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Exploitation of combining ability for yield characters in annual chrysanthemum (*Glebionis coronaria* [L.] Cass. ex Spach.)

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Abstract

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 study of general and specific combining ability of parents and crosses to identify superior parents and crosses respectively. The parent White Majestine followed by Sarpan White were good general combiners for the individual flower weight, The cross combination Sarpan White x Bagalkot Local, Sarpan Yellow x Bagalkot Local, Garden Aids x Dharwad white and Garden Aids x Bagalkot Local 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) ^[9]. 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 Individual flower weight (g), No. of flowers/ Plant, Flower yield/plant (g), Seed yield per plant (g), Test weight (g). 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, seed yield per plant reported higher SCA variance and for the trait individual flower weight, number of flower per plants, flower yield per plant and test weight GCA variance was maximum.

General combining ability (*gca*) and Specific combining ability (*sca*) effects for yield characters in annual chrysanthemum were furnished in Table 2 and Table 3 respectively.

Sarpan White followed by Bagalkot Local exhibited the highest values for positive *gca* effect with additive genes for the Individual flower weight. Sarpan White $\times$ Bagalkot Local reported the highest positive *sca* effect and the *gca* combination of high $\times$ high type showing dominant gene action. Thus, can be exploited by heterosis breeding and recurrent selection

Four parents had significant *gca* effects for individual flower weight. Sarpan White (1.09) and Bagalkot Local (0.30) exhibited positive and Dharwad Yellow (-0.21) and AACS-3 (-0.90) exhibited negative significant *gca* effects.

Three cross combinations *viz.*, Sarpan Yellow $\times$ Bagalkot Local (-0.43), Sarpan White $\times$ Dharwad White (-0.44) and Sarpan White $\times$ Bagalkot Local (0.47) had significant *sca* effects in both directions. The rest of the twelve crosses showed non-significant *sca* effects.

The best general combiner for No. of flowers/ Plant was AACS-3 which recorded maximum positive significant *gca* effect and has additive genes for the trait. Sarpan Yellow $\times$ Bagalkot Local reported positive significant *sca* effects, thus, the crosses *gca* combination was of low $\times$ low type, indicating dominant $\times$ dominant type of gene action. This can be exploited by heterosis breeding and recurrent selection as reported by Anjali (2015) [1] in China aster.

The top two parents that resulted in maximum *gca* effects were AACS-3 (18.24) and Dharwad Yellow (0.68). Two parents *viz.*, AACS-3 (18.24) and Sarpan White (-14.86) showed significant *gca* effects and six were non-significant for the number of flowers per plant. Cross Sarpan Yellow $\times$ Bagalkot Local (11.25) among fifteen showed significant *sca* effects seven crosses showed negative *sca* effects while the other eight crosses exhibited positive *sca* effects.

An increase in flower yield per plant is an important trait to increase productivity. Bagalkot Local was the best general combiner for this trait as it recorded the maximum positive significant *gca* effect. None of the crosses had significant values for the *sca* effect in a positive direction. Garden Aids $\times$ Dharwad White reported positive significant *sca* effects. Thus, the crosses of the *gca* combination were of low $\times$ low type indicating dominant $\times$ dominant type of gene action. This can be exploited by heterosis breeding and recurrent selection as reported by Anjali (2015) [1] and Mrutyunjaya (2021) [8] in China aster. The mean sum of squares was significant for line $\times$ tester effect and variance due to GCA was high compared to SCA. Hence, additive gene action played the main role in the expression of this character. These results conform to Suresh Kumar *et al.* (2004a) [6] in China aster.

The range of *gca* effects varied from -13.16 to 13.36 for flower yield per plant. AACS-3(-13.16) and Bagalkot Local (13.36) had significant *gca* effects in both directions, among eight parents four were having a positive *gca* effect and the rest of the parents were had negative. Among fifteen crosses, nine crosses showed negative *sca* effects while the other six crosses exhibited negative *sca* effects none of the crosses showed a significant *sca* effect in both directions.

