Received: 01 Jun 2020 | Revised: 24 Jul 2021 | Accepted: 03 Aug 2021

Electronic Journal of Plant Breeding

Research Article

Genetic variability and heritability for quantitative traits in China aster [*Callistephus chinensis* (L.) Nees.]

S.K. Nataraj[1]*, G.K. Seetharamu[2], Rajiv Kumar[3], V. Srinivasa[1], B.S. Kulkarni[4] R. Venugopalan[3] and K.B.Naik[5]

[1]College of Horticulture, Mudigere, UAHS, Shivamogga, Karnataka, India
[2]College of Horticulture, GKVK Campus, Bengaluru, Karnataka, India
[3]ICAR-Indian Institute of Horticultural Research, Bengaluru, Karnataka, India
[4]College of Horticulture, Bagalkote, UAHS, Shivamogga, Karnataka, India
[5] College of Horticulture, Mysuru,
***E-Mail:** natarajsk@uahs.edu.in

Abstract
A field experiment was carried out to estimate genetic variability, heritability and genetic advance for 19 traits among 30 genotypes of China aster. The randomized complete block design with two replications was employed at the College of Horticulture, Mudigere, during the year 2017-18. Analysis of variance revealed that significant differences were observed for all the traits. The phenotypic co-efficient of variation (PCV) was a higher magnitude than the genotypic co-efficient of variation (GCV) for all the traits. Narrow differences between GCV and PCV were recorded in all the characters except flowering duration, vase-life and shelf-life, indicating little environmental influence on the expression of these characters. High heritability coupled with high genetic advance as per cent mean was recorded for the number of florets per flower head, the weight of flower per plant, plant height, flower head diameter, individual flower weight, disc diameter, the number of flowers per plant, days to 50 per cent flowering, the number of primary branches per plant, the number of flowers per branches, plant spread (North-South), 1000 seed weight, plant spread (East-West), flower stalk length, seed yield per plant, vase life and shelf life proves more useful for efficient improvement of a character through simple selection.

Key words: China aster, PCV, GCV, heritability, genetic advance

INTRODUCTION

China aster, family, Asteraceae, is a winter annual flower crop resembling chrysanthemum which is an auspicious loose flower in South India. It is the third important traditional commercial flower crop in India after chrysanthemum and marigold grown for its loose flowers, cut flowers, arranging in a vase, floral decorations, making garlands, *venis*; in the landscape for a flower bed, border and is source of natural pigments *viz*., flavonoids, carotenoids and betalains (Bhargav *et al*., 2018). It is primarily grown on a commercial scale in the states *viz.,* Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and West Bengal. In Karnataka, it is grown in 1693 ha with a productivity of 9.39 t/ha (Anon., 2016), spreading over Bengaluru, Chitradurga, Tumkur, Belagavi, Gadag, Bagalkot and Kolar districts (Ramya *et al*., 2019).

The success of any crop improvement mainly depends on the genetic variability that exists in the available genotypes. Most of the existing local China aster genotypes in India have single and semi-double flowers with a prominent disc, short flower stalks and limited colours. Hence, there is a need for improvement through breeding to get desirable characters such as flower form, plant form, flower colour etc. into a single cultivar.

In China aster, most of the characters influencing yield are polygenic and thus, the information on the nature and magnitude of variability among traits in germplasm is the pre-requisite for improving the desired flower trait. The genetic architecture of crops can be better understood with help of the presence of additive and non-additive genetic variances. Breeding value/gain can be predicted with genotype, phenotypic variances and co-efficient of variances. Apart from variability, the information on heritability and genetic advance measures also give an idea at what rate a character is inherited to its progeny (Johnson *et al*., 1955). With this background, the present study was carried out to assess the breeding value of germplasm for various quantitative traits in China aster.

MATERIALS AND METHODS

The present study was conducted at the research block of Floriculture and Landscape Architecture, College of Horticulture, Mudigere during 2017-18. The experimental site was geographically located at 13°7´ North latitude, 75°57´ East longitude and at an altitude of 982 meters above the mean sea level. The soil of the experimental block was red sandy loam with pH 5.00 and E.C. 0.26 dSm^{-1}. The experimental material consists of thirty genotypes of China aster (**Table 1**) were evaluated in a randomized complete block design with two replications with a spacing of 30 x 30 cm under field conditions. Five plants per replication were selected for recording observations on 19 vegetative, flowering and yield attributing traits. Uniform cultural practices were followed to raise the successful crop. Data recorded were subjected to analysis using SAS V 9.3, 2012. Genetic parameters such as genotypic and phenotypic coefficients of variation were estimated according to Burton and Dewane (1953). The genotypic and phenotypic coefficient of variation was classified as low: less than 10%, moderate: 10% to 20% and high: more than 20%. Broad sense heritability (h^2) was estimated as per Weber and Moorthy (1952) and categorised as low: less than 10%, moderate: 10% to 20% and high: more than 20%. The genetic advance as per cent mean was worked out as per Johnson *et al.* (1955) and categorised as low: 0 to 30%, moderate: 31% to 60% and high: 61% and above.

