Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(2): 3890-3893
Received: 23-01-2018
Accepted: 25-02-2018

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Correlation and path analysis studies in chrysanthemum (*Dendranthema grandiflora* TZVELEV)

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Abstract
Correlation and path analysis were carried out in 20 genotypes of chrysanthemum for different yield attributing traits. The results indicated that the primary branches per plant, plant height after full bloom and days to flower bud initiation showed positive significant correlation with number of flowers per plant at both genotypic and phenotypic level. The path coefficient analysis at genotypic level revealed that primary branches per plant, plant height after full bloom and days to flower bud initiation had highest direct positive effect on number of flowers per plant. At phenotypic level primary branches per plant, plant height after full bloom and days to flower bud initiation showed highest direct positive effect on number of flowers per plant. Highest direct negative effect was observed via days to flowering and flowering duration at phenotypic level whereas at genotypic level it was observed via days to flowering followed by plant height at flower bud initiation stage. Hence direct selection for number of primary branches per plant, plant height after full bloom and days to flower bud initiation is suggested for getting yield improvement.

Keywords: Correlation, path analysis studies

Introduction
Chrysanthemum is commonly known as Gul-e-Daudi or Autumn Queen. It belongs to the family Compositae (Asteraceae). It has about 275 different varieties grown in the different parts of the world for the beautification and decoration purposes. So many works have been done on the evaluation of best chrysanthemum cultivars in India and still there are a lot of researches going on to select the best cultivars suitable for particular soil and climatic conditions. The wide range of groups and varieties of this flower made the workers research more complex. Its flower yield is a complex character and is the result of interrelationship of various components. Therefore, information on direct and indirect effect of these components is of great importance. Study of such yield components may provide a solid ground for a successful varietal development programme. Correlation and path coefficient analysis furnishes information regarding the nature and magnitude of various associations and help in the measurement of direct influence of one variable on others. The correlation coefficient indicates the degree of relationship between characters. It is important to know the direct and indirect influences of yield component for selecting suitable genotypes for improving the yield. Therefore, present investigations were carried out to generate such information for *Chrysanthemum.*

Materials and Methods
The experiment was conducted at Horticulture Research Centre, SVPUA&T, Meerut U.P. during 2016-2017 with 20 genotypes of *Chrysanthemum* in randomized block design (RBD) with three replications. Cuttings were planted at 45 cm spacing between ridges and plants. All recommended practices were followed under irrigated condition. The observations were recorded on five randomly selected plants per genotype of each replicate for nine characters like days to flower bud initiation, day to flowering, flower size, flowering duration, plant height at flower bud initiation stage, plant height after full bloom, number of primary branches per plant, plant spread and number of flowers per plant. Correlation coefficient and path analysis were computed by the formula suggested by Al-Jibauri *et al.* (1958)[1], Miller *et al.* (1958)[8] and Dewey and Lu (1959)[4].

Results and Discussion

The correlation coefficients (genotypic and phenotypic) between different characters in *Chrysanthemum* are presented in Table 1 and 2 respectively. In majority of the characters, genotypic correlation coefficient was found to be higher in magnitude than phenotypic correlation coefficient, indicating a strong inherent association among various characters but their phenotypic expression was impeded by the influence of environmental factors. Tables (1 and 2) reveals that number of flowers per plant show highly positive significant correlation with number of primary branches per plant (0.575). Days to flower bud initiation showed positive correlation with days to flowering (0.894) whereas it had negative correlation with Flowering duration (-0.206). Significant and positive correlations were recorded between Flower size with Flowering duration (0.400), Plant height at flower bud initiation stage (0.566), and plant height after full bloom (0.499). Flowering duration had positive and significant association with plant height at flower bud initiation stage (0.414), plant height at full bloom (0.391) and number of primary branches per plant (0.419). Highest correlation was estimated between plant height at flower bud initiation stage and plant height after full bloom (0.927). Number of primary branches per plant also exhibited higher correlation with plant spread (0.443). Present results are in partial agreements with Raghava *et al.* (1992), Kumar and Patil (2003)[7] and Poornima *et al.* (2007)[9].

With the inclusion of more variables in correlation studies, the indirect association becomes more complex. Two characters may show correlation just because they are correlated with the third one. In such circumstances, path coefficient analysis provides an effective mean of finding out direct and indirect effects of association and permits a critical examination of specific forces acting to produce a given correlation and measure the relative importance of each factor. In the present study number of flowers per plant has been taken as dependent variable, whereas, remaining 8 characters were considered as independent variables contributing towards number of flowers per plant.

The data presented in Table 3 and 4 reveals that number of primary branches per plant, plant height after full bloom and days to flower bud initiation had highest direct effects on number of flowers per plant at genotypic and phenotypic level.

At the genotypic level, number of primary branches per plant (0.823), plant height after full bloom (0.509), Days to flower bud initiation (0.358) exhibited maximum direct positive effect on number of flowers per plant but this direct effect was nullified by their indirect effect on number of flowers per plant through each other. Number of primary branches per plant and plant height after full bloom exhibited highest direct positive effect on number of flowers per plant at genotypic level and also the correlation was positive. Plant height at flower bud initiation stage had negative direct effect on number of flowers per plant and negative correlation with number of flowers per plant. Flowering duration exhibited negative direct effect on number of flowers per plant and correlation was also negative at genotypic level. The present findings are in close conformity with earlier findings by Choudhary (1989)[2], Desh Raj *et al.* (1997)[3], Katwate *et al.* (2002)[5] and Krizmanic *et al.* (2006)[6]. From the present study it may be suggested that yield in term of number of flowers per plant could be increased through selection of genotypes on the basis of number of primary branches, plant height after full bloom and days to flower bud initiation in chrysanthemum.

