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Statistical Analysis on Growth and Quality on Chrysanthemum (*Chrysanthemum morifolium* Ramat.) under Ecological Condition of Sub-Humid Zone of Rajasthan

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A B S T R A C T

A field experiment was conducted during kharif season of 2016-17 (July to February) on the title "Statistical analysis on Growth and Quality on Chrysanthemum (*Chrysanthemum morifolium* Ramat.) under Ecological Condition of Sub-Humid Zone of Rajasthan at the Instructional Farm, Department of Floriculture & Landscaping, College of Horticulture & Forestry, Jhalarapatan, Jhalawar. The experiment consisted of 15 varieties 'BC-1-123', 'Shova', 'Accession No-24', 'Pink Cloud', 'Lalima', 'Bravo', 'Jaya', Ravikiran', 'Jafri', 'Shyamal', 'PusaChitraksha', 'White Star', 'PusaKesari', 'Thai Chung Queen' 'PusaArunodaya'. Correlation studies showed that between varieties with Stalk length is significantly and positively correlated with plant height, plant spread, number of leaves per plant, fresh flower weight, flower diameter, stalk diameter and vase life. Flower diameter is significantly positively correlated with stalk length, fresh flower weight, flower yield per plant, flower yield per plot and stalk diameter indicating improvement of these traits will directly influence the yield of flowers.

Introduction

The chrysanthemum flowers are used as both cut flower and loose flower. The major use of chrysanthemum in our country is for making garlands, Veni, bracelets, flower decoration and in religious offerings. The dwarf and compact growing plants are used in flowerbed, mixed borders, edging, pot plants, hanging baskets and window boxes. The number of varieties in the world is reported to be above 2000, in India there are about 1000 varieties are in existence which include exotic as well as indigenously developed in our country (Datta and Bhattacharjee, 2001). The area under flower cultivation in India during 2015-16 was 249 thousand ha with production of 1686 MT of loose flowers and 473 MT cut flowers. Area wise leading flower growing states in India are Andhra Pradesh (35,000 ha), Karnataka (30,000 ha) and Tamil Nadu (29,000 ha). Leading cut flower producing states are West Bengal (27 %), Karnataka (13%) and Orissa (11%) and leading loose flower producing states are Tamil Nadu (19%) and Karnataka (12%). Rajasthan contributed only 2.5 thousand ha area under flower cultivation with production of 2.7 thousand

MT of loose flowers (Anonymous, 2015). Chrysanthemum (*Chrysanthemum morifolium* Ramat.) is occupied an important position among flower crops in the world. The genus belonging to the family Asteraceae includes over 200 species of annuals, perennials, and sub shrubs. The basic chromosome number is n=9 and wide range of ploidy level is found in different cultivars of the species. The chrysanthemum has earned tremendous popularity as an ornamental flower for the garden, as cut flower for interior decoration and for the green house cultivation. Chrysanthemum derived from two Greek words (Chryos-golden, Anthos-flower) which means golden flower. It is also known as "Queen of East", "Autumn Queen", in English language and "Guldaudi" in Hindi language. It is National flower of Japan and originated in China. The development of day neutral cultivars revolutionised the year around availability. In International cut flower trade, it ranks next to rose (Bhattacharjee and De, 2003). Correlation coefficient studies are useful in selecting superior cultivars from their phenotypic and genotypic expression and its analysis furnishes information regarding the nature and magnitude of various associations.

The correlation coefficient indicates the degree of relationship between the characters. To encourage demand for cut flower in the fast growing cities of plain sub-humid region, introduction and popularization is also needed. Any attempt made to encourage cut flower production in the region is not only even help the florists and consumers to get fresh and quality cut flowers regularly but also helps the small and marginal farmers to improve their economic condition. Though many genotypes of standard chrysanthemum can be grown in particular agro-climatic region all are not suited for cut flower purpose or for garden display or for exhibition purposes. So, there is a need for evaluation of hybrids for particular agro-climatic region.

Materials and Methods

The present investigation was carried out during July, 2016 to February, 2017 at the Instructional Farm, Department of Floriculture and Landscaping, College of Horticulture and Forestry, Jhalarapatan city, Jhalawar (Agriculture University, Kota) in order to study the most suitable varieties of standard chrysanthemum for vegetative flowering quality and flower yield characters.