An increase in seed yield per plant is an important trait to increase productivity. Garden Aids and Dharwad White were the two best general combiners for this trait since they recorded maximum positive significant *gca* effect. Garden Aids $\times$ Bagalkot Local cross had significant values for the *sca* effect in a positive direction, thus, the crosses of the *gca* combination were of high $\times$ low type, indicating additive $\times$ dominant type of gene action. The mean sum of squares was significant for line $\times$ tester effect and variance due to SCA was high compared to GCA. Hence, non-additive gene action played the main role in the expression of this character. These results are in conformity with the findings of Singh and Mishra (2010) in marigold.

The range of *gca* effects varied from -0.82 to 0.96 for seed yield per plant. White Majestine (-0.82), Sarpan White (-0.77), Bagalkot Local (-0.31), Dharwad White (0.35) AACS-3 (0.49) and Garden Aids (0.96) had significant *gca* effects in both the direction, and the rest of the parents were nonsignificant. Among fifteen crosses, six crosses showed negative significant *sca* effects and five crosses exhibited positive significant *sca* effects. rest of the crosses showed a nonsignificant *sca* effect.

For test weight, Garden Aids (0.308) had a positive *gca* effect whereas two parents, Sarpan White (-0.17) and White Majestie (-0.22) reported a negative *gca* effect for the test weight. The range of the *gca* effect varied from -0.27 to 0.31.

Among fifteen crosses, seven crosses reported negative *sca* effects and the rest of the crosses reported positive *sca* effects. Garden Aids $\times$ Bagalkot Local (0.29) crosses showed positive significant *sca* effects and Sarpan White $\times$ Bagalkot Local (-0.22) cross showed negative significant *sca* effect for the test weight.

Table 1: Variance due to general and specific combining ability and their ratio for yield characters in annual chrysanthemum

Sl. No.	Sources	Mean sum of squares			Component of variance		
	Degrees of freedom	Line effect	Tester effect	L × T effect	GCA	SCA	VA/VD
		4	2	8			
1.	Individual flower weight(g)	3.02 **	0.69	0.23 **	0.45	0.09	4.82
2.	No. of flowers per plant	836.11 **	3.72	109.53 *	95.82	36.45	2.63
3.	Flower yield per plant (g)	401.76	1369.93 *	271.69	173.00	38.94	4.44
4.	Seed yield per plant (g)	3.66	1.07	2.51 **	0.58	1.23	0.47
5.	Test weight (g)	0.26 *	0.00	0.06	0.03	0.02	1.38

*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 yield characters in annual chrysanthemum

Sl. No.	Parents	Individual flower weight (g)	No. of flowers / Plant	Flower yield /plant (g)	Seed yield per plant (g)	Test weight (g)
1.	White Majestine	-0.10	-1.26	2.29	-0.82 **	-0.22 **
2.	AACS-3	-0.90 **	18.24 **	-13.16 *	0.49 **	0.08
3.	Sarpan White	1.09 **	-14.86 **	9.27	-0.77 **	-0.17 *
4.	Sarpan Yellow	-0.01	-1.23	1.90	0.15	0.003
5.	Garden Aids	-0.07	-0.89	-0.30	0.96 **	0.31 **
	S. Esij	0.08	2.47	5.68	0.091	0.06
	C.D. at 5%	0.17	5.30	12.19	0.20	0.12
	C.D. at 1%	0.24	7.36	16.92	0.27	0.17
	Tester					
6.	Dharwad White	-0.09	-0.5	-4.91	0.35 **	0.002
7.	Dharwad Yellow	-0.21 **	0.68	-8.45	-0.04	-0.001
8.	Bagalkot Local	0.30 **	-0.18	13.36 **	-0.31 **	-0.002
	S. Esij	0.06	1.91	4.40	0.07	0.04
	C.D. at 5%	0.13	4.10	9.44	0.15	0.10
	C.D. at 1%	0.18	5.70	13.11	0.21	0.13

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

Table 3: Specific combining ability (*sca*) effects for yield characters in annual Chrysanthemum