Table 1: Genotypic correlation coefficient among different characters in chrysanthemum

Characters	Days to flower bud initiation	Days to flowering	Flower size (cm)	Flowering duration (days)	Plant height at flower bud initiation stage (cm)	Plant height after full bloom (cm)	Number of primary branches per plant	Plant spread (cm)	Number of flowers per plant
Days to flower bud initiation	1.000	0.894**	0.190	-0.206	0.022	-0.026	-0.288*	-0.108	-0.110
Days to flowering			0.123	-0.187	0.086	0.021	-0.140	-0.007	-0.062
Flower size (cm)				0.400**	0.566**	0.499**	0.072	-0.090	-0.125
Flowering duration (days)					0.414**	0.391**	0.419**	-0.019	0.042
Plant height at flower bud initiation stage (cm)						0.927**	0.122	0.083	-0.003
Plant height after full bloom (cm)							0.125	0.107	0.077
Number of primary branches per plant								0.443**	0.575**
Plant spread (cm)									0.198
Number of flowers per plant									1.000

** Significant at 1% level

Table 2: Phenotypic correlation coefficient among different characters in chrysanthemum

Characters	Days to flower bud initiation	Days to flowering	Flower size (cm)	Flowering duration (days)	Plant height at flower bud initiation stage (cm)	Plant height after full bloom (cm)	Number of primary branches per plant	Plant spread (cm)	Number of flowers per plant
Days to flower bud initiation	1.000	0.886**	0.190	-0.200	0.020	-0.026	-0.287*	-0.108	-0.109
Days to flowering			0.122	-0.187	0.088	0.020	-0.137	-0.007	-0.061
Flower size (cm)				0.399**	0.555**	0.497**	0.072	-0.091	-0.125
Flowering duration (days)					0.400**	0.386**	0.416**	-0.021	0.042
Plant height at flower bud initiation stage (cm)						0.908**	0.119	0.084	-0.003
Plant height after full bloom (cm)							0.123	0.106	0.076
Number of primary branches per plant								0.442**	0.573**
Plant spread (cm)									0.198
Number of flowers per plant									1.000

** Significant at 1% level

Table 3: Genotypic path coefficient among different characters in chrysanthemum

Characters	Days to flower bud initiation	Days to flowering	Flower size (cm)	Flowering duration (days)	Plant height at flower bud initiation stage (cm)	Plant height after full bloom (cm)	Number of primary branches per plant	Plant spread (cm)	Number of flowers per plant
Days to flower bud initiation	**0.358**	-0.248	-0.038	0.056	-0.007	-0.013	-0.237	0.019	-0.110
Days to flowering	0.320	**-0.278**	-0.024	0.051	-0.027	0.011	-0.115	0.001	-0.062
Flower size (cm)	0.068	-0.034	**-0.199**	-0.109	-0.181	0.254	0.059	0.016	-0.125
Flowering duration (days)	-0.074	0.052	-0.080	**-0.271**	-0.132	0.199	0.345	0.003	0.042
Plant height at flower bud initiation stage (cm)	0.008	-0.024	-0.113	-0.112	**-0.319**	0.472	0.100	-0.015	-0.003
Plant height after full bloom (cm)	-0.009	-0.006	-0.099	-0.106	-0.296	**0.509**	0.103	-0.019	0.077
Number of primary branches per plant	-0.103	0.039	-0.014	-0.114	-0.039	0.064	**0.823**	-0.080	0.575**
Plant spread (cm)	-0.039	0.002	0.018	0.005	-0.026	0.054	0.365	**-0.181**	0.198

Residual effect = 0.0531
** Significant at 1% level
Bold values indicate direct effect

Table 4: Phenotypic path coefficient among different characters in chrysanthemum

Characters	Days to flower bud initiation	Days to flowering	Flower size (cm)	Flowering duration (days)	Plant height at flower bud initiation stage (cm)	Plant height after full bloom (cm)	Number of primary branches per plant	Plant spread (cm)	Number of flowers per plant
Days to flower bud initiation	**0.348**	-0.240	-0.040	0.054	-0.005	-0.012	-0.234	0.019	-0.109
Days to flowering	0.308	**-0.271**	-0.025	0.051	-0.021	0.009	-0.112	0.001	-0.061
Flower size (cm)	0.066	-0.033	**-0.208**	-0.108	-0.134	0.217	0.059	0.016	-0.125
Flowering duration (days)	-0.069	0.051	-0.083	**-0.271**	-0.096	0.168	0.340	0.004	0.042
Plant height at flower bud initiation stage (cm)	0.007	-0.024	-0.115	-0.109	**-0.241**	0.396	0.098	-0.015	-0.003
Plant height after full bloom (cm)	-0.009	-0.005	-0.103	-0.105	-0.219	**0.436**	0.101	-0.019	0.076
Number of primary branches per plant	-0.100	0.037	-0.015	-0.113	-0.029	0.054	**0.817**	-0.079	0.573**
Plant spread (cm)	-0.038	0.002	0.019	0.006	-0.020	0.046	0.361	**-0.178**	0.198

Residual effect =0.0540
** Significant at 1% level
Bold values indicate direct effect

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