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Genetic Variability, Heritability and Genetic Advance for Different Traits in China Aster Varieties

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A B S T R A C T

The study was conducted on genetic variability, heritability and genetic advance among the various characters influencing the flower yield of twelve different genotypes of China aster. The field experiment was carried out in Randomized Block Design during *kharif* season of 2016-17 under semi-arid climatic condition at Experimental block of Department of Horticulture, College of Agriculture, UAS, Raichur. The data was observed from five randomly selected competitive plants from each replication for sixteen quantitative traits. The analysis of variance revealed the significance differences among the genotypes. The phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all characters indicating the influence of environment on these characters. High phenotypic and genotypic coefficients of variation was observed for test weight, yield per plant, flower bud initiation, days to flowering, plant height, leaf area, leaf area index and secondary branches. The estimates of heritability (broad sense) varied from 47.00 to 98.50 % for different characters under study. It was found high for all the traits except duration of flowering. High heritability estimates coupled with high genetic advance over mean was observed for all the traits except duration of flowering and dry matter.

Introduction

China aster [*Callistephus chinensis* (L.) Nees] belongs to one of the largest families of flowering plants, 'Asteraceae'. The present day asters have been developed from a single form of wild species known as, *Callistephus chinensis*. The name of the genus 'Callistephus' is derived from two Greek words 'kalistos' meaning 'most beautiful' and 'stephos', a crown, referring to the flower head. The genus *Callistephus* has only a

single species, namely, *Callistephus chinensis*. It is native to China and has spread to European countries and other tropical countries during 1731 AD (Desai, 1967). China aster is one of the most important annual flower crops grown in most parts of the world.

The evolution of China aster [*Callistephus chinensis* (L.) Nees] has a history of remarkable variations. According to Emsweller *et al.,* (1937), the original plant

had single flowers with two or four rows of blue, violet or white ray florets. The stature was medium tall and height of the plant ranged from 18 to 24 inches. The first change in the flower type had been the prolongation or development of central florets and the production of quilled flowers. Germans developed double forms in aster during 18th century. Hence, asters are also called as German asters. Advancement of the aster evolution and large scale seed production by Germans led to the introduction of branching types, tall types, medium tall and dwarf types and this contributed for great evolutionary improvement in China aster.

Materials and Methods

The experiment was carried out in Randomized Block Design with three replications in the Experimental block of Department of Horticulture, College of Agriculture, UAS, Raichur during the year of 2016-17. Twelve different varieties *viz.,* Kamini, Shashank, Poornima, Arka Aadya, Arka Archana, Phule Ganesh White, Phule Ganesh Pink, Phule Ganesh Purple, Phule Ganesh Violet, Mudigere Local, Namdhari Pink and Namdhari White were used for the study. Spacing of 50 cm between replications and 30 cm between two plots were provided for laying out the bunds. The entire experimental land was divided into subplots measuring 3.6 m x 3.0 m and there were totally 36 plots. Forty days old healthy and uniformly grown seedlings were transplanted with a spacing of 30 x 30 cm. The optimum irrigation was given soon after transplanting. Five randomly selected competitive plants from each replication for sixteen quantitative traits were selected.

The observations were recorded on quantitative characters selected for genetic variability studies such as plant height (cm), plant spread (cm), Number of leaves, Number of primary branches, Number of secondary branches, Leaf area (cm^2), Leaf area index, Dry matter (g), Days to flower bud initiation, Days to flowering, Days for 50% flowering, Duration of flowering (days), Number of flowers/plant, Flower diameter (cm), Test weight (g) and yield/plant.

Genetic variability, heritability and genetic advance

Genetic variability is the basis of all crop improvement programmes. Higher the amount of variability in the population, greater is the scope for its improvement by selection. The importance of genetic variability was perceived by Vavilov (1951) for the first time and advocated that wide range of variability provides better scope for selecting a desirable genotype. Knowledge of heritability for different traits seems to be essential for any crop improvement programme because the heritable component is the consequence of genotype and is inherited from generation to generation. Wright (1921) reported that heritability comprised of additive and non-additive components and it is the former which respond to selection.

