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STABILITY ANALYSIS FOR FLOWERING CHARACTERS OF CHRYSANTHEMUM GENOTYPES

C. M. Pradeep Kumar, A. V. D. Dorajeerao, T. Suseela and Zehra Salma

College of Horticulture, Venkataramannagudem, West Godavari district (Andhra Pradesh), India.

Abstract

The present investigation on stability analysis in chrysanthemum (*Dendranthema grandiflora* Tzvelev.) was carried out at College of Horticulture, Venkataramannagudem, West Godavari district of Andhra Pradesh during 2017-2018. The stability of flowering parameters showed that days taken for flower bud initiation worked out to be in the range of average stability for the genotypes Red Gold, Reagun Emperor, Star White, Bc-6-11, Mother Theresa and Pusa Aditya genotypes and genotypes like Star White, Mother Theresa, Reagun Emperor and Pusa Aditya had average stability for days taken for 100 per cent flowering. Among the environments open field showed more favourable for earliness of flowering.

Key words : Environmental indices, open field, polyhouse and shade house.

Introduction

Chrysanthemum (*Dendranthema grandiflora* Tzvelev.) popularly known as Queen of East, belongs to the family Asteraceae (n = 9) and it is native to China. It is cultivated in tropical and subtropical regions of India in an area of 16,630 ha with the production of 1,79,370 metric tonnes under loose flowers (NHB, 2015). The chrysanthemum plants are perennial in nature and the flowers are actually composite inflorescence with two types of florets (disc and ray) arranged on flattened axis called capitulum or head. The flowers are mainly used for making garlands, *veni*, bracelets and for religious offering due to wide variety of colours, shapes, and textures, making them the flower of choice for the mass-market bouquet business (Winogrond, 1999).

In crop improvement studies, 'stability' reflects the suitability of a variety for general cultivation over a wide range of environments. There are two philosophies of plant breeding in this respect. In the first, characters associated with maximum yield in optimum conditions are different from those associated with survival mechanisms. In the second philosophy, the genotypes with a high yield potential under optimum conditions also express their superiority under limiting conditions. Both the philosophies are ultimately concerned with G × E interaction (Ceccarelli, 1989). However, such inferences need testing across locations. According to the dynamic concept, a stable genotype is one which gives predictable performance to environments without any deviation (Becker and Leon, 1988). Assessment of the stability and adaptability of a genotype to different environments is useful for recommending cultivars for known conditions of cultivation and should be a requirement in breeding programmes. Cultivar interaction with environmental factors is an important consideration for plant breeders (Aswath, 2005). Selection of stable genotypes for different agro climatic conditions governs the improvement of chrysanthemum. Identification of stable varieties will help the farmers for successful commercial cultivation of chrysanthemum.

Materials and Methods

The experiment was conducted during the period from August, 2017 to January, 2018 under three different environmental conditions *viz.,* open field, naturally ventilated polyhouse, shade house (50% shade net) in the instructional farm at College of Horticulture, Venkataramannagudem, Andhra Pradesh. To analyse the data over three environments (locations) the stability model proposed by Eberhart and Russell (1966) was used. The model involves the estimation of mean, regression coefficient and deviation from regression.