The experimental site was geographically located at 2304' to 24052' N-Latitude and 75029' to 76056' E-Longitude in the South-Eastern Rajasthan. Agro-climatically, the district falls in Zone –V known as Humid South- Eastern Plain of Rajasthan. The experiment was carried out to evaluate the performance of fifteen varieties *viz*., 'BC-1-123, 'Shova, 'Accession No-24, 'Pink Cloud, 'Lalima, 'Jaya, 'Bravo, 'Ravikiran, 'Jafri, 'Shyamal, 'White Star, 'Thai Chen Queen, 'PusaKesari, 'PusaArunodaya, 'PusaChitraksha'. The rooted cuttings were dipped with Bavistin @ 0.2% before planting then planted at a spacing of 40 cm X 40 cm. Recommended package of practices was employed to obtain satisfactory plant growth.

Adequate measures were taken to prevent lodging by staking the plants and disbudding and dishooting also carried out. Data on plant height (cm), number of leaves (number), flower diameter (cm), stalk diameter (cm), vase life (days), *in-situ* life (days), stalk length (cm), flower yield per plant (kg) and Flower yield per plot (kg). The data was analyzed at 5% level of significance statistically. The vase life and *in-situ* life of flowers were measured up to the colour fading of the flowers.

Statistical analysis

Simple correlation between characters like plant height, number of leaves, flower

diameter, stalk diameter, vase life, stalk length, flower yield per plant and flower yield per plot, flower diameter, stalk girth, stalk length, number of ray florets, duration of flowering, vase life in distilled water and in-situ life were worked out. Correlation coefficients were tested by referring to correlation values (Fisher and Yates, 1963).

Results and Discussion

The data of the correlation values of 19 characters were presented in the Table 1. It presents the both genotypic correlation coefficient and phenotypic correlation coefficient.

Plant height (cm)

The data of correlation matrix of different parameters was given in the Table 1.

It indicated that plant height was significantly positively correlated with both phenotypic and genotypic correlation for plant spread (r_g: 0.64, r_p: 0.57), number of leaves per plant (r_g: 0.81, r_p: 0.73), stem thickness (r_g: 0.62, r_p: 0.53), fresh flower weight (r_g: 0.69, r_p: 0.66), flower yield per plant and flower yield per plot (r_g: 0.79, r_p: 0.74) and stalk length (r_g: 0.86, r_p: 0.80).

It also presented that plant height was non-significantly positively correlated with leaf area (r_g: 0.16, r_p: 0.15), days to flower bud appearance (r_g: 0.14, r_p: 0.10), days to full bloom (r_g: 0.26, r_p: 0.18), number of cut flowers per plant (r_g: 0.36, r_p: 0.34), number of cut flowers per plot (r_g: 0.36, r_p: 0.34), flower diameter (r_g: 0.49, r_p: 0.46), stalk diameter (r_g: 0.36, r_p: 0.34), number of ray florets (r_g: 0.42, r_p: 0.40), vase life (r_g: 0.32, r_p: 0.23) and *in-situ* life (r_g: 0.23, r_p: 0.14) whereas plant height was non-significantly negatively correlated with duration of flowering (r_g: -0.02, r_p: -0.05).

Plant spread (cm)

The plant spread was positively significantly correlated with number of leaves per plant (r_g: 0.67, r_p: 0.58), stem thickness (r_g: 0.71, r_p: 0.61), number of flowers per plant (r_g: 0.74, r_p: 0.65), numbers of flowers per plot (r_g: 0.74, r_p: 0.65), fresh flower weight (r_g: 0.54, r_p: 0.49), flower yield per plant (r_g: 0.77, r_p: 0.67), flower yield per plot (r_g: 0.77, r_p: 0.67), stalk length (r_g: 0.70, r_p: 0.64), stalk diameter (r_g: 0.53, r_p: 0.48), vase life (r_g: 0.69, r_p: 0.62), *in-situ* life (r_g: 0.62, r_p: 0.51) and duration of flowering (r_g: 0.58, r_p: 0.49).

The data also illustrated that plant spread is non-significantly negatively correlated with leaf area (r_g: -0.29, r_p: -0.24) whereas non-significantly positively correlated with days to flower bud appearance (r_g: 0.06, r_p: 0.07), days to full bloom (r_g: 0.25, r_p: 0.21), flower diameter (r_g: 0.39, r_p: 0.37) and numbers of rays florets (r_g: 0.33, r_p: 0.30).