The different genetic parameters should follow in order to evaluate and assess the genetic variability among the various genotypes by adopting following formulae.

Estimation of variance component

Genotypic and phenotypic components of variance were estimated with the help of following formulae.

$$\text{Genotypic variance } (\sigma^2 g) = \frac{\text{MSS (treatment)} - \text{MSS (error)}}{\text{Number of replications}}$$

Phenotypic variance $(\sigma^2 p) = \sigma^2 g + \text{MSS (error)}$

Co-efficient of variation

Both genotypic and phenotypic coefficients were computed for each character as per the method suggested by Burton and Devane (1953).

Genotypic coefficient of variability (GCV) =

$$\frac{\sigma g}{\overline{X}} \times 100$$

Phenotypic coefficient of variability (PCV) =

$$\frac{\sigma p}{\overline{X}} \times 100$$

Where,

σg = Genotypic standard deviation
σp = Phenotypic standard deviation
$\overline{X}$ = General mean of character

GCV and PCV values were categorized as low, moderate and high values as suggested by Sivasubramanian and Menon (1973), which is as follows:

1-10 per cent   : Low
10.1-20 per cent   : Moderate
20.1 per cent and above   : High

Heritability (h^2b)

Heritability in broad sense was computed as the ratio of the total phenotypic variance as suggested by Hanson *et al.,* (1956) and expressed in terms of percentage.

$$\text{Heritability } (h^2) = \frac{\sigma^2 g}{\sigma^2 p} \times 100$$

Where,

$\sigma^2 g$ = Genotypic variance
$\sigma^2 p$ = Phenotypic variance

The heritability percentage was categorized as low, moderate and high as given by Robinson *et al.,* (1949).

0-30 per cent   : Low
30.1-60 per cent   : Moderate
60.1 per cent and above   : High

Genetic advance (GA)

Genetic advance was estimated by using the formula given by Johnson *et al.,* (1955).

$GA = h^2 k \sigma p$
Where,
h^2 = Heritability in broad sense
k = Selection deferential which is equal to 2.06 at 5% intensity of selection (Lush, 1940)
σp = Phenotypic standard deviation

Genetic advance as per cent of mean (GAM)

$$\text{GAM} = \frac{GA}{\overline{X}} \times 100$$

Where,

GA = Genetic advance
X = General mean of the character

Genetic advance as per cent mean was categorized as low, moderate and high as given by Johnson *et al., (1955).

It is as follows,

0-10 per cent   : Low
10.1-20 per cent   : Moderate
20.1 per cent and above   : High

Results and Discussion

Analysis of variance showed significant differences among the genotypes for all the

sixteen quantitative parameters, indicating the sufficient genetic variability to be exploited in breeding programme (Table 1).

A knowledge of the estimates of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2b) and genetic advance as percentage of mean (GAM) would help the breeder in selection of appropriate breeding methods. The interaction of number of component characters may result in boosting the yield of the crop.

Genetic variability studies

Coefficients of variation

Genetic parameters *viz*., range, mean, genotypic co-efficient of variation (GCV), phenotypic co-efficient variation (PCV), heritability (h^2) and genetic advance as per cent of mean (GAM) were calculated to estimate the extent of genetic variability for 16 characters and the results are presented in Table 2 (Fig. 1).

Plant height

Plant height ranged from 34.70 cm to 64.92 cm with mean value of 49.81 cm, with the estimated GCV and PCV of 22.78 and 23.85 per cent, respectively. The highest heritability recorded by this trait was 91.2 per cent, whereas the genetic advance over mean was observed 44.81 per cent.

Plant spread

Plant spread ranged from 16.61 cm to 32.00 cm with mean value of 24.31 cm, with estimated GCV and PCV of 15.46 and 16.71 per cent, respectively. The highest heritability recorded by this trait was 85.50 per cent, while the genetic advance over mean was found to be 29.46 per cent.

Number of leaves

The minimum number of leaves was recorded 129.11, while maximum number of leaves was 182.06 with mean of 155.59. GCV of 11.03 per cent and PCV of 12.13 per cent were recorded for this trait. Heritability value of 82.70 per cent and genetic advance over mean was 20.66 per cent noticed for the character.

