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## Heterosis for growth and yield traits 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) were analyzed for heterosis for 8 characters in annual chrysanthemum. The experiment was conducted at the Department of Floriculture and Landscape Architecture, Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka during 2020-21. Sarpan White × Bagalkot Local and Sarpan Yellow × Dharwad White exhibited Significant negative heterosis for plant height and 50 per cent flowering, respectively. White Majestine × Bagalkot Local and Garden Aids × Bagalkot Local reported significant heterosis for flower yield per plant and seed yield per plant, respectively.

**Keywords:** Annual chrysanthemum, better parent, heterosis, mid parent, standard check

### 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, 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. 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]. The use of heterosis has proved to be one of the most viable methods of breeding to increase productivity and production (Singh and Chaudhary, 1985) [10]. Hybrids have distinct advantages over open pollinated varieties such as earliness, profuse and uniform flowering, increased flower weight, large flower size, elongated flower stalk, longer flower duration etc. Keeping these points in view, the present study was undertaken to exploit heterosis for growth and yield traits in the annual chrysanthemum.

### 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 × tester mating design to develop fifteen F<sub>1</sub> hybrids. White Majestine was used as a standard check. For producing F<sub>1</sub> hybrid seeds, 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 × 30 cm. Uniform cultural practices were followed in all the hybrids, lines and testers. The observations were recorded for namely plant height, number of branches, days to 50 per cent flowering, duration of flowering, number of flowers per plant, flower yield per plant, shelf life and seed yield per plant.

All statistical analysis was performed using WINDOSTAT version 8.6. Mid-parent heterosis (MPH), better parent heterosis (BPH) and heterosis over a standard check for each cross were calculated as a percentage deviation from the mid parent (MP) and better parent (BP) values and commercial check (White Majestine) respectively, (Turner 1953) [12].

## Result and Discussion

Heterosis of fifteen crosses over mid parent (average heterosis), better parent (heterobeltiosis) and standard check (standard heterosis) for 8 parameters were estimated and results were furnished in Table 1. to Table 4. Plant height is an important vegetative trait that determines the growth and vigorousness of the plant. Decreased plant height is a desirable trait for avoiding the lodging of the plant. Nine crosses over the mid parent, nine crosses over the better parent and four crosses over the standard check exhibited significant negative heterosis. Sarpan White x Bagalkot Local and Sarpan Yellow x Dharwad White exhibited maximum heterosis over the mid and standard check. AACS-3 x Bagalkot Local and AACS-3 x Dharwad Yellow exhibited maximum heterosis over the better parents. Heterosis over mid parent ranged from -15.74 per cent (Sarpan White x Bagalkot Local) to 6.14 per cent (AACS-3 x Dharwad White). Better parent heterosis ranged between -20.31 per cent (AACS-3 x Bagalkot Local) to -1.88 per cent (White Majestine x Bagalkot Local). The range of heterosis over standard check White Majestine was observed from -12.90 per cent (Sarpan Yellow x Dharwad White) to 20.38 per cent (AACS-3 x Dharwad White). Only cross (AACS-3 x Dharwad White) showed positive significant heterosis. This is in accordance with the Bayat *et al.* (2012) [3] in petunia, Kattera *et al.* (2014) [5] in annual chrysanthemum. The number of branches is an important parameter contributing to productivity. It decides the density of the plant. Among fifteen crosses, eight crosses over the mid parent, four crosses over the better parent and fifteen crosses over the standard check showed significant heterosis and all most all were in a positive direction. Garden Aids x Dharwad Yellow exhibited the highest heterosis over the better and standard check. White Majestine x Dharwad White exhibited the highest heterosis over the mid parent. Heterosis over the mid parent range varied from 3.17 per cent (Sarpan White x Bagalkot Local) to 46.50 per cent (White Majestine x Dharwad White). For better parent heterosis, the range varied from -14.74 per cent (White Majestine x Bagalkot Local) to 43.31 per cent (Garden Aids x Dharwad Yellow), heterosis over standard check White Majestine ranged from 38.60 per cent (White Majestine x Dharwad Yellow) to 97.37 per cent (Garden Aids x Dharwad Yellow). Similar results were confirmed by Anjali (2015) [1], Bhargav *et al.* (2019b) [4] and Mrutyunjaya (2021) [6] in China aster. For days to 50 per cent flowering the highest negative significant heterosis over mid, better parent and standard check reported in Sarpan Yellow x Dharwad White. One cross over the mid parent, two crosses over the better parent and two crosses over the standard check reported negative significant heterosis. The range of mid parent heterosis for this trait varied from -9.00 per cent for the cross Sarpan Yellow x Dharwad White to 10.75 per cent for the cross AACS-3 x Dharwad Yellow. Better parent heterosis ranged from -9.00 per cent for the cross Sarpan Yellow x Dharwad White and Sarpan Yellow x Dharwad Yellow to 9.57 per cent for the cross AACS-3 x Dharwad Yellow.