Numbers of leaves per plant

The data is illustrated in the Table 1 presented that numbers of leaves per plant is significantly positively correlated with the stem thickness (r_g: 0.54, r_p: 0.48), number of cut flowers per plant (r_g: 0.57, r_p: 0.54), number of cut flowers per plot (r_g: 0.57, r_p: 0.54), flower yield per plant (r_g: 0.68, r_p: 0.64) flower yield per plot (r_g: 0.68, r_p: 0.64) and stalk length (r_g: 0.76, r_p: 0.73).

It also revealed that numbers of leaves per plant was non-significantly positively correlated with days to full bloom (r_g: 0.01, r_p: 0.03), fresh flower weight (r_g: 0.51, r_p: 0.49), flower diameter (r_g: 0.41, r_p: 0.39), stalk diameter (r_g: 0.33, r_p: 0.32), number of ray florets (r_g: 0.17, r_p: 0.16), vase life (r_g: 0.31, r_p: 0.27), *in-situ* life (r_g: 0.25, r_p: 0.25) and duration of flowering (r_g: 0.12, r_p: 0.11) whereas it is non-significantly negatively

correlated with the leaf area (r_g: -0.05, r_p: -0.06) and days to flower bud appearance (r_g: -0.07, r_p: -0.05).

Stem thickness (cm)

The stem thickness is positively correlated with the leaf area (r_g: 0.15, r_p: 0.17), fresh flower weight (r_g: 0.38, r_p: 0.34), flower yield per plant (r_g: 0.44, r_p: 0.39), flower yield per plot (r_g: 0.44, r_p: 0.39), flower diameter (r_g: 0.19, r_p: 0.16), stalk length (r_g: 0.39, r_p: 0.35), stalk diameter (r_g: 0.42, r_p: 0.36), number of rays florets (r_g: 0.25, r_p: 0.22), vase life (r_g: 0.38, r_p: 0.33), *in-situ* life (r_g: 0.33, r_p: 0.26) and duration of flowering (r_g: 0.44, r_p: 0.40). Stem thickness is non-significantly positively correlated with the numbers of cut flowers per plant (r_g: 0.53, r_p: 0.46) and numbers of cut flowers per plot (r_g: 0.53, r_p: 0.46) whereas non-significantly negatively correlated with the days to flower bud appearance (r_g: -0.13, r_p: -0.10) and days to full bloom (r_g: -0.02, r_p: -0.05).

Leaf area

Leaf area is non-significantly positively correlated with the days to full bloom (r_g: 0.05, r_p: 0.03), fresh flower weight (r_g: 0.25, r_p: 0.24), flower yield per plant (r_g: 0.18, r_p: 0.20), flower yield per plot (r_g: 0.18, r_p: 0.20), flower diameter (r_g: 0.41, r_p: 0.41), stalk length (r_g: 0.17, r_p: 0.18), vase life (r_g: 0.10, r_p: 0.06), *in-situ* life (r_g: 0.02, r_p: 0.01), stalk diameter (r_g: 0.26, r_p: 0.24), plant height (r_g: 0.16, r_p: 0.15) and stem thickness (r_g: 0.15, r_p: 0.17). It is significantly negatively correlated with the number of cut flowers per plant (r_g: -0.62, r_p: -0.60) and numbers of cut flowers per plot (r_g: -0.62, r_p: -0.60). The data also recorded that leaf area is non-significantly negatively correlated with the days to flower bud appearance (r_g: -0.04, r_p: -0.05), number of ray florets (r_g: -0.06, r_p: -0.06) and duration of flowering (r_g: -0.05, r_p: -0.03).

Days to flower bud appearance

Days to flower bud appearance is highly significantly positively correlated with the days to full bloom (r_g: 0.94, r_p: 0.90). It is non-significantly negatively correlated with the fresh flower weight (r_g: -0.18, r_p: -0.17), flower yield per plant (r_g: -0.07, r_p: -0.06), flower yield per plot (r_g: -0.07, r_p: -0.06), flower diameter (r_g: -0.17, r_p: -0.16), stalk diameter (r_g: -0.40, r_p: -0.36), number of ray florets (r_g: -0.30, r_p: -0.29), vase life (r_g: -0.22, r_p: -0.12), *in-situ* life (r_g: -0.22, r_p: -0.08), duration of flowering (r_g: -0.28, r_p: -0.20). It also evident that days to flower bud appearance was non-significantly positively correlated with number of cut flowers per plant, numbers of cut flowers per plot (r_g: -0.15, r_p: -0.13) and stalk length (r_g: 0.01, r_p: 0.02).