Number of primary branches

It ranged from 11.05 to 19.16 with mean value of 15.11, with estimated GCV and PCV of 15.31 and 18.88 per cent, respectively. The highest heritability recorded by this trait was 65.70 per cent, while the genetic advance over mean was 25.58 per cent.

Number of secondary branches

It ranged from 19.20 to 37.21 with mean value of 28.21 and estimated GCV and PCV of 20.39 and 20.66 per cent, respectively. The highest heritability recorded by this trait was 97.40 per cent, while the genetic advance over mean was noticed as 41.47 per cent.

Leaf area

Leaf area ranged from 18.87 cm^2 to 36.32 cm^2 with mean value of 27.60 cm^2. The estimated GCV and PCV of 22.83 and 23.44 per cent, respectively were recorded. The highest heritability recorded by this trait was 94.90 per cent, while the genetic advance over mean was observed 45.83 per cent.

Leaf area index

It ranged from 0.02 to 0.04 with mean value of 0.03 with estimated GCV and PCV of 21.10 and 21.70 per cent, respectively. The highest heritability recorded by this trait was 94.50 per cent, while the genetic advance over mean was recorded 42.25 per cent.

Dry matter

Dry matter ranged from 34.31 to 48.02 g plant^{-1} with mean value of 41.17 g plant^{-1}, while estimated GCV and PCV of 8.76 and 10.12 per cent, respectively were recorded. The highest heritability recorded by this trait was 75.00 per cent, while the genetic advance over mean was noticed 15.64 per cent.

Days to flower bud initiation

It ranged from 26.10 days to 63.33 days with mean value of 44.72 days. The estimated GCV and PCV of 26.22 and 26.86 per cent, respectively were recorded. The highest heritability recorded by this trait was 95.30 per cent, while the genetic advance over mean was recorded 52.75 per cent.

Days to flowering

The number of days to flowering for the genotypes ranged from 30.60 to 73.33 days with a mean value of 51.97 days. For this trait the GCV and PCV were found to be 25.38 and 26.08 per cent, respectively with very high heritability of 94.70 per cent. Genetic advance as per cent of mean of 50.86 per cent was recorded.

Days to 50% flowering

The number of days to 50 per cent flowering for the genotypes ranged from 55.33 to 79.00 days with a mean value of 67.17 days for this trait the GCV and PCV were found to be 12.12 and 12.36 per cent, respectively with very high heritability of 96.00 per cent. Genetic advance as per cent of mean of 24.46 per cent was recorded.

Duration of flowering

Duration of flowering ranged from 26.00 to 34.44 days with a mean value of 30.22days.

For this trait the GCV and PCV were found to be 7.26 and 10.52 per cent, respectively with medium heritability of 47.00 per cent. Low genetic advance as per cent of mean was recorded 10.33 per cent.

Number of flowers/plant

It ranged from 39.00 to 68.53 with mean value of 53.77, with the estimated GCV and PCV of 17.57 and 18.53 per cent, respectively. The highest heritability recorded by this trait was 89.00 per cent, while the genetic advance over mean was recorded 34.33 per cent.

Size of the flower (diameter)

The average size of the flower ranged from 3.77 cm to 6.35 cm with a mean value of 5.06 and the estimated GCV and PCV of 16.69 and 17.52 per cent, respectively. The highest heritability recorded by this trait was 90.70 per cent, while the genetic advance over mean was recorded 32.76 per cent.

Test weight

The average test weight of fresh flowers ranged from 19.51 g to 55.33 g with mean value of 37.42 g, while the estimated GCV and PCV of 42.15 and 42.47 per cent, respectively were recorded. The highest heritability recorded by this trait was 98.50 per cent, while the genetic advance over mean was noticed 86.18 per cent.

Yield per plant (g)

Yield per plant ranged from 88.01 g to 214.67 g, the average value being 151.34 g, with the estimated GCV and PCV of 29.88 and 30.36 per cent, respectively. The highest heritability recorded by this trait was 96.90 per cent, whereas the genetic advance over mean was observed 60.59 per cent.

