Original Research Article

Correlation and Path Analysis in China Aster
[*Callistephus chinensis* (L) Nees]

D. Naikwad*, K. Kandpal, M.G. Patil, A. Hugar and V. Kulkarni

*Department of Horticulture, University of Agricultural Sciences, Raichur, Karnataka,
Raichur-584102, Karnataka, India*

*Corresponding author

A B S T R A C T

The study was conducted on correlation and path analysis among the different characters influencing the flower yield of twelve different genotypes of China aster. The 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. Correlation among the different characters influencing the number of leaves, number of secondary branches plant^{-1} and plant spread showed significant positive correlation with yield both at phenotypic and genotypic level suggesting good scope for improvement of yield. The results for path analysis indicated that test weight (10 flower weight), number of secondary branches plant^{1} and number of flowers plant^{-1} directly influenced the flower yield and had maximum direct effect. This result suggests that these traits can be directly used to improve the yield of China aster.

Introduction

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.

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.

China aster is a free blooming half hardy, easy growing winter annual crop grown for cut flower as well as loose flower. The bloom type depends mainly upon the relative number of the two kinds of florets and their shapes. The most suitable character for the classification of China aster is the shape of ray florets. The present day varieties are available in diverse forms, different types and a wide spectrum of colour ranges *viz.*, pink, primrose, pale blue, mauve, purple, scarlet, creamy white, pure white, violet etc.

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 plants from each genotypes and replication were tagged for recording the observations after discarding the border plants at both the ends.

The observations were recorded on quantitative characters selected for correlation studies are plant height, 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. The observed data were subjected to statistical analysis. Fisher's method of analysis of variance was applied for the analysis and interpretation of data as given by Panse and Sukhatme (1967). The path coefficient analysis was carried out by using the technique outlined by Dewey and Lu (1959) for flower yield and its components keeping flower yield as resultant variable and its component as causal variables.

Results and Discussion

Knowledge of degree of association of yield with its components is of great importance, because yield is not an independent character, but it is the resultant of the interactions of a number of component characters among themselves as well as with the environment in which the plant grows. Further each character is likely to be modified by action of genes present in the genotypes of plant and also by the environment and it becomes difficult to evaluate this complex character directly. Therefore, correlation study of yield with its

component traits has been executed to find out the yield contributing traits.

Phenotypic correlation coefficient

The phenotypic correlation coefficient among different characters showed that flower yield per plant had the positive and highly significant association with number of leaves (0.7850), number of secondary branches (0.7844), plant spread (0.7649), leaf area index (0.7542), flower size (0.7306), leaf area (0.6930), plant height (0.6820), dry matter (0.6691), test weight (0.5774) and number of primary branches (0.5151).

Besides, plant spread (0.7649) had positive and significant association with number of secondary branches (0.7873), number of leaves (0.7850) had positive and significant association with leaf area index (0.8216), number of primary branches (0.5151) with leaf area index (0.6525), number of secondary braches (0.7844) had significantly positive association with leaf area index (0.8704), dry matter (0.8572), leaf area (0.8087), flower size (0.8063) and test weight (0.6505). Significantly positive association of leaf area (0.6930) with leaf area index (0.9275). Leaf area index (0.7542) had positive and significant association with dry matter (0.8678), flower size (0.8240). Dry matter (0.6691) recorded positive and significant association with flower size (0.7841) and test weight (0.5509).

Days to flower bud initiation had significantly positive association with days to first flowering (0.9768), days to 50 per cent flowering (0.9388). Significantly positive association of days to first flowering with days to 50 per cent flowering (0.9500), test weight (0.5566) and flower size (0.5380). Days to 50 per cent flowering had positive and significant association with test weight (0.6217) and number of primary branches (0.5382). Flower size (0.7306) recorded positive and significant

association with test weight (0.5698) the result is in substantiation with Baweja (2000), Zosiamliana *et al.,* (2012) and Shantappa *et al.,* (2015) (Fig. 2 and Table 1).

Genotypic correlation coefficient

Genotypic correlation coefficient among different characters showed that flower yield per plant had positive and significant association with number of leaves per plant (0.8970), plant spread (0.8135), number of secondary branches (0.8123), plant dry matter (0.8058), leaf area index (0.7959), flower size (0.7861), plant height (0.7159), leaf area (0.7104), number of primary branches per plant (0.6659) and test weight (0.5947) (Fig. 1 and 3; Table 2 and 3).