Days to full bloom

The data illustrated that days to full bloom was non-significantly positively correlated with the numbers of cut flowers per plant (r_g: 0.06, r_p: 0.06), numbers of cut flowers per plot (r_g: 0.06, r_p: 0.06), fresh flower weight (r_g: 0.13, r_p: 0.12), flower yield per plant (r_g: 0.18, r_p: 0.18), flower yield per plot (r_g: 0.18, r_p: 0.18), flower diameter (r_g: 0.12, r_p: 0.12) and stalk length (r_g: 0.22, r_p: 0.22). It also recorded that days to full bloom was non-significantly negatively correlated with the stalk diameter (r_g: -0.04, r_p: -0.02), number of ray florets (r_g: -0.15, r_p: -0.15), vase life (r_g: -0.01, r_p: 0.03), *in-situ* life (r_g: -0.06, r_p: 0.09) and duration of flowering (r_g: -0.13, r_p: -0.13).

Numbers of cut flowers per plant

The data given in the Table 1 presented that the numbers of cut flowers per plant is non-significantly positively correlated with the numbers of cut flower per plot (r_g: 1.00, r_p: 1.00), flower yield per plant (r_g: 0.29, r_p: 0.31),

flower yield per plot (r_g: 0.29, r_p: 0.31), stalk length (r_g: 0.25, r_p: 0.24), vase life (r_g: 0.33, r_p: 0.25), *in-situ* life (r_g: 0.26, r_p: 0.22) and duration of flowering (r_g: 0.14, r_p: 0.14).

Numbers of cut flowers per plant is highly significantly positively correlated with the plant spread (r_g: 0.74, r_p: 0.65), number of leaves per plant (r_g: 0.57, r_p: 0.54) and stem thickness (r_g: 0.53, r_p: 0.46) whereas negatively significantly correlated to the leaf area (r_g: -0.62, r_p: -0.60).

It is non-significantly negatively correlated with the fresh flower weight (r_g: -0.09, r_p: -0.08), flower diameter (r_g: -0.28, r_p: -0.27), stalk diameter (r_g: -0.12, r_p: -0.12) and number of ray florets (r_g: -0.07, r_p: -0.07).

Numbers of cut flowers per plot

Numbers of cut flowers per plot is highly significantly correlated with the plant spread (r_g: 0.74, r_p: 0.65), number of leaves per plant (r_g: 0.57, r_p: 0.54) and stem thickness (r_g: 0.53, r_p: 0.46). It is negatively significantly correlated to the leaf area (r_g: -0.62, r_p: 0.60) and it is non-significantly negatively correlated with the fresh flower weight (r_g: -0.09, r_p: -0.08), flower diameter (r_g: -0.28, r_p: -0.27), stalk diameter (r_g: -0.12, r_p: -0.12) and number of ray florets (r_g: -0.07, r_p: -0.07).

It is non-significantly positively correlated with the number of cut flowers per plot (r_g: 1.00, r_p: 1.00), flower yield per plant (r_g: 0.29, r_p: 0.31), flower yield per plot (r_g: 0.29, r_p: 0.31), stalk length (r_g: 0.25, r_p: 0.24), vase life (r_g: 0.33, r_p: 0.25), *in-situ* life (r_g: 0.26, r_p: 0.22) and duration of flowering (r_g: 0.14, r_p: 0.14).

Fresh flower weight (g)

Fresh flower weight is highly significantly positively correlated with the flower yield per plant (r_g: 0.90, r_p: 0.89), flower yield per plot (r_g: 0.90, r_p: 0.89), flower diameter (r_g: 0.81, r_p: 0.78), stalk length (r_g: 0.82, r_p: 0.81), stalk diameter (r_g: 0.87, r_p: 0.85), and number of ray florets (r_g: 0.65, r_p: 0.65). It is also evident that fresh flower weight is non-significantly positively correlated with the vase life (r_g: 0.38, r_p: 0.31), *in-situ* life (r_g: 0.22, r_p: 0.20) and duration of flowering (r_g: 0.33, r_p: 0.30).

