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Genetic variability, character association and path coefficient analysis in China aster (*Callistephus chinensis*)

TEERATH SINGH RAI[1], S V S CHAUDHARY[2], S R DHIMAN[3], R K DOGRA[4] and R K GUPTA[5]

Dr Y S Parmar University of Horticulture and Forestry, Nauni, Himachal Pradesh 173 230

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ABSTRACT

Ten cultivars of China aster [*Callistephus chinensis* (L.) Nees] were evaluated for 12 growth and flowering related traits to study their genetic parameters such as variability, heritability, genetic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), correlation and path coefficient analysis. Significant differences among cultivars for all the growth and flowering related traits were reported through analysis of variance. Wide range in mean performance has been reported in characters such as plant height (41.15-102.25 cm), plant spread (23.79-55.70 cm), days to first flower opening (77.25-106.25 days), flowering duration (25.65-41.30 days) and weight of flowers/plant (84.50-174.42 g). Higher genotypic and phenotypic coefficient of variation was recorded for plant height and plant spread. High heritability (>80%) was recorded for all traits, except number of harvests of loose flower. The genetic advance ranged from 1.36 (individual flower weight) to 57.15 (weight of flowers/plant). High values of genetic gain were recorded for plant height (69.81%), followed by weight of flowers/plant (50.97%). Weight of flowers/plant is significantly and positively correlated both at genotypic and phenotypic level to plant height, plant spread, flower head diameter, number of flowers/plant and individual flower weight. Path coefficient analysis using correlation coefficients revealed that number of flowers/plant contributed highest positive direct effect on weight of flowers/plant, followed by individual flower weight and plant height. Various cultivars performed differently for various quantitative characters. Therefore, cultivars with superior traits can be utilised in hybridization to transfer desirable traits into a single cultivar.

Key words: Correlation, GCV, Heritability, PCV, Path analysis

China aster [*Callistephus chinensis* (L.)] Nees belongs to family Asteraceae and is native of China (Navalinskien *et al*. 2005). It is one of the most popular annual flowering plant cultivated throughout the world. *Callistephus chinensis* has diploid (2n) chromosome number 18 (Huziwara 1954).

Crop improvement depends on the extent of genetic variability available and efficient selection. The amount of variability can be determined with the help of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV). High heritability along with high genetic advance can be used for efficient selection (Johnson *et al*. 1955). Indirect selection will be helpful only after studying the correlation coefficients between various desirable traits. To simplify the complex interactions among various traits, path coefficient analysis is highly effective method which reveals the direct and indirect causes of such interactions. Quantitative approach has been used for studying various flowering characters in China aster (Rao 1982, Negi *et al*. 1983, Khangjarakpam *et al*. 2015, Tirakannanavar *et al*. 2015). The present investigation was, therefore, conducted to study genetic parameters of variability, correlation coefficients and path coefficient analysis which would be helpful in designing future breeding programmes.

[1]e mail: teerathrai@gmail.com

MATERIALS AND METHODS

The present study was conducted at the Experimental Research Farm of Department of Floriculture and Landscape Architecture, Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan during the year 2015. The experiment consisted of 10 genotypes namely Phule Ganesh White, Phule Ganesh Pink, Phule Ganesh Purple, Phule Ganesh Violet, Arka Aadya, Arka Archana, Arka Shashank, Arka Kamini, Arka Poornima and Violet Cushion. The experiment was laid out in randomized block design with four replications. Fifteen plants/replication were planted at a spacing of 30 cm between rows and 25 cm within row. The study was conducted under open field conditions. Five random plants were selected for recording observations for various growth and flowering traits, viz. plant height (cm), plant spread (cm), number of primary branches/plant, stalk length (cm), days to first flower opening, days to 50% flower opening, number of harvests of loose flower, flower head diameter (cm), number of flowers/plant, weight of flowers/plant (g), individual flower weight (g) and flowering duration (days). The genotypic and phenotypic coefficients of variance were calculated as suggested by Burton and De-Vane (1953) and heritability (broad sense), genetic advance

and genetic gain were calculated as/the formulae given by Johnson *et al*. (1955). The correlations were calculated as Al-Jibouri *et al*. (1958) and path analysis was done by following Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance revealed significant differences among the cultivars for various growth and flowering characters. Hence, this infers that wide range of variability