Table 1. List of genotypes used for study, source and pedigree

S. No.	Genotypes	Source	Pedigree
1	AAC-1	KRCCH, Arbhavi	Selection from local Arka Kamini
2	Arka Aadya		Pure line selection
3	Arka Archana		Pure line selection
4	Arka Kamini	ICAR-IIHR, Bengaluru	Pure line selection
5	Arka Poornima		Pure line selection
6	Arka Shashank		Pure line selection
7	Arka Violet Cushion		Pure line selection
8	Kurenai Rose	Private company	Pure line selection
9	Kurenai White		Pure line selection
10	Local Light Pink	KRC College of Horticulture, Arbhavi	Local selection
11	Local Pink		Local selection
12	Local Violet	ICAR-IIHR, Bengaluru	Local selection
13	Local White		Local selection
14	Matsumoto White		Pure line selection
15	Matsumoto Apricot		Pure line selection
16	Matsumoto Blue	Dhandeep seeds, Pune	Pure line selection
17	Matsumoto Pink		Pure line selection
18	Matsumoto Red		Pure line selection
19	Matsumoto Rose		Pure line selection
20	Matsumoto Scarlet	Dhandeep seeds, Pune	Pure line selection
21	Matsumoto Yellow		Pure line selection
22	Namdhari Pink	Namdhari Company, Bengaluru	Pure line selection
23	Namdhari White		Pure line selection
24	PG Purple		Pure line selection
25	PG Pink	Directorate of Floriculture Research (DFR), Pune	Pure line selection
26	PG Violet		Pure line selection
27	PG White		Pure line selection
28	SAT-2		Pure line selection
29	SAT-3	Sarpan hybrid Seed Company, Dharwad	Pure line selection
30	SAT-4		Pure line selection

RESULTS AND DISCUSSION

Analysis of variance showed significant differences among genotypes for all the 19 quantitative traits studied (**Table 2**). The extent of variability present in China aster was measured in terms of variance, genotypic co-efficient of variation, phenotypic co-efficient of variation, heritability in the broad sense and genetic advance as per cent mean (**Table 3**). Variation for all the characters studied due to phenotypic co-efficient of variation was higher than genotypic co-efficient of variation which indicated greater genotype x environment interaction. Khangjarakpam *et al*. (2014) also reported high PCV than GCV for different variables in China aster. However, narrow differences between GCV and PCV were observed for all the characters except flowering duration, vase life and shelf life, indicating the minimal environmental influence on the expression of these characters.

The estimates of the genotypic and phenotypic coefficient of variation were high for plant spread (East-West and North-South), the weight of flowers per plant, disc diameter, the number of flowers per branch, plant height, the number of flowers per pant, individual flower weight, the number of florets per flower head, flower stalk length, the weight of 100 flowers, seed yield per plant and flower head diameter. The results are in agreement with the findings of Rai *et al*. (2017), Naikwad *et al.* (2018), Sankari *et al*. (2019) in China aster and Prakash *et al*.(2017) in Okra.

The moderate genotypic and phenotypic co-efficient of variation was observed for the characters 1000 seed weight, shelf life, vase life and days to 50 per cent flowering. Khangjarakpam *et al*. (2014) observed moderate genotypic and phenotypic co-efficient of variation for days to 50 per cent flowering, vase life and shelf life. Sankari *et al*. (2019) also reported moderate PCV and GCV for days to 50 per cent flowering in China aster. The low genotypic and phenotypic co-efficient of variation was observed for the flowering duration. These results are in line with results of Khangjarakpam *et al*. (2014) and Naikwad *et al*. (2018) in China aster.

The characters *viz.,* plant height, plant spread (North-South and East-West), the number of primary branches per plant, the number of florets per flower head, disc diameter, flower stalk length, the number of flowers per plant, the number of flowers per branch, the number of flowers per square meter, weight of 100 flowers, flower weight per plant and seed yield per plant recorded high genotypic co-efficient of variation coupled with the narrow difference between the genotypic and phenotypic co-efficient of variation.