Besides, days to flowering recorded positive and significant association with days to 50 per cent flowering (0.9855), test weight (0.5747) and flower size (0.4894). Significant and positive correlation of days to flower bud initiation with days to 50 per cent flowering (0.9734). Plant height (0.7159) recorded significantly positive correlation with leaf area index (0.9689) leaf area (0.9678). Significantly positive correlation of leaf area (0.7104) with leaf area index (0.9659). Number of primary branches (0.6659) showed significantly positive correlation with dry matter (0.9639). Significant and positive correlation of number of secondary branches (0.8123) with dry matter (0.9601). Leaf area index (0.7959) recorded significantly positive correlation with dry matter (0.9554). Significant and positive correlation of number of leaves (0.8970) with leaf area index (0.9217). Dry matter (0.8058) had significantly positive correlation with flower size (0.8931) and test weight (0.7861). Significant and positive correlation of plant spread (0.8135) with dry matter (0.8627). Number of flowers per plant had significantly positive correlation with test weight (0.6462).

Table.1 Phenotypic co-efficient of correlation among traits in China aster

	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16
X1	0.6489**	0.7915**	0.6332**	0.7823**	0.8881**	0.897**	0.7444**	0.5743**	0.6095**	0.6533**	0.1232	-0.0167	0.7615**	0.5754**	**0.682****
X2		0.5844**	0.529**	0.7873**	0.7062**	0.7489**	0.6878**	0.2713	0.3164*	0.3415*	0.38*	0.1066	0.7335**	0.469**	**0.7649****
X3			0.6054**	0.726**	0.7715**	0.8216**	0.6876**	0.4869**	0.5296**	0.598**	0.2625	0.0428	0.7983**	0.5423**	**0.785****
X4				0.6344**	0.5824**	0.6526**	0.5952**	0.2917	0.3674*	0.3629*	0.3916*	-0.1674	0.6423**	0.4638**	**0.5151****
X5					0.8087**	0.8704**	0.8572**	0.4099*	0.4522**	0.5034**	0.3236	-0.1127	0.8063**	0.6505**	**0.7844****
X6						0.9275**	0.8096**	0.522**	0.5401**	0.5462**	0.211	0.1446	0.8461**	0.4169*	**0.693****
X7							0.8678**	0.527**	0.5686**	0.6132**	0.2607	0.0452	0.824**	0.5721**	**0.7542****
X8								0.3029	0.3404*	0.3477*	0.328	-0.0209	0.7841**	0.5509**	**0.6691****
X9									0.9768**	0.9388**	0.0879	-0.366*	0.491**	0.4646**	**0.2216**
X10										0.9500**	0.1021	-0.387*	0.5385**	0.5566**	**0.2902**
X11											0.1966	-0.396*	0.5382**	0.6217**	**0.376***
X12												-0.172	0.4087*	0.2339	**0.3036**
X13													-0.0604	-0.599**	**0.2095**
X14														0.5698**	**0.7306****
X15															**0.5774****

* Significance - @ 5 %   **Significance - @ 1%
X1- Plant height (cm)   X2- Plant spread (cm)   X3- No. of leaves   X4- No. of primary branches
X5- No. of secondary branches   X6- Leaf area (cm^2)   X7- Leaf area index   X8- Dry matter production (g)
X9- Days to flower bud initiation   X10- Days to flowering   X11-Days for 50 per cent flowering   X12- Duration of flowering
X13- Number of flowers per plant   X14- Flower diameter (cm)   X15-Test weight (10 flower weight in g)   X16-Yield per plant (g)