Heterosis over standard check White Majestine and the range was from -8.08 percent for Sarpan Yellow x Dharwad White and Sarpan Yellow x Dharwad Yellow to 7.07 percent for AACS-3 x Dharwad White. Similarly reported by Anjali (2015) [1] and Mrutyunjaya (2021) [6] in China aster. Heterosis in a positive direction is desirable for flower duration. An increase in flower duration helps in the continuous harvest of the flowers for longer days. Among fifteen crosses, eight crosses over the mid parent, four crosses over the better parent and three crosses over the standard check showed significant positive heterosis. AACS-3 x Dharwad Yellow resulted in maximum heterosis over mid and better parent and showed significant heterosis over the mid, better and standard check. Average heterosis for the duration of flowering ranged from -51.41 percent for AACS-3 x Bagalkot Local to 80.95 percent for AACS-3 x Dharwad Yellow. Heterosis over better parents ranged between -62.93 percent (AACS-3 x Bagalkot Local) to 54.65 per cent for (AACS-3 x Dharwad Yellow). The per cent heterosis over check White Majestine ranged from -60.91 (AACS-3 x Bagalkot Local) to 40.00 (White Majestine x Dharwad White). Similar findings were reported by Suresh kumar *et al.* (2004b) [11], Bhargav *et al.* (2019b) [4] and Mrutyunjaya (2021) [6] in China aster. For a number of flowers per plant five crosses over the mid-parent, four crosses over the better parent and six crosses over the standard check exhibited significant positive heterosis. AACS-3 x Dharwad White, AACS-3 x Dharwad Yellow, AACS-3 x Bagalkot Local and Sarpan Yellow x Bagalkot Local showed positive significant heterosis over the mid, better and standard check. AACS-3 x Dharwad White reported the highest heterosis over the standard check. Average heterosis over mid parent ranged from -33.51 per cent to 69.06 per cent for Sarpan White x Bagalkot Local and AACS-3 x Dharwad White, respectively. Better parent heterosis ranged from -38.44 per cent (Sarpan White x Bagalkot Local) to 56.54 per cent (AACS-3 x Dharwad Yellow). Heterosis over standard check White Majestine was from -25.53 per cent (Sarpan White x Bagalkot Local) to 110.94 per cent (AACS-3 x Dharwad White). Results obtained were similar to that of Anjali (2015) [1], Bhargav *et al.* (2019b) [4] and Mrutyunjaya (2021) [6] in China aster. An increase in flower yield per plant is an important trait to increase productivity. Positive heterosis is desirable for the trait. Eight crosses over the mid parent, five crosses over the better parent and two crosses over the standard check reported significant positive heterosis. White Majestine x Bagalkot Local and Sarpan yellow x Bagalkot Local showed positive significant heterosis over the mid, better and standard check. The top three hybrids with mid-parent heterosis were White Majestine x Bagalkot Local (113.43%), AACS-3 x Bagalkot Local (107.10%) and Sarpan Yellow x Bagalkot Local (105.40%). The top three hybrids over better parent heterosis were AACS-3 x Bagalkot Local (100.85%), Sarpan Yellow x Bagalkot Local (66.67%) and White Majestine x Bagalkot Local (65.79). Top three hybrids showing heterosis over standard check White Majestine were White Majestine x Bagalkot Local (65.79), Sarpan Yellow x Bagalkot Local (48.12) and Sarpan White x Bagalkot Local (39.78). Similar results were confirmed by Pavani (2014) [7] Anjali (2015) [1] and Mrutyunjaya (2021) [6] in China aster. For shelf life twelve crosses over the mid parent, eight crosses over the better parent and five crosses over standard check reported significant positive heterosis. White Majestine x Dharwad