Sl. No.	Crosses	Individual flower weight (g)	No. of flowers / Plant	Flower yield / plant (g)	Seed yield per plant (g)	Test weight (g)
1.	White Majestine × Dharwad White	0.08	-6.6	-11.57	-0.39 *	-0.04
2.	White Majestine × Dharwad Yellow	-0.24	2.22	-6.71	-0.28	-0.01
3.	White Majestine × Bagalkot Local	0.16	4.38	18.28	0.67 **	0.05
4.	AACS-3 × Dharwad White	-0.05	6.1	2.20	0.05	0.01
5.	AACS-3 × Dharwad Yellow	0.06	2.52	3.34	1.36 **	0.12
6.	AACS-3 × Bagalkot Local	-0.01	-8.62	-5.53	-1.42 **	-0.13
7.	Sarpan White × Dharwad White	-0.44 **	4.5	-2.22	0.27	0.16
8.	Sarpan White × Dharwad Yellow	-0.03	1.52	9.62	0.68 **	0.07
9.	Sarpan White × Bagalkot Local	0.47 **	-6.02	-7.39	-0.94 **	-0.22 *
10.	Sarpan Yellow × Dharwad White	0.16	-5.63	-2.06	0.41 *	0.04
11.	Sarpan Yellow × Dharwad Yellow	0.27	-5.61	-3.92	-0.66 **	-0.06
12.	Sarpan Yellow × Bagalkot Local	-0.42 **	11.25 *	5.97	0.25	0.03
13.	Garden Aids × Dharwad White	0.26	1.63	13.65	-0.34 *	-0.17
14.	Garden Aids × Dharwad Yellow	-0.07	-0.65	-2.32	-1.10 **	-0.12
15.	Garden Aids × Bagalkot Local	-0.19	-0.99	-11.33	1.44 **	0.26 *
	S.Esij	0.14	4.28	9.84	0.16	0.1
	C.D. at 5%	0.30	9.18	21.11	0.34	0.21
	C.D. at 1%	0.41	12.74	29.30	0.47	0.30

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

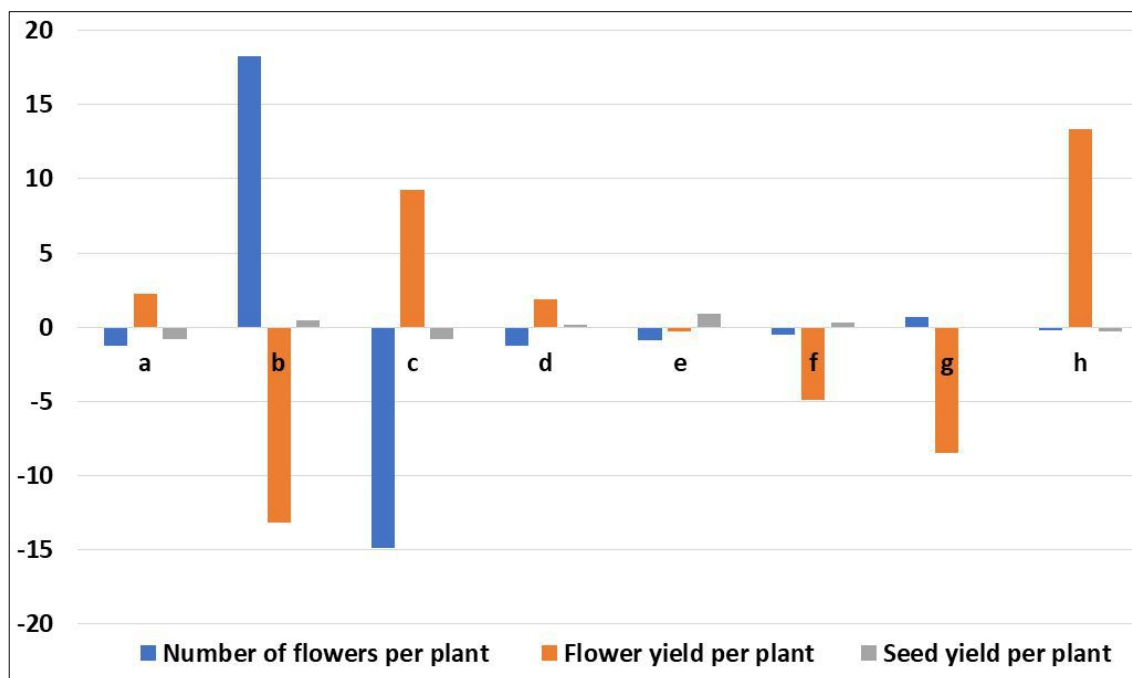


Fig 1: Estimates of *gca* effect of parents for yield characters

a. White Majestine	b. AACS-3	c. Sarpan White	d. Sarpan Yellow
e. Garden Aids	f. Dharwad White	g. Dharwad Yellow	h. Bagalkot Local