Flower yield per plant (g)

The data illustrated that flower yield per plant is significantly positively correlated with the flower diameter (r_g: 0.61, r_p: 0.59), stalk length (r_g: 0.92, r_p: 0.88), stalk diameter (r_g: 0.74, r_p: 0.71), number of ray florets (r_g: 0.65, r_p: 0.62) and vase life (r_g: 0.52, r_p: 0.39) whereas non-significantly positively correlated with the flower yield per plot (r_g: 1.00, r_p: 1.00), *in-situ* life (r_g: 0.31, r_p: 0.27) and duration of flowering (r_g: 0.23, r_p: 0.23).

Flower yield per plot (g)

The flower yield per plot is significantly positively correlated with the flower diameter (r_g: 0.61, r_p: 0.59), stalk length (r_g: 0.92, r_p: 0.88), stalk diameter (r_g: 0.74, r_p: 0.71), number of ray florets (r_g: 0.65, r_p: 0.62) and vase life (r_g: 0.52, r_p: 0.39) whereas non-significantly positively correlated with the *in-situ* life (r_g: 0.31, r_p: 0.27) and duration of flowering (r_g: 0.23, r_p: 0.23).

Flower diameter (cm)

The data presented in the table 1 presented that flower diameter is significantly positively correlated with stalk length (r_g: 0.70, r_p: 0.68) and stalk diameter (r_g: 0.74, r_p: 0.71), whereas it is non-significantly positively correlated with the number of ray florets (r_g: 0.34, r_p: 0.32), vase life (r_g: 0.52, r_p: 0.42), *in-situ* life (r_g: 0.48, r_p: 0.42) and duration of flowering (r_g: 0.48, r_p: 0.44).

Table.1 Correlation matrix among different characters of standard chrysanthemum

S. No.	PS	NOLPP	ST	LA	DTFBA	DTFB	NOCFPP	NOCPPLOT	FFW	FYPP	FYPPLOT	FD	SL	SD	NORF	VL	ISL	DOF
PH G	0.64**	0.81**	0.62*	0.16	0.14	0.26	0.36	0.36	0.69**	0.79**	0.79**	0.49	0.86**	0.36	0.42	0.32	0.23	-0.02
P	0.57*	0.73**	0.53*	0.15	0.10	0.18	0.34	0.34	0.66**	0.74**	0.74**	0.46	0.80**	0.34	0.40	0.23	0.14	-0.05
PS G		0.67**	0.71**	-0.29	0.06	0.25	0.74**	0.74**	0.54*	0.77**	0.77**	0.39	0.70**	0.53**	0.33	0.69**	0.62*	0.58*
P		0.58*	0.61*	-0.24	0.07	0.21	0.65**	0.65**	0.49	0.67**	0.67**	0.37	0.64**	0.48	0.30	0.62*	0.51	0.49
NOLPP G			0.54*	-0.05	-0.07	0.01	0.57**	0.57**	0.51	0.68**	0.68**	0.41	0.76**	0.33	0.17	0.31	0.25	0.12
P			0.48	-0.06	-0.05	0.03	0.54*	0.54*	0.49	0.64**	0.64**	0.39	0.73**	0.32	0.16	0.27	0.25	0.11
ST G				0.15	-0.13	-0.02	0.53*	0.53*	0.38	0.44	0.44	0.19	0.39	0.42	0.25	0.38	0.33	0.44
P				0.17	-0.10	-0.05	0.46	0.46	0.34	0.39	0.39	0.16	0.35	0.36	0.22	0.33	0.26	0.40
LA G					-0.04	0.05	-0.62*	-0.62*	0.25	0.18	0.18	0.41	0.17	0.26	-0.06	0.10	0.02	-0.05
P					-0.05	0.03	-0.60*	-0.60*	0.24	0.20	0.20	0.41	0.18	0.24	-0.06	0.06	0.01	-0.03
DTFBA G						0.94**	0.15	0.15	-0.18	-0.07	-0.07	-0.17	0.01	-0.40	-0.30	-0.22	-0.22	-0.28
P						0.90**	0.13	0.13	-0.17	-0.06	-0.06	-0.16	0.02	-0.36	-0.29	-0.12	-0.08	-0.20
DTFB G							0.06	0.06	0.13	0.18	0.18	0.12	0.22	-0.04	-0.15	-0.01	-0.06	-0.13
P							0.06	0.06	0.12	0.18	0.18	0.12	0.22	-0.02	-0.15	0.03	0.09	-0.03
NOCFPP G								1.00	-0.09	0.29	0.29	-0.28	0.25	-0.12	-0.07	0.33	0.26	0.14
P								1.00	-0.08	0.31	0.31	-0.27	0.24	-0.12	-0.07	0.25	0.22	0.14
NOCPPLOT G									-0.09	0.29	0.29	-0.28	0.25	-0.12	-0.07	0.33	0.26	0.14
P									-0.08	0.31	0.31	-0.27	0.24	-0.12	-0.07	0.25	0.22	0.14
FFW G										0.90**	0.90**	0.81**	0.82**	0.87**	0.65**	0.38	0.22	0.33
P										0.89**	0.89**	0.78**	0.81**	0.85**	0.65**	0.31	0.20	0.30
FYPP G											1.00	0.61*	0.92**	0.74**	0.65**	0.52*	0.31	0.23
P											1.00	0.59*	0.88**	0.71**	0.62*	0.39	0.27	0.23
FYPPLOT G												0.61*	0.92**	0.74**	0.65**	0.52*	0.31	0.23
P												0.59*	0.88**	0.71**	0.62*	0.39	0.27	0.23
FD G													0.70**	0.74**	0.34	0.52	0.48	0.48
P													0.68**	0.71**	0.32	0.42	0.42	0.44
SL G														0.62*	0.46	0.59*	0.42	0.15
P														0.60*	0.45	0.52*	0.40	0.16
SD G															0.52*	0.52*	0.41	0.55*
P															0.51	0.46	0.35	0.50
NORF G																0.18	0.12	0.22
P																0.14	0.09	0.20
VL G																	0.97**	0.48
P																	0.82**	0.37
ISL G																		0.51
P																		0.43