White and Sarpan White x Dharwad Yellow showed maximum heterosis over a standard check and also positive significant heterosis over the mid and better parent. White Majestine x Dharwad White (38.82%), AACs-3 x Bagalkot Local (37.66%) and Sarpan White x Dharwad Yellow (37.21%) were the top three hybrids with maximum heterosis over the mid parent. The top three hybrids with the highest heterosis over better parents were AACs-3 x Bagalkot Local (32.50%), Sarpan White x Dharwad Yellow (31.11%) and AACs-3 x Dharwad White (27.03%). The top three hybrids with maximum heterosis over standard check were Sarpan White x Dharwad Yellow (20.41%), White Majestine x Dharwad White (20.41%) and Garden Aids x Dharwad Yellow (12.24%). These results are in confirming with the findings of Pratiksha Kumari *et al.* (2017)<sup>[8]</sup> in China aster. An increase in seed yield per plant is an important trait to

increase productivity. Positive heterosis is desirable for the trait. Eight crosses over the mid parent, six crosses over the better parent and two crosses over standard check reported significant positive heterosis. Garden Aids x Bagalkot Local and AACs-3 x Dharwad Yellow showed positive significant heterosis over the mid, better and standard check. The top three hybrids with mid parent heterosis were AACs-3 x Dharwad Yellow (61.68%), AACs-3 x Dharwad White (30.65%) and Sarpan Yellow x Dharwad White (27.33%). The top two hybrids over better parent heterosis were AACs-3 x Dharwad Yellow (60.49%), Sarpan Yellow x Dharwad White (20.61%) and AACs-3 x Dharwad White (20.29%). The top three hybrids showing heterosis over standard check White Majestine were, Garden Aids x Bagalkot Local (10.76) and AACs-3 x Dharwad Yellow (7.22). Similar results were confirmed by Singh and Mishra (2010)<sup>[9]</sup> in marigold.

**Table 1:** Estimates of heterosis (%) for plant height and number of branches

Sl. No.	Crosses	Plant height (cm)			Number of branches		
		MP	BP	SC	MP	BP	SC
1	White Majestine × Dharwad White	-11.11 **	-11.94 **	-10.26 **	46.50 **	37.98 *	56.14 **
2	White Majestine × Dharwad Yellow	-9.90 **	-10.55 **	-9.24 *	16.61	0.64	38.60 *
3	White Majestine × Bagalkot Local	-1.31	-1.88	-0.73	6.58	-14.74	42.11 *
4	AACS-3 × Dharwad White	6.14 *	-3.64	20.38 **	21.57	5.08	63.16 **
5	AACS-3 × Dharwad Yellow	-9.97 **	-18.43 **	1.91	16.77	10.17	71.05 **
6	AACS-3 × Bagalkot Local	-11.93 **	-20.31 **	-0.44	4.09	0.53	67.54 **
7	Sarpan White × Dharwad White	-6.33 *	-8.39 *	-2.35	39.16 **	26.75	74.56 **
8	Sarpan White × Dharwad Yellow	-3.03	-5.36	0.88	16.56	16.56	60.53 **
9	Sarpan White × Bagalkot Local	-15.74 **	-17.88 **	-12.46 **	3.17	-5.79	57.02 **
10	Sarpan Yellow × Dharwad White	-15.50 **	-16.46 **	-12.90 **	40.46 **	38.35 *	61.40 **
11	Sarpan Yellow × Dharwad Yellow	-2.92	-4.22	-0.15	33.79 *	23.57	70.18 **
12	Sarpan Yellow × Bagalkot Local	-2.07	-3.52	0.59	35.60 **	15.26	92.11 **
13	Garden Aids × Dharwad White	-7.21 *	-7.93 *	-4.69	45.26 **	32.69 *	81.58 **
14	Garden Aids × Dharwad Yellow	-6.44 *	-7.37 *	-4.11	43.77 **	43.31 **	97.37 **
15	Garden Aids × Bagalkot Local	-4.30	-5.38	-2.05	26.59 *	15.26	92.11 **
	S.Em ±	1.98	2.29	2.29	1.72	1.99	1.99
	C.D at 5%	4.25	4.91	4.91	3.70	4.28	4.28
	C.D at 1%	5.91	6.82	6.82	5.14	5.93	5.93