Table.1 Analysis of variance for quantitative characters of various China aster genotypes

| Sl. No.	Source of variation/ parameters	Mean sum of squares		
		Replication	Genotypes	Error
	Degrees of freedom	**2**	**11**	**22**
1	Plant height (cm)	14.7	301.70*	9.4
2	Plant spread (cm)	1.6	53.20*	2.8
3	Number of leaves	92.19	896.54*	58.49
4	Number of primary branches	0.65	18.33*	2.71
5	Number of secondary branches	12.82	97.28*	2
6	Leaf area (cm^2)	36.87	98.09*	1.72
7	Leaf area index	0	0.0001*	0
8	Dry matter (g)	87.7	43.60*	4.3
9	Days to flower bud initiation	14.1	454.40*	7.3
10	Days to flowering	8.7	573.20*	10.6
11	Days for 50% flowering	0.4	215.20*	11.8
12	Duration of flowering (days)	38.6	21.70*	5.8
13	Number of flowers/plant	12.2	275.00*	9.9
14	Yield/plant (g)	90	5833.70*	62.4
15	Flower diameter (cm)	0.2	2.20*	0.1
16	Test weight (g)	0.4	510.70*	2.6

*Significant at 5 % probability

Table.2 Estimates of phenotypic and genotypic coefficients of variation, heritability and genetic advance for different traits in China aster

Sl. No	Characters	Range		Mean	GCV (%)	PCV (%)	h^2_{BS} (%)	GAM (%)
1	Plant height (cm)	34.70	64.92	49.81	22.78	23.85	91.20	44.81
2	Plant spread (cm)	16.61	32.00	24.31	15.46	16.71	85.50	29.46
3	Number of leaves	129.11	182.06	155.59	11.03	12.13	82.70	20.66
4	Number of primary branches	11.05	19.16	15.11	15.31	18.88	65.70	25.58
5	Number of secondary branches	19.20	37.21	28.21	20.39	20.66	97.40	41.47
6	Leaf area (cm^2)	18.87	36.32	27.60	22.83	23.44	94.90	45.83
7	Leaf area index	0.02	0.04	0.03	21.10	21.70	94.50	42.25
8	Dry matter (g)	34.31	48.02	41.17	8.76	10.12	75.00	15.64
9	Days to flower bud initiation	26.10	63.33	44.72	26.22	26.86	95.30	52.75
10	Days to flowering	30.60	73.33	51.97	25.38	26.08	94.70	50.86
11	Days for 50% flowering	55.33	79.00	67.17	12.12	12.36	96.00	24.46
12	Duration of flowering (days)	26.00	34.44	30.22	7.26	10.52	47.00	10.33
13	Number of flowers/plant	39.00	68.53	53.77	17.57	18.53	89.00	34.33
14	Flower diameter (cm)	3.77	6.35	5.06	16.69	17.52	90.70	32.76
15	Test weight (g)	19.51	55.33	37.42	42.15	42.47	98.50	86.18
16	Yield/plant (g)	88.01	214.67	151.34	29.88	30.36	96.90	60.59

GCV- Genotypic co-efficient of variance h^2_{BS} - Broad sense heritability
PCV- Phenotypic co-efficient of variance   GAM- Genetic advance as per cent of mean