Table.2 Genotypic co-efficient of correlation among traits in China aster

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16
X1	1	0.7166**	0.9200**	0.7732**	0.8487**	0.9678**	0.9689**	0.9229**	0.6243**	0.653**	0.7001**	0.251	-0.0476	0.865**	0.6088**	**0.7159****
X2		1	0.7044**	0.8061**	0.8615**	0.7428**	0.8311**	0.8627**	0.2786	0.3472*	0.3864*	0.5209**	0.0965	0.8588**	0.501**	**0.8135****
X3			1	0.7269**	0.8024**	0.8947**	0.9217**	0.8247**	0.5264**	0.569**	0.663**	0.3604*	0.1641	0.8746**	0.6016**	**0.897****
X4				1	0.8156**	0.7475**	0.8591**	0.9639**	0.4022*	0.4187*	0.4803*	0.8614**	-0.1159	0.7488**	0.5735**	**0.6659****
X5					1	0.8392**	0.8996**	0.9601**	0.413*	0.4763**	0.5157*	0.4284*	-0.1085	0.849**	0.6672**	**0.8123****
X6						1	0.9659**	0.9258**	0.5498**	0.5727**	0.5739**	0.2056	0.1516	0.9059**	0.4280*	**0.7104****
X7							1	0.9554**	0.5521**	0.5975**	0.6213**	0.2456	0.0349	0.8895**	0.5834**	**0.7959****
X8								1	0.3402*	0.4164*	0.4207*	0.2296	-0.0037	0.8931**	0.6356**	**0.8058****
X9									1	0.0013	0.9734**	0.1667	-0.388*	0.5213**	0.4894**	**0.2297**
X10										1	0.9855**	0.1684	0.4199*	0.5691**	0.5747**	**0.2991**
X11											1	0.2218	-0.434*	0.5912**	0.6444**	**0.3883***
X12												1	-0.2366	0.5056**	0.3274	**0.4389***
X13													1	-0.01	0.6462**	**0.2108**
X14														1	0.6138**	**0.7861****
X15															1	**0.5947****

* Significance - @ 5 %   **Significance - @ 1%

X1- Plant height (cm)   X2- Plant spread (cm)   X3- No. of leaves   X4- No. of primary branches
X5- No. of secondary branches   X6- Leaf area (cm^2)   X7- Leaf area index   X8- Dry matter production (g)
X9- Days to flower bud initiation   X10- Days to flowering   X11-Days for 50 per cent flowering   X12- Duration of flowering
X13- Number of flowers per plant   X14- Flower diameter (cm)   X15-Test weight (10 flower weight in g)   X16-Yield per plant (g)

Table.3 Genotypic path coefficients showing direct and indirect effects of different traits on yield per plant in China aster

