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Genotypic and Phenotypic Path Analysis for Flower Yield in Chrysanthemum (*Dendranthema grandiflora* Tzvelve)

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A B S T R A C T

Ten genotypes of chrysanthemum (*Dendranthema grandiflora* Tzvelve) were assessed for 12 quantitative and qualitative traits to study the path analysis of different parameters with yield components and their direct and indirect effects on flower yield. Genotypic path coefficient analysis revealed that flower yield per plant was directly and positively influenced by number of flowers per plant, individual flower weight, days to flower bud initiation and shelf life of flowers. Whereas, negative direct influence by days taken for fifty per cent flowering, number of primary branches and duration of flowering were noticed. Further, the path coefficient analysis (phenotypic) revealed that flower yield per plant had positive direct effect from number of flowers per plant, individual flower weight, days taken for flower bud initiation, flower diameter and shelf life of flowers; whereas, negative direct effect through days taken for fifty per cent flowering was noticed. Hence, selection for these traits would be effective for flower yield improvement in chrysanthemum.

Introduction

Flowers and flowering plants are fascinating part of our life. Among them, chrysanthemum (chryos - golden; anthos - flower) called as "Queen of the East" is a most interesting and popular flower crop of commercial importance. It ranks third in the International cut flower trade next to rose and carnation in demand and popularity. Chrysanthemum is native to China, belonging to the family Asteraceae which is the most phylogenetically advanced dicotyledonous family. The inflorescence is called as capitulum or head consisting of large number of tiny florets closely mounted on a flattened stem end, which gives a false appearance of single bloom. Garden chrysanthemum which was previously known as *Chrysanthemum morifolium* (Ramat) and now it is called as *Dendranthema grandiflora* (Tzvelev) Kumbar *et al.,* (2017) In India chrysanthemum commercially cultivated in states like Tamil Nadu, Karnataka, Maharashtra, Rajasthan,

Madhya Pradesh and Bihar. Its cultivation is popular around the cities like Delhi, Kolkata, Lucknow, Kanpur, Chennai, Allahabad and Bengaluru. It is grown in an area of 5,453 ha with production of 59,543 Mt and productivity of 10.92 t/ha in Karnataka for loose flower purpose (Anon., 2016). Still, there is a need to increase chrysanthemum cultivation which is limiting due to lack of high yielding varieties with attractive flowers. A study was conducted to study the path analysis of different parameters with yield components and their direct and indirect effects on flower yield.

Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection can be based for genetic improvement in yield. Yield being a complex character, is collectively influenced by various characters which are polygenically inherited and highly subjected to environment variations. Hence, for an effective and efficient selection of genotypes for yield, the knowledge of direction and magnitude of association between yield and its components and among the components themselves is very much essential. The phenotypic correlations indicate the extent of the observed relationship between two characters. This does not give true genetic picture of the relationship because it includes both heritable and non-heritable association. Genotypic correlations provide an estimate of inherent association between genes controlling any two characters.

Improving genetic correlation was mainly due to pleiotrophy and linkage (Jain, 1982). To split the observed correlations in to direct and indirect effect, the concept of path coefficient analysis was originally developed by Wright (1921), which splits the correlation coefficient into the measures of direct and indirect effect so that relative influence of each component character on yield could be assessed. That in

turn helps to select the lines for further crop improvement.