PH: Plant height PS: Plant spread, NOLPP: Number of leaves per plant, ST: Stem thickness, LA: Leaf area, DTFBA: Days to flower bud appearance, DTFB: Days to full bloom, NOCFPP: Number of cut flower per plant, NOCFPP: Number of cut flower per plot, FFW: Fresh flower weight, FYPP: Flower yield per plant, FYPP: Flower yield per plot, FD: Flower diameter, SL: Stalk length, SD: Stalk diameter, NORF: Number of ray florets, VL: Vase life, ISL: *In-situ* life DOF: Duration of flowering

Stalk length (cm)

Stalk length is positively and significantly correlated with stalk diameter (r_g: 0.62, r_p: 0.60), vase life (r_g: 0.59, r_p: 0.52) and non-significantly positively correlated with number of ray florets (r_g: 0.46, r_p: 0.45), *in-situ* life (r_g: 0.42, r_p: 0.40) and duration of flowering (r_g: 0.15, r_p: 0.16).

Stalk diameter (cm)

It is significantly positively correlated with the number of ray florets (r_g: 0.52, r_p: 0.51), vase life (r_g: 0.52, r_p: 0.46) and duration of flowering (r_g: 0.55, r_p: 0.50), whereas stalk diameter non-significantly positively correlated with the *in-situ* life (r_g: 0.41, r_p: 0.35).

Numbers of rays florets

Numbers of ray florets is non-significantly positively correlated with the vase life (r_g: 0.18, r_p: 0.14), *in-situ* life (r_g: 0.12, r_p: 0.09) and duration of flowering (r_g: 0.22, r_p: 0.20).

Vase life in distilled water (days)

The data given in the table 1 presented that it is highly significantly correlated with the *in-situ* life (r_g: 0.97, r_p: 0.82) and non-significantly positively correlated with the duration of flowering (r_g: 0.48, r_p: 0.37)

***In-situ* life (days)**

In-situ life of flower is non-significantly positively correlated with the duration of flowering (r_g: 0.51, r_p: 0.43).

The aim of correlation studies is primarily to know the suitability of various characters for indirect selection because of selection of any particular traits may induce undesirable changes in the associated characters. Further, direct selection for yield is not feasible, as it is a complex quantitative character and it is highly influenced by environment. As such, high genotypic and environmental interactions are likely to restrict the improvement. Therefore, the correlation between yield and yield components are of considerable importance in selection programme.

Yield is a complex trait, the expression of which depends on the action and multiple interaction of various components. Correlation measures the degree of association between the characters. In the present study, association of different cut flower characters with yield was studied and compared for superiority. Information on correlations between the important cut flower characters are of considerable help in the efficient selection programme. Correlations ensure simultaneous improvement in one, two or more variables and negative correlations bring out the need to obtain a compromise between the desirable traits.