Fig.1 Genotypic and phenotypic coefficient of variation for sixteen characters in China aster
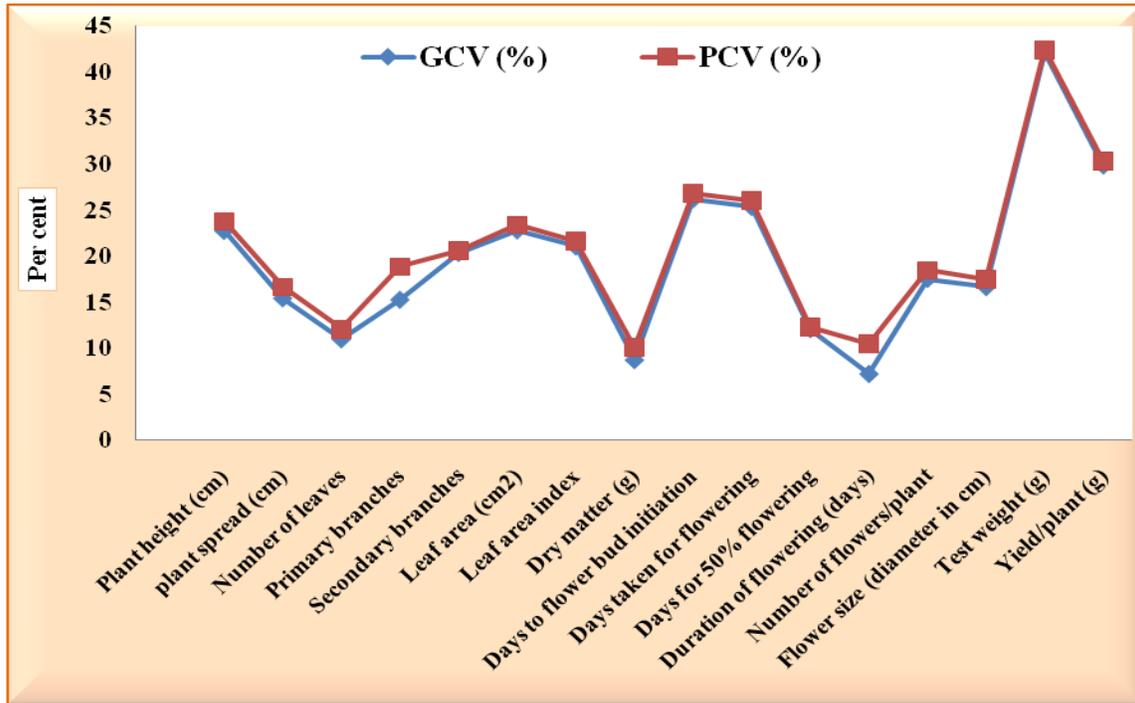
Fig.2 Heritability estimates and genetic advances over mean for sixteen characters in China aster
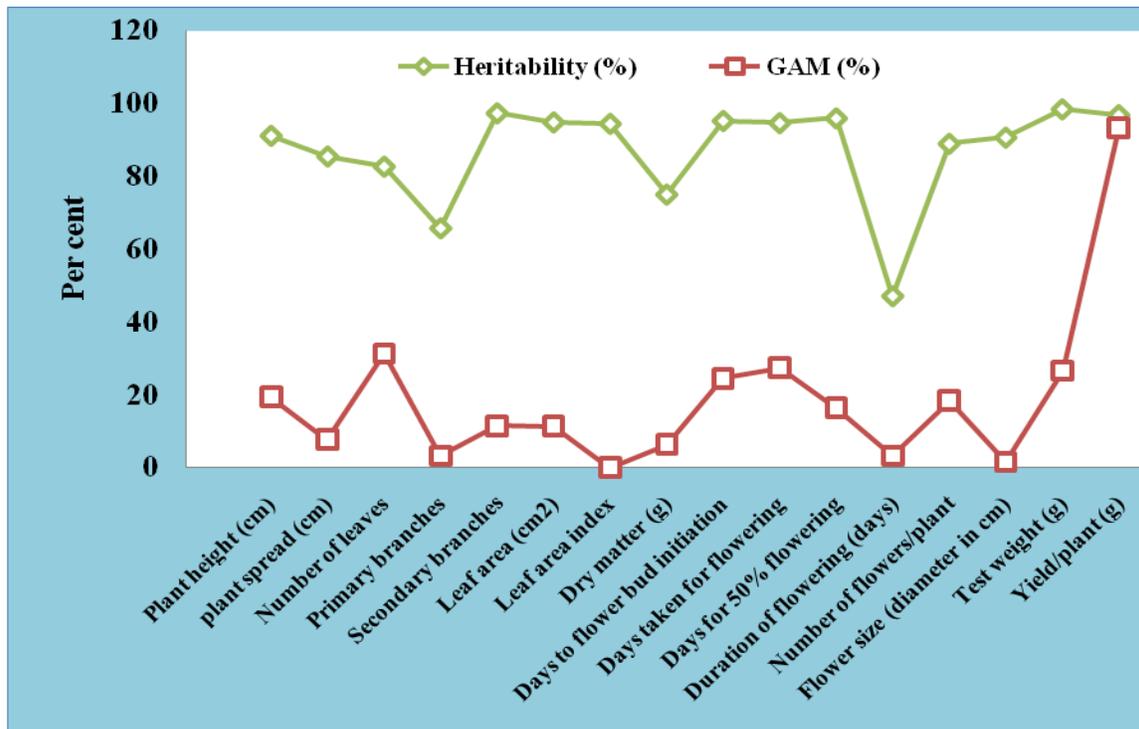
Genetic variability studies