The effectiveness of selection for any character depends not only on the amount of variability but also on the extent to which the variability is heritable. The magnitude of heritable variability is the most important aspect of the genetic constitution of the breeding material, which has

Table 2. Analysis of variance for various components in China aster genotypes

Character	Mean sum of squares			SEm±	CD @ 5%
	Replications	Treatments (genotypes)	Error		
Degrees of freedom	**1**	**29**	**29**		
Plant height	0.0006	502.65*	1.80	0.93	2.74
Plant spread-NS	1.12	578.34*	2.71	1.12	3.32
Plant spread-EW	18.70	590.25*	13.63	2.56	7.55
Number of primary branches/ plant	0.06	21.01*	0.22	0.33	0.97
Days to 50 % flowering	0.41	136.24*	1.24	0.77	2.28
Number of florets/ flower head	12.51	1405.44*	1.37	0.81	2.40
Flowering duration	1.06	37.96*	1.89	4.93	2.81
Flower head diameter	0.05	1.85*	0.07	0.06	0.17
Disc diameter	0.07	0.73*	0.039	0.04	0.12
Flower stalk length	3.50	31.33*	0.99	0.70	2.03
Vase life	0.59	6.32*	0.24	0.34	1.01
Shelf life	0.07	0.51*	0.02	0.11	0.34
Number of flowers/plant	0.004	345.97*	2.28	1.05	3.09
Number of flowers/branch	0.008	13.46*	0.25	0.35	1.03
Individual flower weight	0.010	1.00*	0.004	0.04	0.13
Weight of 100 flowers	95.18	7090.60*	78.54	6.16	18.12
Flower yield per plant	3.61	5419.46*	7.39	1.89	5.56
Seed yield per plant	0.05	3.69*	0.14	0.26	0.76
1000 seed weight	0.01	0.20*	0.004	0.04	0.13

*Significant at 5% level

a close bearing on the response to selection (Panse, 1957). The genotypic co-efficient of variation together with heritability estimates would give the best picture of the amount of advancement to be achieved through selection. The heritable portion of variability was thus determined with the help of broad sense heritability estimates (Burton, 1952) and it also includes additive, dominant and epistatic genic effects.

In the present study, the magnitude of heritability in the broad sense was high for all the traits except for flowering duration (**Table 3**). Heritability estimates were ranged from 51.80 per cent (flowering duration) to 99.80 *per cent* (number of florets per flower head). Similar results were also reported by Rai *et al.* (2017) and Kumari *et al*. (2018) in China aster.

Johnson *et al*. (1955) suggested that heritability along with genetic advance is more useful in predicting the resultant effect of selecting the best individuals. High heritability coupled with high genetic advance as per cent mean was recorded for the number of florets per flower head, the weight of flowers per plant, plant height, flower head diameter, individual flower weight, disc diameter, the number of flowers per plant, days to 50 per cent flowering, the number of primary branches per plant, the number of flowers per branches, plant spread (North-South), 1000 seed weight, plant spread (East-West), flower stalk length, seed yield per plant, vase life and shelf life, indicated the effectiveness of selection through phenotypic performance, but high heritability it does not mean high genetic gain, high heritability estimates along with high genetic advance is useful for selection. Thus, these characters can be improved through pure line selection. High heritability coupled with high genetic advance as per cent mean was also reported for the number of florets per flower head, the weight of flower per plant, plant height, flower head diameter (Ashwath and Parthasarathy, 1993; Raghava and Negi, 1994), individual flower weight and disc diameter (Pavani, 2014); the number of flowers per plant and per square meter, days to 50 per cent flowering, the number of primary branches per plant and the number of flowers per branches, plant spread (Khangjarakpam *et al*., 2014 in China Aster; Patel *et al*., 2019 in Marigold) and 1000 seed weight, flower stalk length, seed yield per plant, vase life, shelf life, flower diameter (Rai *et al*., 2017). High heritability associated with high genetic advance proves more useful for efficient improvement of a character through selection.