Materials and Methods

The experiment was conducted to study the correlation of the different morphological characters influencing the flower yield in different genotypes of chrysanthemum (*Dendranthema grandiflora* Tzvelve). The experimental material comprised of ten chrysanthemum genotypes such as Marigold, Dall White, Karnool, Dall Yellow, Poornima Yellow, Poornima Pink, Calcutta Shantini, Poornima Red, Poornima White and Dundi were evaluated in Complete Randomized Design with three replications during *kharif* 2017-18 at K. R. C. College of Horticulture, Arabhavi. The plants were planted at a spacing of 60 X 45 cm and all the recommended cultural practices were followed. Five competitive plants were tagged at random in each treatment in each replication for recording detailed observation and the data were recorded for all the 12 quantitative and qualitative characters *viz.,* plant height, number of primary and secondary branches, number of leaves at 90 days after planting, leaf area (cm^2), days taken for flower bud initiation, days for 50 per cent flowering, duration of flowering (days), number of flowers per plant, individual flower weight (g), diameter of flower (cm), shelf life (h) and flower yield per plant (g/plant) were recorded. Mean values were subjected to analysis of variance, genotypic and phenotypic path analysis was carried out separately to know the direct and indirect effects of the important components, which are the standardized partial regression. Coefficients were obtained by solving the following set of 'p' simultaneous equations through the use of 'Doo-little techniques' as given by Goulden (1959). The direct and indirect effects were classified based on the scale given by Lenka and Mishra (1973).

More than 1.0 - Very high
0.30 to 0.99 - High
0.20 to 0.29 - Moderate
0.10 to 0.19 - Low
0.00 to 0.09 - Very low

Results and Discussion

The genotypic and phenotypic path analysis studies were carried out for the 12 characters to know the nature of relationship existing between flower yield per plant (g/plant) and its other component characters (Table 1).

Path coefficient analysis

The correlation coefficients only indicate the relationship between independent variable and the dependent variable without specifying cause and effect of relationship.

Using Path coefficient analysis, it is possible to resolve the correlations, which will provide an indirect contribution of different quantitative traits. The analysis was done for flower yield per plant, which is dependent variable. Genotypic and phenotypic paths for the dependent variable were computed.

Genotypic path coefficient analysis for flower yield per plant

The path analysis of flower yield per plant was done with twelve independent characters involving growth, flowering, yield and quality parameters. The matrix of direct and indirect effects presented in the Table 1.

Genotypic path coefficient analysis

Number of flowers showed highly significant and positive association for flower yield per plant (0.615). This is mainly because of its direct positive effect (0.803) and indirect positive effect through days taken for flower bud initiation (0.434) and indirect negative effect through individual flower weight (-0.419).

Days taken to flower bud initiation showed highly significant and positive association for flower yield per plant (0.563). This is mainly because of its high direct positive effect (0.657) and indirect positive effect through number of flowers (0.531) and indirect negative effect through days to fifty per cent flowering (-0.466) and individual flower weight (-0.143).

Shelf life of flowers had significant and positive association for flower yield per plant (0.365). This is mainly because of its high direct positive effect (0.381) and indirect positive effect through individual flower weight (0.366) and indirect negative effect through days taken for fifty per cent flowering (-0.223) and number of flowers (-0.170).

Duration of flowering had highly significant and negative association for flower yield per plant (-0.652).

This is mainly because of its direct negative effect (-0.125) and indirect positive effect through days to 50 per cent flowering (0.109) and indirect negative effect through individual flower weight (-0.364) and shelf life (-0.213).

Flower yield per plant as dependent variable

Flower yield per plant was directly and positively influenced by number of flowers per plant (0.803), individual flower weight (0.713), days to flower bud initiation (0.657) and shelf life of flowers (0.381).

Whereas, negative direct effects by days taken for fifty per cent flowering (-0.544), number of primary branches (-0.167) and duration of flowering (-0.125) were noticed.

The path coefficient analysis for flower yield per plant was carried out considering twelve component and complementary characters.