Coefficients of variation

The phenotypic variance measures the magnitude of variation arising out differences in phenotypic values while, the genotypic variance measures the magnitude of variation arising out differences in genotypic values. As the phenotypic genotypic variance in absolute values cannot be used to compare magnitude of variability of different growth and yield parameters. Hence, these parameters are converted into co-efficient of variance at genotypic and phenotypic levels.

The estimates of phenotypic and genotypic coefficients of variation gave a clear picture of amount of variations present in the available varieties. For all the characters studied, phenotypic coefficients of variation were higher in magnitude than genotypic coefficients of variation, though difference was very less in majority the case. Thus, showing these traits were less influenced by environmental factors. Coefficients of variation varied in magnitude from character to character (either low or moderate or high). The higher magnitude of genetic coefficient of variation showing narrow difference between PVAR and GVAR indicates simple selection procedure would be sufficient to improve such traits in China aster.

The phenotypic coefficients of variation (PVAR) was found high for test weight, yield per plant, flower bud initiation, days to flowering, plant height, leaf area, leaf area index and number of secondary branches whereas moderate PVAR was found for number of flowers, flower size, plant spread, number of primary branches, days to 50 per cent flowers, number of leaves, dry matter and duration of flowering. Similar results for phenotypic coefficients of variation were observed by Kumar *et al.,* (2003), Pal and George (2002), Nandakishore and Raghava

(2001), Sirohi and Behera (2000) and Singh and Sen (2000). Genotypic coefficients of variation (GVAR) was found high for test weight, yield per plant, flower bud initiation, days to flowering, plant height, leaf area, leaf area index and secondary branches whereas moderate GVAR was observed for number of flowers, flower size, plant spread, primary branches, days to 50 per cent flowers, number of leaves, while it was recorded low for dry matter and duration of flowering. Similar results for genotypic coefficients of variation were observed by Kumar *et al.,* (2003), Pal and George (2002), Nandakishore and Raghava (2001), Sirohi and Behera (2000) and Singh and Sen (2000).

Heritability

The genotypic coefficient of variation does not offer full scope to estimate the variations that are heritable and therefore, estimation of heritability becomes necessary. Burton and De Vane (1953) had suggested that genetic coefficient of variation along with heritability estimates would give a reliable indication of expected amount of improvement through selection.

The estimates of heritability (broad sense) varied from 47.00 - 98.50 % for different characters under study. It was found high for all the traits *viz.,* test weight, number of secondary branches, yield per plant, days to 50 per cent flowers, days to flower bud initiation, leaf area, days to flowering, leaf area index, plant height, flower size, number of flowers per plant, plant spread, number of leaves, dry matter and primary branches except duration of flowering whereas, medium heritability was observed for duration of flowering. Kumar *et al.,* (2003), Pal and George (2002), Nandakishore and Raghava (2001) and Singh and Sen (2000) also did similar kind of studies and found similar results (Fig. 2).

Genetic advance as per cent of mean

High heritability estimates coupled with high genetic advance over mean was observed for test weight, yield per plant, days to flowering, days to flower bud initiation, leaf area, plant height, leaf area index, number of secondary branches, number of flowers per plant, flower size, plant spread, number of primary branches, days to 50 per cent flowering and number of leaves and the moderate genetic advance were recorded for dry matter and duration of flowering. Similar results were also observed Singh and Sen (2000), Nandakishore and Raghava (2001) and Pal and George (2002).

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