Table 1 Genetic parameters for various growth and flowering traits in China aster

Character	Mean	Range	GCV (%)	PCV (%)	Heritability (%)	Genetic advance	Genetic gain (%)
Plant height (cm)	66.35	41.15-102.25	34.07	34.26	98.90	46.32	69.81
Plant spread (cm)	39.22	23.79-55.70	30.71	31.66	94.04	24.05	61.34
No. of primary branches	14.95	11.65-19.00	18.34	19.97	84.31	5.19	34.69
Stalk length (cm)	26.25	21.93-32.60	15.40	16.17	90.74	7.93	30.22
Days to first flower opening	92.90	77.25-106.25	11.43	11.86	92.89	21.09	22.70
Days to 50% flower opening	108.04	92.45-123.20	9.84	10.35	90.34	20.81	19.26
No. of harvests of loose flower	11.78	7.25-15.75	23.20	25.99	79.68	5.02	42.66
Flower head diameter (cm)	5.47	4.42-6.82	15.46	16.08	92.43	1.68	30.62
No. of flowers/plant	27.55	19.60-34.35	18.73	20.00	87.70	9.95	36.13
Weight of flowers/plant (g)	112.12	84.50-174.42	24.88	25.02	98.89	57.15	50.97
Individual flower weight (g)	4.06	3.25-5.30	17.09	17.89	91.17	1.36	33.61
Flowering duration (days)	34.16	25.65-41.30	15.56	17.24	81.86	9.93	29.07

Table 2 Phenotypic and Genotypic correlation coefficients for various traits in China aster

Character		1	2	3	4	5	6	7	8	9	10	11	12
1	P	1.00											
	G	1.00											
2	P	0.52*	1.00										
	G	0.54*	1.00										
3	P	-0.69*	-0.19	1.00									
	G	-0.75*	-0.19	1.00									
4	P	-0.44*	-0.63*	0.27	1.00								
	G	-0.47*	-0.67*	0.32*	1.00								
5	P	0.62*	0.07	-0.86*	-0.35*	1.00							
	G	0.64*	0.08	-0.97*	-0.35*	1.00							
6	P	0.58*	0.03	-0.84*	-0.29	0.98*	1.00						
	G	0.60*	0.06	-0.96*	-0.31*	1.00*	1.00						
7	P	-0.52*	0.03	0.78*	0.19	-0.91*	-0.92*	1.00					
	G	-0.58*	0.02	0.94*	0.20	-0.99*	-0.99*	1.00					
8	P	0.81*	0.64*	-0.55*	-0.46*	0.48*	0.43*	-0.36*	1.00				
	G	0.84*	0.68*	-0.64*	-0.54*	0.53*	0.48*	-0.44*	1.00				
9	P	-0.17	0.21	0.52*	-0.21	-0.47*	-0.50*	0.43*	-0.15	1.00			
	G	-0.18	0.25	0.54*	-0.24	-0.48*	-0.53*	0.47*	-0.15	1.00			
10	P	0.46*	0.50*	-0.11	-0.31	0.07	0.02	-0.03	0.39*	0.64*	1.00		
	G	0.46*	0.52*	-0.13	-0.34*	0.08	0.02	-0.05	0.41*	0.67*	1.00		
11	P	0.73*	0.40*	-0.60*	-0.14	0.52*	0.49*	-0.45*	0.65*	-0.14	0.61*	1.00	
	G	0.77*	0.45*	-0.71*	-0.15	0.58*	0.55*	-0.53*	0.67*	-0.17	0.64*	1.00	
12	P	-0.47*	0.07	0.77*	0.19	-0.91*	-0.91*	0.98*	-0.33*	0.43*	-0.01	-0.41*	1.00
	G	-0.51*	0.06	0.94*	0.21	-0.98*	-0.99*	0.99*	-0.38*	0.47*	-0.01	-0.46*	1.00

1. Plant height (cm), 2. Plant spread (cm), 3. No. of primary branches, 4. Stalk length (cm), 5. Days to first flower openingm 6. Days to 50% flowering, 7. No. of harvests of loose flower, 8. Flower head diameter (cm), 9. No. of flowers/plant, 10. Weight of flowers/plant (g), 11. Individual flower weight (g), 12. Flowering duration (days).

exists among the cultivars and substantial improvement in this crop is possible.