Table.1 Genotypic and phenotypic path coefficient analysis of different quantitative and qualitative characters in chrysanthemum genotypes

		X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	rG	rP
X1	G	**-0.034**	-0.050	0.179	-0.016	-0.013	0.165	-0.070	-0.036	0.542	-0.416	-0.019	0.049	0.282	0.205
	P	**-0.013**	0.006	0.007	0.007	-0.034	0.075	-0.028	0.000	0.625	-0.398	-0.060	0.018		
X2	G	-0.010	**-0.167**	0.066	0.004	-0.007	-0.142	0.045	0.037	-0.233	0.038	0.033	0.233	-0.104	-0.133
	P	-0.003	**0.027**	0.004	-0.002	-0.018	-0.062	0.013	0.000	-0.289	0.029	0.090	0.079		
X3	G	-0.027	-0.050	**0.222**	-0.007	-0.008	-0.164	0.224	-0.053	0.302	-0.653	0.002	-0.131	-0.342	-0.153
	P	-0.007	0.009	**0.012**	0.003	-0.021	-0.075	0.081	0.000	0.338	-0.461	0.019	-0.050		
X4	G	-0.021	0.026	0.064	**-0.026**	0.004	0.560	-0.362	-0.032	0.633	-0.452	-0.066	-0.035	0.294	0.260
	P	-0.007	-0.005	0.002	**0.013**	0.013	0.296	-0.172	0.000	0.816	-0.462	-0.222	-0.014		
X5	G	-0.022	-0.053	0.086	0.006	**-0.020**	-0.236	0.209	0.012	0.111	0.077	0.038	0.145	0.352	0.332
	P	-0.007	0.008	0.004	-0.003	**-0.064**	-0.125	0.098	0.000	0.147	0.085	0.129	0.060		
X6	G	-0.008	0.036	-0.056	-0.022	0.007	**0.657**	-0.466	0.025	0.531	-0.143	-0.062	0.063	0.563**	0.520**
	P	-0.003	-0.005	-0.003	0.011	0.022	**0.357**	-0.227	0.000	0.712	-0.157	-0.216	0.029		
X7	G	-0.004	0.014	-0.092	-0.017	0.008	0.563	**-0.544**	0.025	0.245	-0.024	-0.049	0.156	0.281	0.273
	P	-0.001	-0.001	-0.004	0.008	0.023	0.302	**-0.268**	0.000	0.333	-0.020	-0.169	0.069		
X8	G	-0.010	0.049	0.095	-0.007	0.002	-0.134	0.109	**-0.125**	-0.031	-0.364	-0.021	-0.216	-0.652**	-0.573**
	P	-0.003	-0.005	0.004	0.003	0.006	-0.070	0.046	**-0.001**	-0.034	-0.350	-0.074	-0.096		
X9	G	-0.023	0.049	0.084	-0.020	-0.003	0.434	-0.166	0.005	**0.803**	-0.419	-0.048	-0.081	0.615**	0.620**
	P	-0.007	-0.007	0.004	0.010	-0.008	0.230	-0.081	0.000	**1.103**	-0.426	-0.163	-0.035		
X10	G	0.020	-0.009	-0.204	0.016	-0.002	-0.132	0.018	0.064	-0.472	**0.713**	0.035	0.195	0.242	0.271
	P	0.007	0.001	-0.007	-0.008	-0.007	-0.074	0.007	0.000	-0.615	**0.763**	0.121	0.083		
X11	G	0.009	-0.075	0.007	0.023	-0.011	-0.552	0.363	0.036	-0.519	0.335	**0.073**	0.107	-0.203	-0.175
	P	0.003	0.009	0.001	-0.011	-0.031	-0.294	0.173	0.000	-0.688	0.353	**0.261**	0.048		
X12	G	-0.004	-0.102	-0.076	0.002	-0.008	0.109	-0.223	0.071	-0.170	0.366	0.021	**0.381**	0.365*	0.326
	P	-0.001	0.012	-0.004	-0.001	-0.022	0.059	-0.105	0.000	-0.221	0.361	0.072	**0.176**		

Residual Effect = 0.077; * and ** indicate significant at 5 and 1 per cent probability level, respectively. rG= Genotypic correlation coefficient of flower yield per plant

rP= Phenotypic correlation coefficient of flower yield per plant; Bold: Direct effect; Above and below diagonal: Indirect effect