Table 3. Estimates of genotypic and phenotypic coefficient of variation, heritability and genetic advance for various traits in China aster

Character	Mean± SEm	Range		GV	PV	GCV (%)	PCV (%)	h^2_{bs} (%)	GA	GAM (%)
		Min.	Max.							
Plant height (cm)	47.78 ±0.93	24.10	88.30	257.08	258.92	33.37	33.49	99.30	32.91	68.50
Plant spread-NS (cm)	33.63 ±1.14	11.40	68.20	287.81	299.45	50.49	51.51	96.10	34.78	103.54
Plant spread-EW (cm)	32.74 ±2.56	10.90	62.10	288.68	302.26	51.82	53.03	95.50	34.20	104.33
Number of Primary branches/plants	9.02 ± 0.33	4.30	15.00	10.82	11.04	36.27	36.64	98.00	6.71	73.98
Days to 50% flowering	68.35 ±0.77	56.00	81.00	67.50	68.74	12.02	12.13	98.20	16.77	24.53
Number of florets/flower head	97.17 ±0.89	41.20	146.00	701.68	703.03	27.25	27.27	99.80	54.51	56.08
Flowering duration (days)	33.35±4.93	25.00	41.00	5.31	10.25	6.91	9.59	51.80	3.42	10.27
Flower head diameter (cm)	4.57 ±0.06	3.06	6.36	0.92	0.93	21.01	21.09	99.20	1.97	43.10
Disc diameter (cm)	1.38 ±0.04	0.94	4.39	0.36	0.36	43.53	43.77	98.90	1.23	89.20
Flower stalk length (cm)	15.74 ±0.70	7.70	27.20	17.12	18.16	25.95	26.72	94.30	8.27	51.91
Vase life (days)	7.59 ±0.34	4.50	10.40	1.80	1.85	12.56	13.93	81.27	2.28	23.36
Shelf life (days)	2.93 ±0.12	2.10	3.90	0.193	0.28	14.46	17.67	66.96	0.74	24.42
Number of flowers/plant	42.00 ±1.05	17.10	63.50	171.84	174.13	31.28	31.49	98.70	26.82	64.02
Number of flowers/branch	6.22 ±0.35	2.50	12.40	6.60	6.86	41.25	42.05	96.40	5.23	83.78
Individual flower weight (g)	2.53 ±0.04	1.44	4.05	0.49	0.50	27.93	28.05	99.10	1.45	57.29
Weight of 100 flowers (g)	243.37 ±6.16	143.73	407.58	3506.06	3584.63	24.33	24.60	97.80	120.63	49.56
Weight of flowers/plant (g)	111.11 ±1.89	30.09	233.15	2706.03	2713.43	46.60	46.67	99.70	107.81	96.21
Seed yield/plant (g)	6.07 ±0.26	3.75	8.75	1.77	1.91	21.95	22.80	92.60	2.64	43.51
1000 seed weight (g)	2.09 ±0.04	1.38	2.67	0.09	0.10	14.95	15.29	95.60	0.63	30.12

GV: Genotypic variance, PV: Phenotypic variance, GCV: Genotypic coefficient variation, PCV: Phenotypic coefficient of variation, h^2bs: Heritability, GA: Genetic advance, GAM: Genetic advance as per cent mean

High heritability and high genetic advance as per cent mean with moderate genetic advance was recorded for days to 50 per cent flowering, indicating the presence of dominant and epistatic gene effects due to non-additive gene action. The high heritability is being exhibited due to favorable influence of environment rather than genotype, selection for such traits may not be rewarding inferring that the trait could be improved through hybridization. High heritability and moderate genetic advance have also been reported for days to 50 per cent flowering (Rai *et al.,* 2017 and Naikwad *et al.,* 2018) in China aster.

The number of primary branches per plant, flower head diameter, disc diameter, flower stalk length, vase life, shelf life, the number of flowers per branch, individual flower weight and 1000 seed weight which determines the yield recorded high heritability coupled with low genetic advance, indicating non-additive gene action. Similar results were also observed for 50 per cent flowering (Rai *et al*., 2017 and Sankari *et al.,* 2019) and flower diameter (Sankari *et al.,* 2019) in China aster.

The trait flowering duration recorded moderate heritability, low genetic advance and moderate genetic advance as per cent mean indicating the action of non-additive gene action and these traits can be improved through heterosis. Similar results were also reported by Naikwad *et al*. (2018), Kumari *et al*. (2018) and Sankari *et al*. (2019) in China aster.

The present study revealed that the traits such as the number of florets per flower head, the weight of flowers per plant, plant height, flower head diameter, individual flower weight, the number of flowers per plant, the number of flowers per branch, plant spread (North-South and East-West) and seed yield per plant are controlled by additive gene action, therefore, these traits can be improved through selection. While, the traits such as days to 50 per cent flowering, flowering duration, the number of primary branches per plant, flower head diameter, disc diameter, flower stalk length, vase life, shelf life, the number of flowers per branch, individual flower weight and 1000 seed weight are controlled by non-additive gene action which might be attributed to dominant or epistatic, hence, heterosis breeding and pure line selection are the best breeding methods for improvement of these traits in China aster.