Significantly correlations between two characters indicate that selection for the improvement of one character leads to the simultaneous improvement in the other character depending upon the magnitude of association between them. The characters are considered to be independent when weak correlations exist between them and selection for a character may not affect the other. It is evident that correlations exist between cut flower characters among themselves and in turn with the yield also.

In the present study, it was observed that for most of the characters genotypic correlation coefficients were higher than phenotypic correlation coefficients. Similar trend has been reported by Gourishankarayya *et al.*, (2005) in African marigold, and Singh and Kumar, (2008) in marigold. These findings

therefore indicate that there is strong inherent association between various characters and the phenotypic expression for different characters under study was lessened by the influence of the environment.

Genetic correlations may be accounted by linkage or pleiotropy (Mode and Robinson, 1959). Generally genotypic correlations are considered true correlations from breeding point of view. The plant height was significantly positively correlated with both phenotypic and genotypic correlation of plant spread, number of leaves per plant, stem thickness, fresh flower weight, flower yield per plant, flower yield per plot and stalk length indicating taller plants will produce stalks of long length with more number of leaves per plant and high fresh flower weight. Suvija *et al.,* (2016b) was also reported that plant height was significantly correlated with flower yield per plant and stem girth in chrysanthemum. Similar findings were also reported by Vetrivel *et al.,* (2014) in chrysanthemum and Bharathi *et al.,* (2014b) in African marigold.

Number of cut flowers per plant was highly significantly positively correlated with the plant spread, number of leaves per plant, stem thickness indicates more plant spread leads to increase in more of number of cut flowers per plant and more number of leaves per plant and it is non-significantly positively correlated with number of cut flowers per plot, flower yield per plant, flower yield per plot, stalk length, vase life, *in-situ* life and duration of flowering indicating that increase in number of flowers per plant will result in may or may not increase of all these characters. Vikas *et al.,* (2011) also reported that number of cut flowers per plant was significantly correlated with the vase life, and longevity of flower in Dahlia. Kumar *et al.,* (2012) reported duration of flowering is positively significant correlated with number of flowers per plant in chrysanthemum. Bharathi *et al.,* (2014b) reported a number of flowers per plant were positively and significantly correlated with flower yield per plant in African marigold. Similar findings were also reported by Suvija *et al.,* (2016b) in chrysanthemum, Kumar (2014) in gerbera and Arulmani *et al.,* (2016b) in Gaillardia.

Number of leaves per plant had significantly positive correlation with plant height, plant spread, stem thickness, number of flowers per plant, number of flowers per plot, flower yield per plant, flower yield per plot, stalk length and non-significantly positively correlated with days to full bloom, fresh flower weight, flower diameter, stalk diameter, number of ray florets, vase life, *in-situ* life and duration of flowering. The results are in agreement with the observation made by Singh and Singh, (2005) in marigold. So, more number of leaves means more plant height and stalk length. Vikas *et al.,* (2011) reported that number of leaves per plant is significantly correlated with plant height, stem thickness, number of days for flowering, number of ray florets, stalk length, vase life and number of flowers per plant in Dahlia. Mishra *et al.,* (2013) was found that number of leaves per plant was significantly correlated with plant height and number of flowers per plant in chrysanthemum. Vetrivel *et al.,* (2014) reported number of leaves per plant at harvest stage is significantly correlated with number of buds per plant in chrysanthemum.

Stalk length is positively and significantly correlated with plant height, plant spread, number of leaves per plant, fresh flower weight, flower yield per plant, flower yield per plot, flower diameter, stalk diameter, vase life. As stalk length is an important character for cut flower production which has more market value thus stalk length can be increased with increase of any one of the characters, since these characters has highly

significant positive correlations with stalk length so a straight way selection from cultivars will be more effective for the improvement of chrysanthemum. It is non-significantly positively correlated with stem thickness, leaf area, days to flower bud appearance, days to full bloom, number of cut flower per plant and number of cut flower per plot, number of ray florets, *in-situ* life and duration of flowering. Kumar (2014) reported stalk length is positively correlated with number of ray florets, flower diameter, days to harvest stage after flower open in gerbera. The similar correlation findings has been reported by Singh and Kumar (2008) in marigold and Vetrivel *et al.,* (2014) reported stalk length is significantly and positively correlated with the plant height, days to flower bud appearance, flower bud diameter, days to harvest and weight of cut stem at both genotypic and phenotypic correlation coefficient in chrysanthemum. Vikas *et al.,* (2011) reported positively correlated with duration of flowering and flower diameter in dahlia.

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