\*Significant at 5 percent level \*\* Significant at 1 percent level

MP- Mid parent, BP- Better parent, SC- Standard check (White Majestine)

**Table 2:** Estimates of heterosis (%) for days to 50 per cent flowering and duration of flowering

Sl. No.	Crosses	Days to 50 per cent flowering			Duration of flowering (Days)		
		MP	BP	SC	MP	BP	SC
1	White Majestine × Dharwad White	-3.52	-4.00	-3.03	37.50 **	35.09 **	40.00 **
2	White Majestine × Dharwad Yellow	2.62	-1.01	-1.01	20.41 *	7.27	7.27
3	White Majestine × Bagalkot Local	-4.04	-4.04	-4.04	-7.96	-10.34	-5.45
4	AACS-3 × Dharwad White	9.28 *	6.00	7.07	74.86 **	34.21 **	39.09 **
5	AACS-3 × Dharwad Yellow	10.75 **	9.57 *	4.04	80.95 **	54.65 **	20.91 *
6	AACS-3 × Bagalkot Local	-0.52	-3.03	-3.03	-51.41 **	-62.93 **	-60.91 **
7	Sarpan White × Dharwad White	5.10	3.00	4.04	16.04 *	7.89	11.82
8	Sarpan White × Dharwad Yellow	6.38	4.17	1.01	11.96	5.10	-6.36
9	Sarpan White × Bagalkot Local	-0.51	-2.02	-2.02	-14.95	-21.55 *	-17.27 *
10	Sarpan Yellow × Dharwad White	-9.00*	-9.00*	-8.08 *	-29.81 **	-35.96 **	-33.64 **
11	Sarpan Yellow × Dharwad Yellow	-5.21	-9.00*	-8.08 *	21.11 *	15.96	-0.91
12	Sarpan Yellow × Bagalkot Local	-4.52	-5.00	-4.04	-12.38	-20.69 *	-16.36
13	Garden Aids × Dharwad White	6.81	2.00	3.03	29.03 **	5.26	9.09
14	Garden Aids × Dharwad Yellow	4.92	4.35	-3.03	39.24 **	27.91 *	0.00
15	Garden Aids × Bagalkot Local	-3.16	-7.07	-7.07	-4.26	-22.41 *	-18.18 *
	S.Em ±	1.57	1.82	1.82	1.53	1.77	1.77
	C.D at 5%	3.37	3.89	3.89	3.28	3.79	3.79
	C.D at 1%	4.68	5.40	5.40	4.55	5.26	5.26

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

MP- Mid parent, BP- Better parent, SC- Standard check (White Majestine)

**Table 3:** Estimates of heterosis (%) for number of flowers per plant and flower yield per plant

Sl. No.	Crosses	Number of flowers per plant			Flower yield per plant (g)		
		MP	BP	SC	MP	BP	SC
1	White Majestine × Dharwad White	-4.12	-16.78	13.07	19.36	-1.14	-1.14
2	White Majestine × Dharwad Yellow	24.70	10.28	43.47 *	29.63	0.70	0.70
3	White Majestine × Bagalkot Local	33.43 *	21.86	47.42 *	113.43 **	65.79 **	65.79 **
4	AACS-3 × Dharwad White	69.06 **	55.26 **	110.94 **	64.07 *	47.03	-3.48
5	AACS-3 × Dharwad Yellow	67.08 **	56.54 **	103.65 **	73.57 *	68.34	-6.82
6	AACS-3 × Bagalkot Local	42.49 **	38.19 *	67.17 **	107.10 **	100.85 *	11.18
7	Sarpan White × Dharwad White	-11.7	-22.37	5.47	55.38 *	33.84	21.56
8	Sarpan White × Dharwad Yellow	-14.21	-23.13	0.00	82.11 **	46.55 *	33.10
9	Sarpan White × Bagalkot Local	-33.51 *	-38.44 *	-25.53	91.25 **	53.91 *	39.78
10	Sarpan Yellow × Dharwad White	-3.54	-14.54	16.11	44.37	25.51	11.54
11	Sarpan Yellow × Dharwad Yellow	1.94	-7.94	19.76	44.26	17.06	4.03
12	Sarpan Yellow × Bagalkot Local	49.13 **	39.20 *	68.39 **	105.40 **	66.67 **	48.12 *
13	Garden Aids × Dharwad White	10.76	2.46	39.21	34.24	1.41	30.32
14	Garden Aids × Dharwad Yellow	10.64	4.44	35.87	12.25	-19.70	3.20
15	Garden Aids × Bagalkot Local	11.83	9.30	32.22	31.62	-5.84	21.00
	S.Em ±	5.24	6.05	6.05	12.06	13.92	13.92
	C.D at 5%	11.24	12.98	12.98	25.86	29.86	29.86
	C.D at 1%	15.60	18.02	18.02	35.89	41.44	41.44