X1: Plant height (90 DAP) (cm)	**X2: Number of primary branches (90 DAP)**	**X3: Number of secondary branches (90 DAP)**	**X4: Number of leaves (90 DAP)**
X5: Leaf area (cm^2)	X6: Days to flower bud initiation	X7 : Days to fifty per cent flowering	X8: Duration of flowering (days)
X9: Number of flowers per plant	X10: Individual flower weight (g)	X11: Flower diameter (cm)	X12: Shelf life (h)
G: Genotypic path coefficient value	G: Phenotypic path coefficient value		

The residual effect of the genotypic path analysis was low (0.077) indicating that, the characters considered for the path analysis were appropriate for the study and flower yield per plant was taken as a dependent variable. Flower yield per plant had positive direct effect from number of flowers per plant, individual flower weight, flower diameter, number of leaves, plant height and plant spread. Results are in line with Shiragur (2009) and Sahu and Sharma (2014) in chrysanthemum; Rai *et al.,* (2017) and Kumari *et al.,* (2017) in China aster.

Phenotypic path

The phenotypic path analysis of flower yield per plant was done with twelve independent characters involving growth, flowering, yield and quality parameters. The matrix of direct and indirect effects is presented in the Table 1.

Number of flowers per plant showed highly significant and positive effect (0.620) on flower yield per plant. This is mainly because of its very high direct positive effect (1.103) and indirect positive effect through days taken for flower bud initiation (0.230) and indirect negative effect through individual flower weight (-0.163).

Days taken for flower bud initiation showed highly significant and positive effect (0.520) on flower yield per plant. This is mainly because of direct positive effect (0.357) and indirect positive effect through number of flowers (0.712) and indirect negative effect through flower diameter (-0.216) and individual flower weight (-0.157).

Duration of flowering showed highly significant and negative effect (-0.573) on flower yield per plant. This is mainly because of its negligible direct negative effect (-0.001) and indirect negative effect through individual

flower weight (-0.350) and shelf life of flowers (-0.096).

Flower yield per plant as dependent variable

Flower yield per plant had positive direct effect from number of flowers per plant (1.103), individual flower weight (0.763), days taken for flower bud initiation (0.357), flower diameter (0.261) and shelf life of flowers (0.176). Whereas, negative direct effect through days taken for fifty per cent flowering (-0.268) was noticed.

The path coefficient analysis for flower yield per plant was carried out considering twelve component and complementary characters. The residual effect of the phenotypic path analysis was low (0.105) indicating that, the characters considered for the path analysis were appropriate for the study and flower yield per plant is taken as a dependent variable.

Flower yield per plant was directly and positively influenced by number of flowers per plant, individual flower weight, shelf life and days to flower bud initiation. Similar result was reported for number of branches, number of leaves, leaf area and flower diameter by Sirohi and Behera (1999); Karuppaiah *et al.,* (2004) and Misra *et al.,* (2013) in chrysanthemum, Anuradha and Narayanagowda (2000); Magar *et al.,* (2010) in gerbera; Karuppaiah and Kumar (2010) in marigold. Therefore, direct selection for these traits would reward for improvement of yield. Whereas, negative direct effects through days taken for fifty per cent flowering, number of primary branches and flower duration. Similar results found by Kore (2014) and Kumari *et al.,* (2017) in China aster.

Genotypic path coefficient analysis revealed that flower yield per plant was directly and

positively influenced by number of flowers per plant, individual flower weight, days to flower bud initiation and shelf life of flowers. Whereas, negative direct influence by days taken for fifty per cent flowering, number of primary branches and duration of flowering were noticed. Further, the path coefficient analysis (phenotypic) revealed that flower yield per plant had positive direct effect from number of flowers per plant, individual flower weight, days taken for flower bud initiation, flower diameter and shelf life of flowers; whereas, negative direct effect through days taken for fifty per cent flowering was noticed. Hence, selection for these traits would be effective for flower yield improvement in chrysanthemum.

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