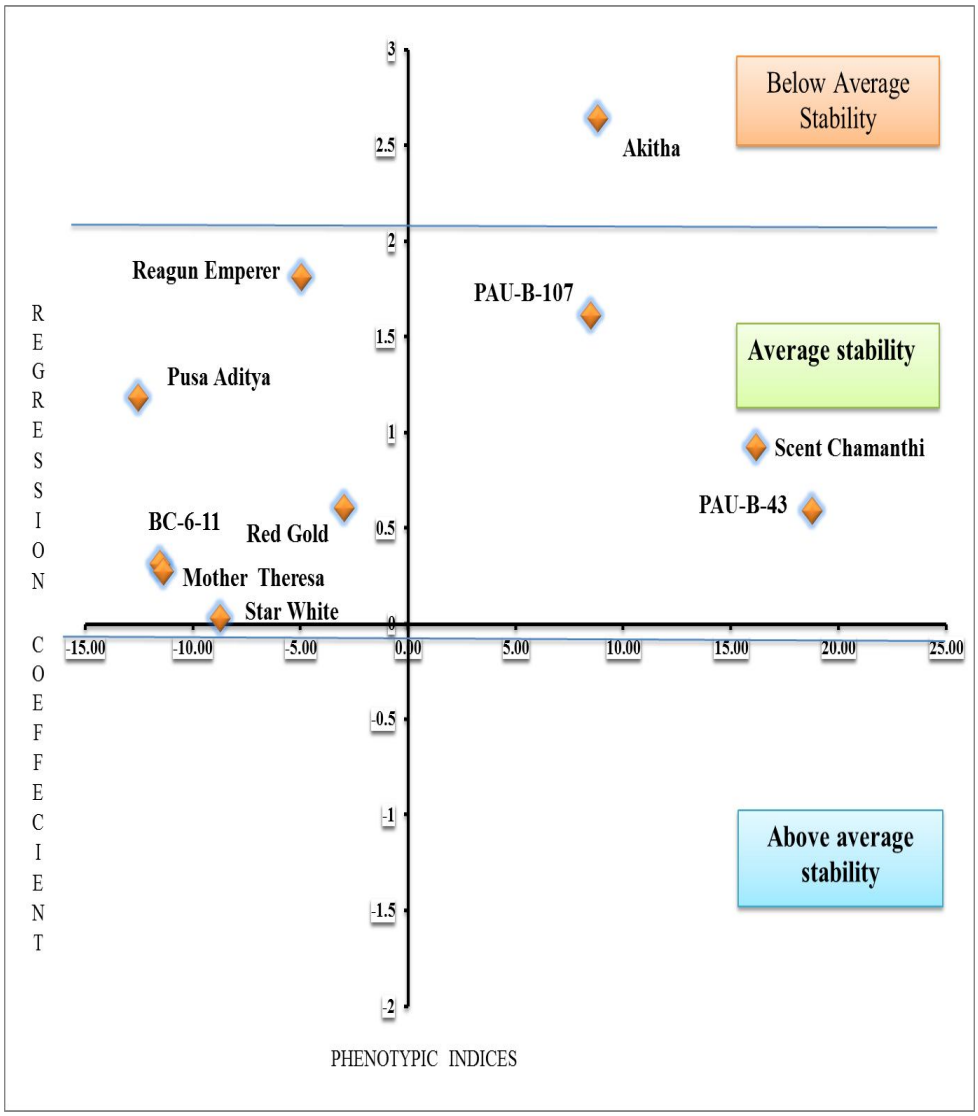

Fig. 2 :

Results and Discussion

The analysis of variance (table 1) revealed that the genotypes, environments and interaction between the genotype and environment (G x E) were significant for all the characters indicating the diversity among the genotypes, environments and G x E studied. A perusal of the results on environmental index for various traits under different environments (table 2) indicated open field earliness to flowering whereas *in situ* longevity and duration of flowering found superior by shade house.

Flowering parameters

Days taken for bud initiation

The data presented in table 3 and showed in fig. 1 that there were significant differences in the days taken for bud initiation among the genotypes and environments. The number of days taken for bud initiation was at a minimum of 61.67 days in Pusa Aditya under open field. The maximum number of days for bud initiation was recorded by PAU-B-43 (99.00 days) under polyhouse.

The open field (E_1) was found to be more favourable for early bud initiation since the data were at high magnitude as compared to other environments. In this environment, the genotype Pusa Aditya recorded early bud initiation (61.67 days) which was on par with Mother Theresa (65.67 days) and BC-6-11 (65.67 days). However, the genotype PAU-B-43 (94.33 days) exhibited the latest bud initiation.

The pooled mean over environments revealed that the earliest bud initiation was shown by the genotype Pusa Aditya (65.44 days) and latest by PAU-B-43 (96.72 days). The genotypes Red Gold (75.00 days), Reagun Emperor (73.00 days), Star White (69.22 days), Bc-6-11 (66.61 days), Mother Theresa (66.44 days), Pusa Aditya