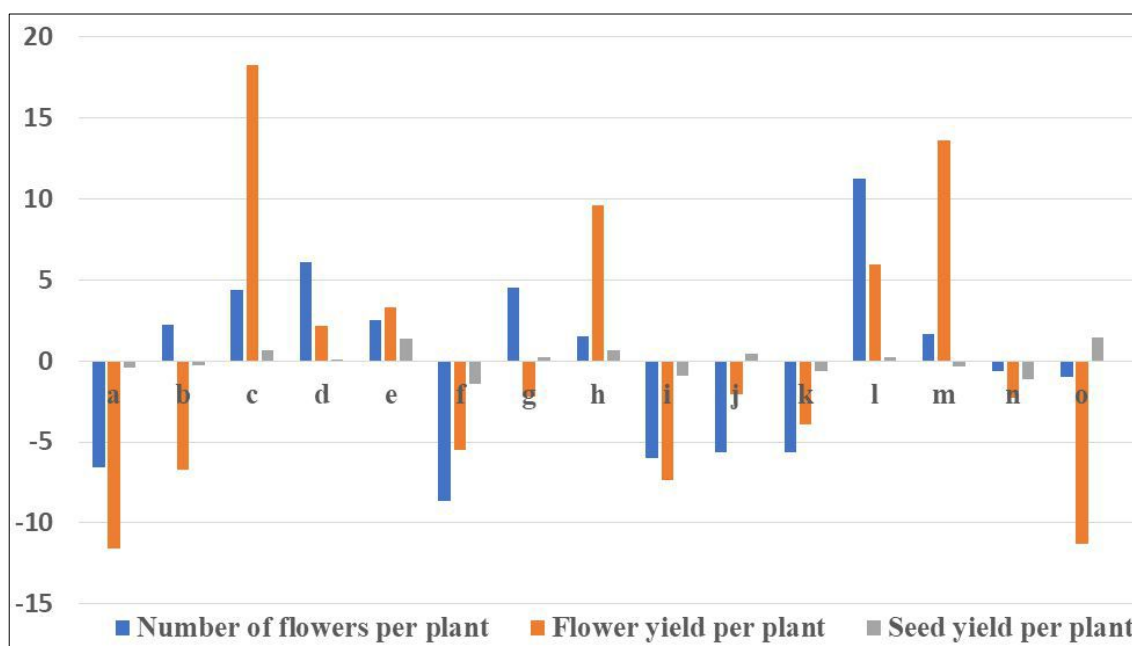


Fig 2: Estimates of *sca* effect of hybrids for yield characters

a. White Majestine × Dharwad White	b. White Majestine × Dharwad Yellow	c. White Majestine × Bagalkot Local	d. AACS-3 × Dharwad White	e. AACS-3 × Dharwad Yellow
f. AACS-3 × Bagalkot Local	g. Sarpan White × Dharwad White	h. Sarpan White × Dharwad Yellow	i. Sarpan White × Bagalkot Local	j. Sarpan Yellow × Dharwad White
k. Sarpan Yellow × Dharwad Yellow	l. Sarpan Yellow × Bagalkot Local	m. Garden Aids × Dharwad White	n. Garden Aids × Dharwad Yellow	o. Garden Aids × Bagalkot Local

Conclusions

The parent White Majestine followed by Sarpan White were good general combiners for the individual flower weight, Garden Aids was a good general combiner for the seed yield per plant. For flower yield per plant, Bagalkot Local was a good general combiner. AACS-3 was the good combiner for the number of flowers per plant.

The cross Sarpan White × Bagalkot Local exhibited a significant positive *sca* effect for individual flower weight. For the number of flowers per plant, Sarpan Yellow × Bagalkot Local reported significant positive *sca* effects. Garden Aids × Dharwad white for flower yield per plant, Garden Aids × Bagalkot Local for seed yield per plant.

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