	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
X1	**0.2302**	0.1649	0.2117	0.178	0.1953	0.2227	0.223	0.2124	0.1437	0.1503	0.1611	0.0578	-0.011	0.1991	0.1401
X2	-0.0012	**-0.0016**	-0.0011	-0.0013	-0.0014	-0.0012	-0.0013	-0.0014	-0.0005	-0.0006	-0.0006	-0.0008	-0.0002	-0.0014	-0.0008
X3	0.2988	0.2288	**0.3248**	0.2361	0.2606	0.2906	0.2993	0.2678	0.171	0.1848	0.2153	0.1171	0.0533	0.2841	0.1954
X4	-0.0333	-0.0347	-0.0313	**-0.0431**	-0.0351	-0.0322	-0.037	-0.0415	-0.0173	-0.018	-0.0207	-0.0371	0.005	-0.0322	-0.0247
X5	0.5006	0.5081	0.4732	0.4811	**0.5898**	0.495	0.5306	0.5663	0.2436	0.2809	0.3042	0.2526	-0.064	0.5007	0.3935
X6	0.1256	0.0964	0.1161	0.097	0.1089	**0.1298**	0.1253	0.1201	0.0713	0.0743	0.0745	0.0267	0.0197	0.1176	0.0555
X7	-0.338	-0.2899	-0.3215	-0.2997	-0.3138	-0.337	**-0.3488**	-0.3333	-0.1926	-0.2084	-0.2167	-0.0857	-0.0122	-0.3103	-0.2035
X8	-0.3544	-0.3313	-0.3167	-0.3702	-0.3687	-0.3555	-0.3669	**-0.384**	-0.1306	-0.1599	-0.1616	-0.0882	0.0014	-0.343	-0.2441
X9	0.01	0.0044	0.0084	0.0064	0.0066	0.0088	0.0088	0.0054	**0.0159**	0.016	0.0155	0.0027	-0.0062	0.0083	0.0078
X10	-0.2017	-0.1073	-0.1758	-0.1293	-0.1471	-0.1769	-0.1846	-0.1286	-0.3093	**-0.3089**	-0.3044	-0.052	0.1297	-0.1758	-0.1775
X11	-0.1192	-0.0658	-0.1129	-0.0818	-0.0878	-0.0977	-0.1058	-0.0716	-0.1658	-0.1678	**-0.1703**	-0.0378	0.0739	-0.1007	-0.1097
X12	0.041	0.0851	0.0589	0.1407	0.07	0.0336	0.0401	0.0375	0.0272	0.0275	0.0362	**0.1634**	-0.0387	0.0826	0.0535
X13	-0.0197	0.0399	0.0678	-0.0479	-0.0449	0.0627	0.0144	-0.0015	-0.1604	-0.1736	-0.1794	-0.0978	**0.4134**	-0.0041	-0.2671
X14	-0.1675	-0.1663	-0.1693	-0.1449	-0.1643	-0.1754	-0.1722	-0.1729	-0.1009	-0.1102	-0.1144	-0.0979	0.0019	**-0.1936**	-0.1188
X15	0.3649	0.3003	0.3607	0.3438	0.4	0.2566	0.3498	0.381	0.2934	0.3445	0.3863	0.1963	-0.3874	0.368	**0.5995**
Correlation with yield	**0.7159**	**0.8135**	**0.897**	**0.6659**	**0.8123**	**0.7104**	**0.7959**	**0.8058**	**0.2297**	**0.2991**	**0.3883**	**0.4389**	**0.2108**	**0.7861**	**0.5947**