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

MP- Mid parent, BP- Better parent, SC- Standard check (White Majestine)

**Table 4:** Estimates of heterosis (%) for shelf life and seed yield per plant

Sl. No.	Crosses	Shelf life (hours)			Seed yield per plant (g)		
		MP	BP	SC	MP	BP	SC
1	White Majestine × Dharwad White	38.82 **	20.41 **	20.41 **	-18.29 **	-26.71 **	-26.71 **
2	White Majestine × Dharwad Yellow	15.56 **	6.12	6.12	-15.73 **	-30.13 **	-30.13 **
3	White Majestine × Bagalkot Local	7.87	-2.04	-2.04	-18.51 **	-21.55 **	-21.55 **
4	AACS-3 × Dharwad White	28.77 **	27.03 **	-4.08	30.65 **	20.29 **	-4.49
5	AACS-3 × Dharwad Yellow	33.33 **	26.83 **	6.12	61.68 **	60.49 **	7.22 *
6	AACS-3 × Bagalkot Local	37.66 **	32.50 **	8.16	-13.80 **	-25.79 **	-31.33 **
7	Sarpan White × Dharwad White	33.33 **	20.00 **	10.20 *	3.03	2.44	-17.72 **
8	Sarpan White × Dharwad Yellow	37.21 **	31.11 **	20.41 **	13.08 **	2.88	-17.37 **
9	Sarpan White × Bagalkot Local	27.06 **	20.00 **	10.20 *	-32.08 **	-36.56 **	-41.30 **
10	Sarpan Yellow × Dharwad White	23.81 **	8.33	6.12	27.33 **	20.61 **	-4.24
11	Sarpan Yellow × Dharwad Yellow	3.37	-4.17	-6.12	13.04 **	8.91 *	-22.66 **
12	Sarpan Yellow × Bagalkot Local	-4.55	-12.50 *	-14.29 **	4.49	-7.66 *	-14.56 **
13	Garden Aids × Dharwad White	19.05 **	4.17	2.04	19.24 **	17.15 **	-3.61
14	Garden Aids × Dharwad Yellow	23.60 **	14.58 **	12.24 *	10.68 **	-0.38	-18.04 **
15	Garden Aids × Bagalkot Local	18.18 **	8.33	6.12	26.72 **	19.70 **	10.76 **
	S.Em ±	0.99	1.15	1.15	0.19	0.22	0.22
	C.D at 5%	2.13	2.46	2.46	0.42	0.48	0.48
	C.D at 1%	2.96	3.42	3.42	0.58	0.67	0.67

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

MP- Mid parent, BP- Better parent, SC- Standard check (White Majestine)

## Conclusions

From the present investigation it is concluded that, White Majestine × Bagalkot Local and Sarpan Yellow × Bagalkot Local are the top most hybrids concerning yield potentiality. Sarpan White × Bagalkot Local and Sarpan Yellow × Dharwad White found promising for plant height and early flowering. Heterosis can be exploited for vegetative, flowering, quality and yield related traits by selecting the appropriate cross combinations in annual chrysanthemum. Since, these are the essential traits that directly or indirectly affect the production potential of the crop, therefore, emphasis may be given to the development of F<sub>1</sub> hybrids with the improved flower quality and yield in annual chrysanthemum.

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