Estimation of genetic parameters for growth and flowering traits

Genotypic coefficient of variation by itself is not a correct measure to know the heritable variations present and should be considered together with heritability estimates to get the best picture of the amount of advance to be expected from the selections (Burton 1952). High heritability estimates are helpful in making selection of superior genotypes on the basis of quantitative characters (Table 1). However, Johnson *et al*. (1955) suggested that heritability estimates along with genetic gain are more helpful than the heritability value alone in predicting the result for selecting the best individual. Higher phenotypic and genotypic coefficients of variation were reported for plant height (34.26% and 34.07%, respectively) followed by plant spread (31.66% and 30.71%, respectively). The estimates were found to be low for days to first flower opening (11.86% and 11.43%, respectively) and days to 50% flower opening (10.35% and 9.84%, respectively). The heritability estimates for all characters were high (>80%), except for number of harvests of loose flower. The estimates of genetic gain were comparatively high for plant height (69.81%), plant spread (61.34%) and weight of flowers/plant (50.97%). Minimum genetic gain was recorded for days to 50% flower opening (19.26%), followed by days to first flower opening (22.70%). The estimates of phenotypic and genotypic coefficients of variability give a clear picture of amount of variations present in the available germplasm. Phenotypic coefficients of variability were higher in magnitude than the genotypic coefficients of variability for all characters studied, though difference was very less. This indicates the role of environment in expression of genotype. Similar results were reported by Kumar and Patil (2003), Khangjarakpam *et al*. (2014) and Tirakannanavar *et al*. (2015) in China aster; Sharma (2014) and Singh *et al*. (2014) in marigold.

Phenotypic and genotypic correlation coefficients for various traits in China aster

Correlation coefficients among different traits had been worked out and are presented in Table 2. In general, the genotypic correlation coefficients were higher than phenotypic correlation coefficients. This may be due to the interaction of genotypes with the environment. These correlation coefficients provide a measure of association among traits and can be utilised in selection. It is evident from the data that weight of flowers/plant was significantly and positively correlated to plant height, plant spread, individual flower weight, flower diameter and number

Table 3 Path coefficient analysis for various traits in China aster

Character		1	2	3	4	5	6	7	8	9	10	11
1	P	0.358	-0.043	0.053	-0.009	0.104	-0.119	-0.023	-0.050	-0.131	0.377	-0.019
	G	-0.488	0.252	0.736	-0.152	0.034	-0.339	-0.773	0.413	-0.170	0.217	0.583
2	P	0.187	-0.082	0.014	-0.013	0.012	-0.006	0.001	-0.039	0.165	0.206	0.003
	G	-0.265	0.463	0.190	-0.220	0.004	-0.035	0.026	0.334	0.237	0.125	-0.067
3	P	-0.245	0.015	-0.077	0.006	-0.144	0.172	0.034	0.034	0.400	-0.312	0.032
	G	0.365	-0.089	-0.984	0.106	-0.052	0.538	1.254	-0.315	0.507	-0.200	-1.060
4	P	-0.157	0.052	-0.021	0.020	-0.059	0.060	0.008	0.028	-0.160	-0.075	0.008
	G	0.227	-0.312	-0.319	0.326	-0.019	0.176	0.267	-0.264	-0.227	-0.043	-0.240
5	P	0.223	-0.006	0.066	-0.007	0.168	-0.202	-0.040	-0.029	-0.362	0.271	-0.038
	G	-0.314	0.038	0.957	-0.114	0.053	-0.562	-1.328	0.259	-0.450	0.162	1.115
6	P	0.207	-0.003	0.065	-0.006	0.165	-0.205	-0.040	-0.026	-0.385	0.251	-0.038
	G	-0.295	0.029	0.943	-0.102	0.053	-0.562	-1.335	0.237	-0.494	0.156	1.119
7	P	-0.184	-0.002	-0.060	0.004	-0.153	0.188	0.044	0.022	0.337	-0.231	0.041
	G	0.282	0.009	-0.923	0.065	-0.053	0.561	1.336	-0.214	0.440	-0.147	-1.133
8	P	0.290	-0.052	0.043	-0.009	0.080	-0.088	-0.016	-0.062	-0.119	0.336	-0.014
	G	-0.412	0.316	0.633	-0.176	0.028	-0.272	-0.584	0.489	-0.144	0.189	0.429
9	P	-0.060	-0.017	-0.040	-0.004	-0.078	0.102	0.019	0.009	0.776	-0.071	0.018
	G	0.089	0.118	-0.535	-0.079	-0.026	0.298	0.631	-0.075	0.933	-0.046	-0.533
10	P	0.261	-0.033	0.047	-0.003	0.088	-0.100	-0.020	-0.040	-0.106	0.517	-0.017
	G	-0.377	0.207	0.700	-0.050	0.031	-0.311	-0.702	0.329	-0.153	0.281	0.525
11	P	-0.167	-0.006	-0.060	0.004	-0.153	0.187	0.043	0.020	0.335	-0.213	0.042
	G	0.251	0.027	-0.920	0.069	-0.052	0.554	1.334	-0.185	0.439	-0.130	-1.135