Residual effect = 0.158   Diagonal (bold) values indicate direct effects;

X1- Plant height (cm)   X2- Plant spread (cm)   X3- No. of leaves   X4- No. of primary branches

X5- No. of secondary branches   X6- Leaf area (cm^2)   X7- Leaf area index   X8- Dry matter production (g)

X9- Days to flower bud initiation   X10- Days to flowering   X11-Days for 50 per cent flowering   X12- Duration of flowering

X13- Number of flowers per plant   X14- Flower diameter (cm)   X15-Test weight (10 flower weight in g)   X16-Yield per plant (g)

Fig.1 Genotypic path coefficients showing direct and indirect effects of different traits on yield per plant in China aster
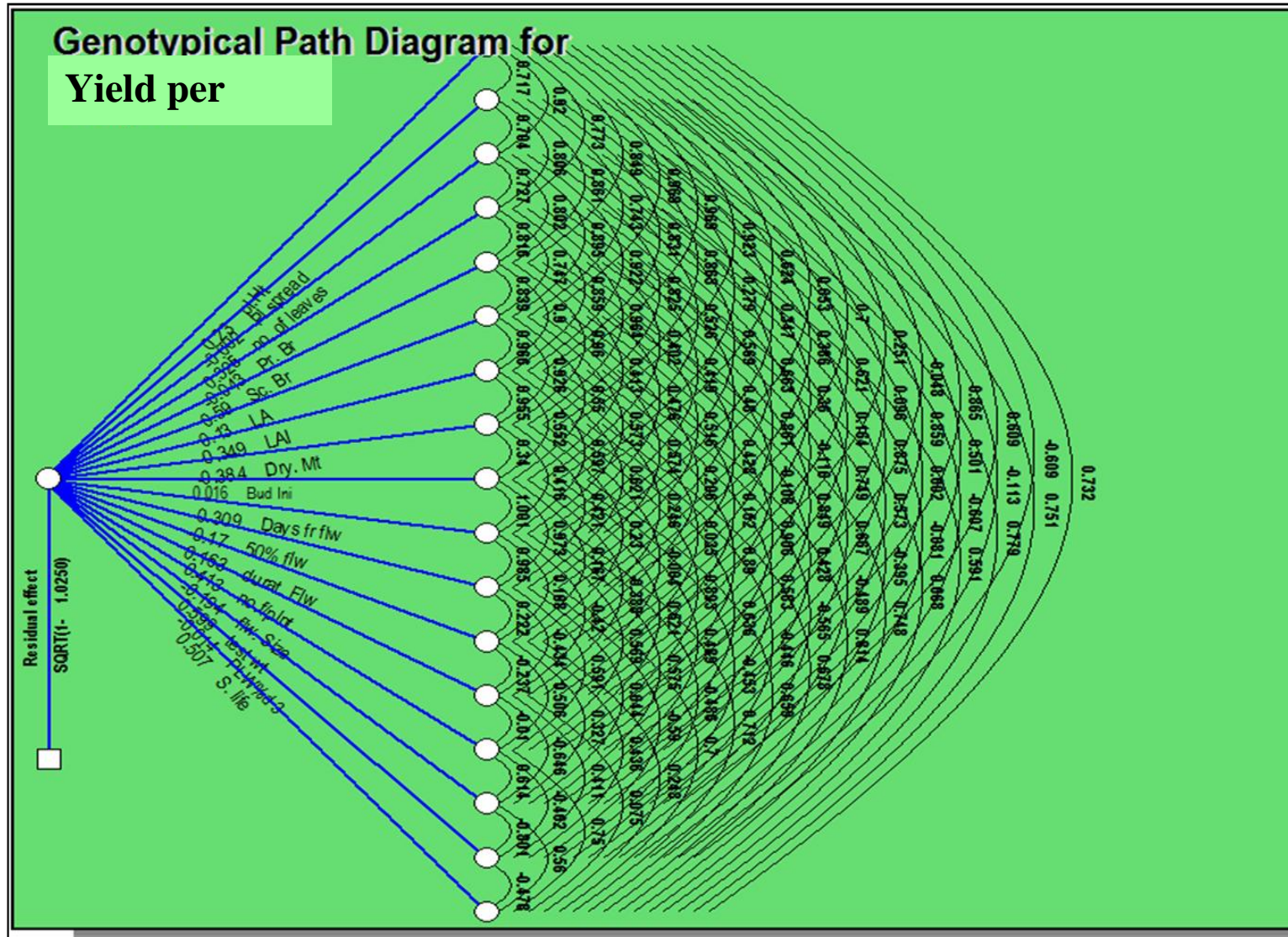
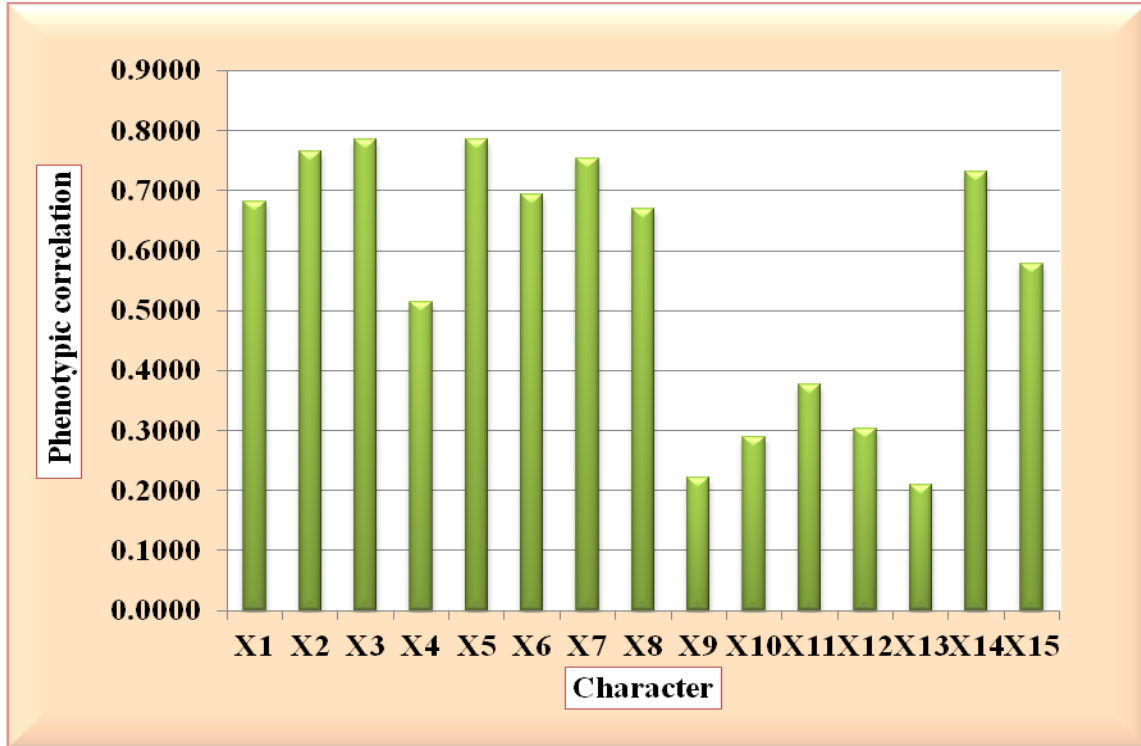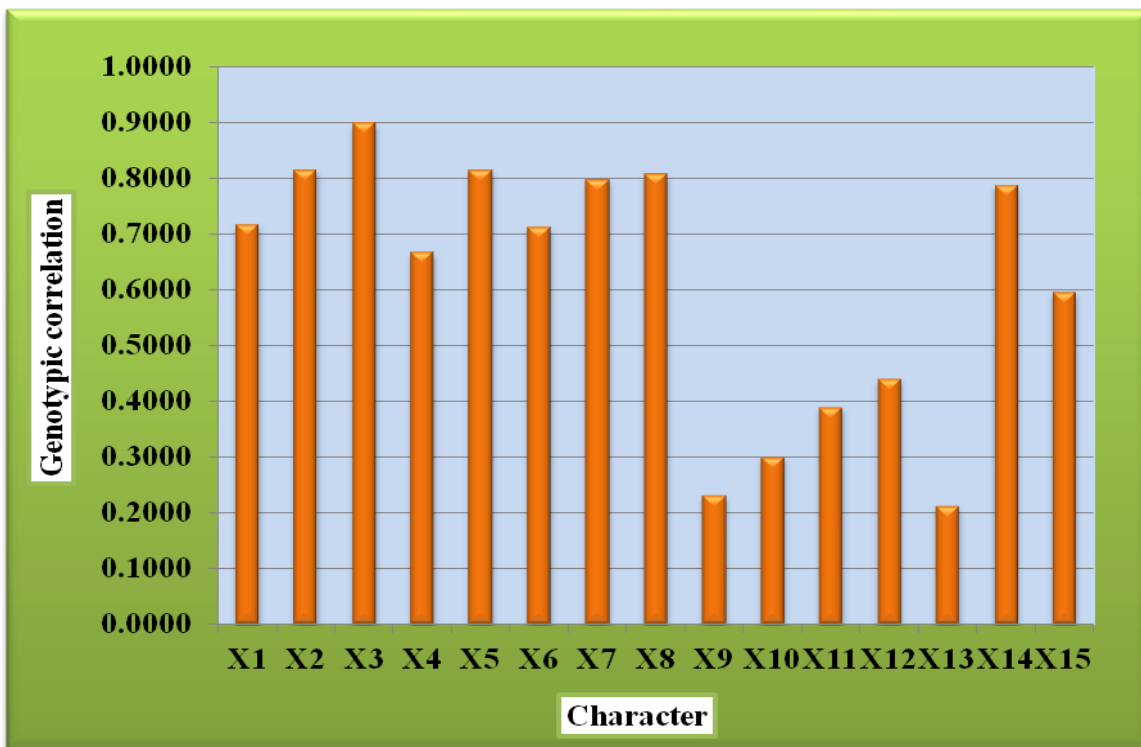**Fig.2** Phenotypic co-efficient of correlation among traits in China aster