REFERENCES

Anonymous. 2016. Horticulture crop statistics of Karnataka state at a glance 2015-16. Department of Horticulture, *Lal bagh,* Bengaluru. p. 37.

Ashwath, C. and Parthasarathy, V.A. 1993. Heritability and correlation studies in aster (*Callistephus chinensis* Nees). *Indian J. Hort.,* **50**(1): 89-92.

Bhargav, V., Kumar, R, Shivashankara, K.S., Rao, T.M., Dhananjaya, M.V., Sane A., Bharathi, T.U., Venugopalan, R. and Roy, T.K. 2018. Diversity of flavonoids profile in China aster [*Callistephus chinensis* (L.) Nees] genotypes. *Ind. Crops Prod.,* **111**(18): 513–519. [Cross Ref]

Burton, G.W. 1952. Quantitative inheritance in grasses. *Proceedings of 6th International Grassland Congress.,* **1**: 277-283.

Burton, G.W. and Dewane, E.W. 1953. Estimating heritability in tall fescue (*Festuca arundinaceae*) from replicated clonal material. *Agronomy J.,* **45**: 478-481. [Cross Ref]

Johnson, H.W., Robinson, H.F. and Comstock, R.E. 1955. Genotypic and phenotypic correlations in soybeans and their implication in selection. *Agronomy J.,* **47**: 477-483. [Cross Ref]

Khangjarakpam, G., Kumar, R., Seetharamu, G.K., Manjunatha, T.M., Dhananjaya, M.V., Venugopalan, R. and Padmini, K. 2014, Genetic variability for quantitative traits in China aster (*Callistephus chinensis*). *J. Hortl. Sci*., **9**(2):141-144.

Kumari, P., Kumar, R., Rao T.M., Bharathi, T.U., Dhananjaya, M.V. and Bhargav, V. 2018. Exploitation of heteriosis for growth, quality and yield traits in China aster [*Callistephus chinensis* (L.) Nees]. *Indian J. Agri. Sci*., **88**(3): 453-457.

Naikwad, D., Kandpal, K., Hugar, A., Patil, M.G. and Kulkarni, V. 2018. Genetic variability, heritability and genetic advance for different traits in China aster varieties. *Int. J. Curr. Microbiol. App. Sci.,* **7**(4): 3329-3338. [Cross Ref]

Panse, V.G. 1957. Genetics of quantitative characters in relation to plant breeding. *Ind. J. Genet*., **17**: 318-328.

Patel, M. A., Chawla, S. L., Chavan, S. K., Shah, H. P. and Patil, D. S. 2019. Genetic variability, heritability and genetic advance studies in marigold (*Tagetes spp.*) under the South Gujarat region. *Electron. J. plant Breed*., **10** (1): 272 – 276. [Cross Ref]

Pavani, U. 2014. Studies on combining ability and heterosis for qualitative and quantitative traits in China aster (*Callistephus chinensis* (L.) Nees). *Ph.D. Thesis. Dr. Y.S.R. Horti. Uni. Telangana.*

Prakash, K., Pichaimutu, M. and Akshatha, H. 2017. Studies on variability, correlation and path analysis of traits contributing to fruit yield and its components in okra (*Abelmoschus esculentus* L. Moench). *Electron. J. plant Breed*., **8** (1): 134 – 141. [Cross Ref]

Raghava, S.P.S. and Negi, S.S. 1994. Genetic analysis of various quantitative traits in China aster (*Callistephus chinensis* Nees). *Ind. J. Hort.,* **51**:106-110.

Rai, T.S., Chaudhary, S.V.S., Dhiman, S.R., Dogra, R.K. and Gupta, R.K. 2017. Genetic variability, character association and path coefficient analysis in China aster (*Callistephus chinensis*). *Indian J. Agril. Sci.,* **87**(4): 540-543.

Ramya, H.M., Nataraj, S.K. and Rajiv, K. 2019. Character association and path coefficient analysis in F_2 segregating population of cross "Arka Kamini x PG Violet" in China aster (*Callistephus chinensis* [L.] Nees). *Int. J. Curr. Microb. Appl. Sci.*, **8**(4): 1314-1318. [Cross Ref]

Sankari, A, Anand, M., Kavitha, M. and Anita, B. 2019. *Per se* performance of China aster

(*Callistephus chinensis* Nees.) varieties for yield under Nilgiris. *Int. J. Che. Stu.,* **7**(3): 1649-1652.

Weber, C.R. and Moorthy, B.R. 1952. Heritable and non-heritable relationships and variability for oil content and agronomic characters in the F_2 generation of soybean crosses. *Agron. J.*, **44**: 202-209. [Cross Ref]