Residual effect: 0.076 and -0.042 for phenotypic and genotypic correlation path analysis, respectively. 1. Plant height (cm), 2. Plant spread (cm), 3. No. of primary branches, 4. Stalk length (cm), 5. Days to first flower opening, 6. Days to 50% flowering 7. No. of harvests of loose flower, 8. Flower head diameter (cm), 9. No. of flowers/plant, 10. Individual flower weight (g), 11. Flowering duration (days)

of flowers/plant. Similar results have been reported by Khangjarakpan *et al.* (2015). Plant height had significant positive correlation with plant spread, days to first flower opening, days to 50% flower opening, flower head diameter and individual flower weight. These results are in line with the findings of Tirakannanavar *et al*. (2015).

Plant spread also had significant positive correlation with flower head diameter and individual flower weight. Similarly, number of primary branches was found to be positively correlated to number of harvests of loose flower, number of flowers/plant and flowering duration. Likewise, number of flowers/plant showed significantly positive correlation with plant spread, weight of flowers/plant and flowering duration. These results are in confirmation with the findings of Bhanupratap *et al*. (1999) and Sharma (2014) in marigold, and Sreenivasalu *et al*. (2008) in China aster.

Path coefficient analysis for various traits in China aster

Path coefficient analysis divides the association between two traits into direct and indirect effects. Considering weight of flowers/plant to be a dependent trait, phenotypic and genotypic coefficients of correlation between weight of flowers/plant and all other characters were further partitioned into direct and indirect effects (Table 3). It is evident from the data that on portioning the phenotypic correlation into direct and indirect effects, maximum positive direct effect on weight of flowers/plant was recorded for number of flowers/plant (0.776) followed by individual flower weight, plant height, days to first flower opening, number of harvests of loose flower, flowering duration and stalk length. Maximum negative direct effect was recorded for days to 50% flowering (-0.205) followed by plant spread, number of primary branches and flower head diameter. Highest positive and direct contribution was recorded for number of harvests of loose flower (1.336), followed by number of flowers/plant, flower head diameter, plant spread, stalk length, individual flower weight and days to first flower opening. Whereas, flowering duration had the maximum negative direct effect on weight of flowers/plant (-1.135), followed by number of primary branches, days to 50% flowering and plant height. The results suggest that there had been change in both magnitude and direction. Similar results have been reported by Khangjarakpam (2015) in China aster and Singh *et al*. (2014) in marigold.

The present study revealed existence of considerable variation among China aster cultivars and presence of highly heritable traits like plant height, plant spread, stalk length, days to first flower opening, flower head diameter, weight of flowers/plant and individual flower weight which can be used in future crop improvement programmes for breeding new cultivars with superior growth and flowering traits.

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