Fig.3 Genotypic co-efficient of correlation among traits in China aster

Significantly positive correlation of days to 50 percent flowering (0.3883) with test weight (0.6444) and flower size (0.5912). Flower size (0.7861) recorded significantly positive correlation with test weight (0.6138). The result was in conformity with Baweja (2000), Singh and Sen (2000), Sirohi and Behera (2000), Kumar *et al.,* (2003) and Shantappa *et al.,* (2015).

Path analysis

Knowledge of degree of association of yield with its components is of great importance, because yield is not an independent character, but it is the resultant of the interactions of a number of component characters among themselves as well as with the environment in which the plant grows. Further each character is likely to be modified by action of genes present in the genotypes of plant and also by the environment and it becomes difficult to evaluate this complex character directly. Therefore, correlation study of yield with its component traits has been executed to find out the yield contributing traits.

Among all the characters studied test weight (0.5995) had highest positive direct effect on flower yield per plant followed by number of secondary branches (0.5898), number of flowers per plant (0.4134), number of leaves (0.3248), plant height (0.2302), duration of flowering (0.1634), leaf area (0.1298) and days to flower bud initiation (0.0159), whereas negative direct effect was executed by dry matter (-0.384) followed by leaf area index (-0.3488), days to flowering (-0.3089), flower size (-0.1936), days to 50 per cent flowering (-0.1703), number of primary branches (-0.0431) and plant spread (-0.0016) at genotypic level. Residual effect was found to be (0.158).

The maximum positive indirect effect of secondary branches (0.5663) *via* dry matter, test weight (0.3863) *via* 50 per cent flowering, number of leaves (0.2993) *via* leaf area index, plant height (0.2230) *via* leaf area index, duration of flowering (0.1407) *via* primary branches, days to flowering (0.1297) *via* number of leaves per plant, leaf area (0.1256) *via* plant height, 50 per cent flowering (0.0739) *via* number of flowers per plant, number of flowers per plant (0.678) *via* number of branches, flower bud initiation (0.0088) *via* leaf area and leaf area index, primary branches (0.005) *via* number of flowers per plant, flower size (0.0019) via number of flowers per plant, dry matter (0.0014) *via* number of flowers per plant were recorded on flower yield per plant at genotypic level. Similar results are reported by Kumar *et al.,* (2012) and Manjula and Nataraj (2016).

From the present investigation it can be concluded that among the twelve genotypes, Phule Ganesh White had recorded maximum flower yield per plant and it was positively and significantly correlated with test weight, plant spread, number of secondary branches and leaf area at genotypic level. Test weight (0.5995) had highest positive direct effect on flower yield per plant followed by number of secondary branches (0.5898). Maximum indirect negative effect of test weight estimate via number of flowers per plant.

Acknowledgement

References

Baweja, H. S., 2000. Correlation studies in China aster (*Callistephus chinensis* Nees.). *Indian J. Hill Farm,* 13 (1/2): 93-94.

Desai, B. L., 1967. Flower description in

China aster (*Callistephus chinensis*). *In:* Seasonal flowers. ICAR Publication, New Delhi, pp. 53-56.

Dewey, J. R. and Lu, K. H., 1959. Correlation and path analysis of components of crested wheat grass seed production. *Agron. J.,* 51: 515-518.

Kumar, M. and Chattopadhyay, T. K., 2002. Evaluation of chrysanthemum cultivars for commercial cultivation. *Environ. Eco*, 20 (1): 49-51.

Kumar, M., Kumar, S., Singh, M. K., Malik, S. and Kumar, A., 2012. Studies on correlation and path analysis in chrysanthemum (*Dendranthema grandiflora* Tzvelev.). *International J. Pl. Res*., 25 (2): 62-65.

Manjula, B. S. and Nataraj, S. K., 2016. Genetic correlation and path coefficient analysis in dahlia (*Dahlia variabilis* L.) genotypes under hill zone of Karnataka. *The Bioscan,* 11 (2):1089-1092.

Panse, U. G. and Sukhatme, B. V., 1967. Statistical methods for agricultural workers, ICAR Publication, New Delhi, pp. 100-161.

Shantappa, T., Katagi, Abhishek, Jagadeesha, R. C. and Halesh, G. K., 2015. Studies on genotypic evaluation and correlation studies in China aster [*Callistephus chinensis* (L.) Nees]. *Indian Res. J. Genet. Biotech,* 7 (2): 179 – 186.

Singh, D. and Sen, N. L., 2000. Genetic variability, heritability and genetic advance in marigold. *J. Orn. Hort.,* (New series), 36 (2): 75-78.

Sirohi, P. S. and Behera, T. K., 2000. Genetic variability in chrysanthemum. *J. Orn. Hort.,* (New Series), 3 (1): 34-36.

Zosiamliana, J. H., Reddy, G. S. N. and Rymbai, H., 2012. Growth, flowering and yield characters of some cultivars of China aster (*Callistephus chinensis* Nees.). *J. Nat. Prod. Plant Resources*, 2 (2): 302-305.