8	Bagalkot Local	1.31 **	-1.2	-4.75 **
	S.Esij	0.28	0.57	0.56
	C.D. at 5%	0.60	1.23	1.20
	C.D. at 1%	0.83	1.71	1.66

\*Significant at 5 per cent level \*\*Significant at 1 per cent level

**Table 3:** General combining ability (*gca*) effects for Flower diameter and Shelf life in annual chrysanthemum

Sl. No.	Parents	Flower diameter (cm)	Shelf life (hours)
1	White Majestine	-0.15 *	0.67
2	AACS-3	-0.59 **	-0.5
3	Sarpan White	0.64 **	2.00 **
4	Sarpan Yellow	0.28 **	-2.50 **
5	Garden Aids	-0.17 *	0.33
	S.Esij	0.07	0.47
	C.D. at 5%	0.15	1.01
	C.D. at 1%	0.20	1.40
<b>Tester</b>			
6	Dharwad White	-0.08	0.37
7	Dharwad Yellow	0.02	0.57
8	Bagalkot Local	0.06	-0.93 *
	S.Esij	0.05	0.36
	C.D. at 5%	0.11	0.78
	C.D. at 1%	0.16	1.08

\*Significant at 5 per cent level \*\*Significant at 1 per cent level

**Table 4:** Specific combining ability (*sca*) effects for flowering parameter in annual Chrysanthemum

Sl. No.	Crosses	Days to first flowering	Days to 50% flowering	Duration of flowering (days)
1	White Majestine × Dharwad White	-2.45 **	-1.27	2.36
2	White Majestine × Dharwad Yellow	1.95 **	0.73	-2.84 *
3	White Majestine × Bagalkot Local	0.49	0.53	0.48
4	AACS-3 × Dharwad White	-1.25	1.07	5.29 **
5	AACS-3 × Dharwad Yellow	-1.45 *	0.57	3.29 *
6	AACS-3 × Bagalkot Local	2.693 **	-1.63	-8.59 **

7	Sarpan White × Dharwad White	0.69	0.40	0.09
8	Sarpan White × Dharwad Yellow	0.49	-0.10	-1.91
9	Sarpan White × Bagalkot Local	-1.17	-0.30	1.81
10	Sarpan Yellow × Dharwad White	0.92	-1.77	-7.04 **
11	Sarpan Yellow × Dharwad Yellow	-0.88	-0.77	2.16
12	Sarpan Yellow × Bagalkot Local	-0.04	2.53	4.88 **
13	Garden Aids × Dharwad White	2.09 **	1.57	-0.71
14	Garden Aids × Dharwad Yellow	-0.11	-0.43	-0.71
15	Garden Aids × Bagalkot Local	-1.97 **	-1.13	1.41
	S.Esij	0.62	1.28	1.25
	C.D. at 5%	1.34	2.75	2.68
	C.D. at 1%	1.86	3.82	3.72

\*Significant at 5 per cent level \*\*Significant at 1 per cent level

**Table 5:** Specific combining ability (*sca*) effects for Flower diameter and Shelf life in annual chrysanthemum

Sl. No.	Crosses	Flower diameter(cm)	Shelf life (hours)
1	White Majestine × Dharwad White	-0.29 *	2.63 **
2	White Majestine × Dharwad Yellow	0.42 **	-1.07
3	White Majestine × Bagalkot Local	-0.12	-1.57
4	AACS-3 × Dharwad White	-0.01	-2.20 *
5	AACS-3 × Dharwad Yellow	-0.03	0.1
6	AACS-3 × Bagalkot Local	0.04	2.10 *
7	Sarpan White × Dharwad White	-0.20	-1.2
8	Sarpan White × Dharwad Yellow	0.12	1.1
9	Sarpan White × Bagalkot Local	0.08	0.1
10	Sarpan Yellow × Dharwad White	0.21	2.30 *
11	Sarpan Yellow × Dharwad Yellow	-0.13	-0.9
12	Sarpan Yellow × Bagalkot Local	-0.08	-1.4
13	Garden Aids × Dharwad White	0.30 *	-1.53
14	Garden Aids × Dharwad Yellow	-0.38 **	0.77
15	Garden Aids × Bagalkot Local	0.08	0.77
	S.Esij	0.12	0.81
	C.D. at 5%	0.25	1.74
	C.D. at 1%	0.35	2.42

\*Significant at 5 per cent level \*\*Significant at 1 per cent level

## Conclusions

From the studies it is concluded that, the parent White Majestine followed by Sarpan White were good general combiners for days to first flowering, duration of flowering, flower diameter, For flower yield per plant, Bagalkot Local was a good general combiner. AACS-3 was the good combiner for 50% flowering. The cross Sarpan White × Dharwad White reported a significant negative *sca* effect for days to 50 percent flowering. White Majestine × Dharwad White cross showed a maximum negative *sca* effect for days to first flowering. Garden Aids × Bagalkot Local for seed yield per plant, White Majestine × Dharwad Yellow reported a significant *sca* effect for flower diameter, AACS-3 × Dharwad White reported a significant *sca* effect for the duration of flowering.

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