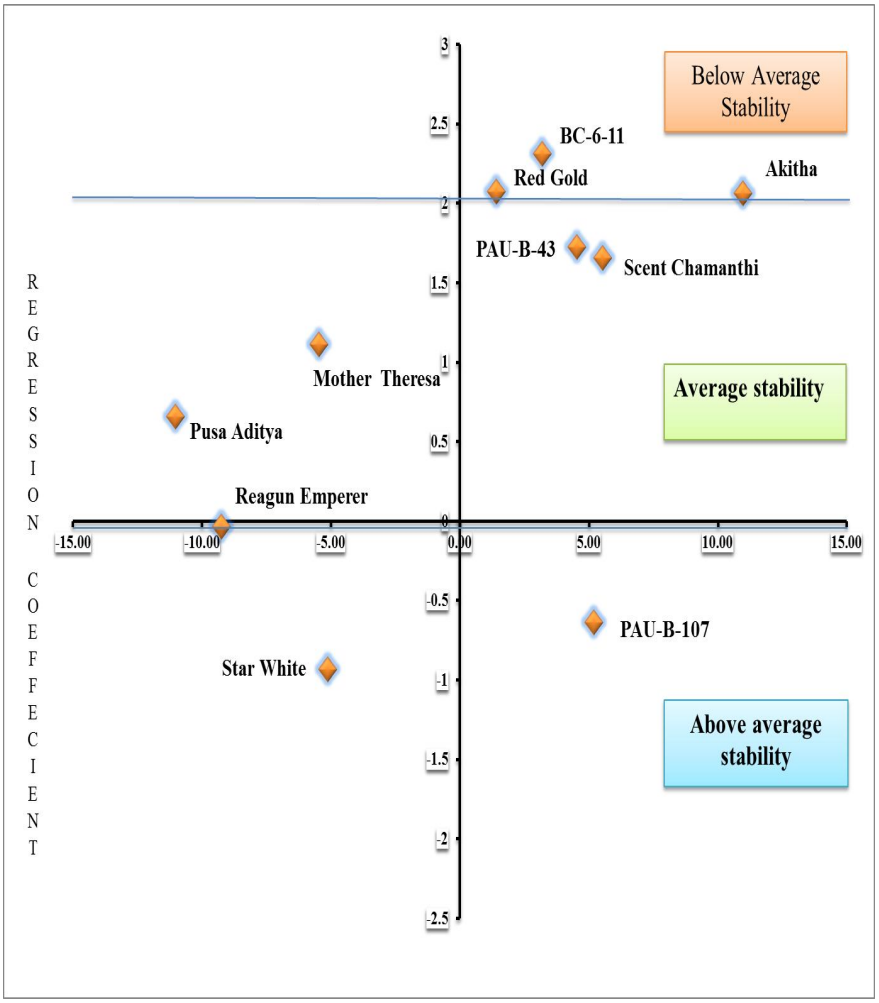

Fig. 2 :

Table 1 : Analysis of variance (pooled) for stability parameters (mean sum of squares) in chrysanthemum (*Dendranthema grandiflora* Tzvelev.) for flowering characters.

S. no.	Parameters	Genotypes (g)	Environ-ment (E)	Gen.x Env.	E (linear)	G x E (linear)	Pooled deviation	Pooled error
1	Days taken for flower bud initiation	430.124**	111.493**	12.515*	222.985**	14.935	9.086**	3.899
2	Days taken for buds to display colour from initiation	47.398*	44.070	14.749	88.141	4.725	22.296**	6.507
3	Days taken for 50 per cent flowering	276.117*	127.480*	74.258	254.960**	129.625**	17.001	108.218
4	Days taken for 100 per cent flowering	158.056*	241.300*	42.008**	482.600**	67.397*	14.957**	2.872
5	Duration of flowering (days)	65.425**	89.824**	0.621	179.648**	1.010*	0.208	1.982
6	*In situ* longevity of flower (days)	50.445**	10.133**	0.162	20.267**	0.222	0.092	0.651

(65.44 days) exhibited significantly earlier bud initiation compared to population mean (77.98 days).

These genotypes had regression co-efficient near to unity with non-significant deviation from linearity (S^2d_i). It indicated that these were well adapted to different environments with average stability. It is interesting to note that the genotype Akitha showed significant deviation from linearity (S^2d_i) and hence became unpredictable in

Table 2 : Environmental indices for flowering parameters in chrysanthemum (*Dendranthema grandiflora* Tzvelev.)

S. no.	Parameters	Open field (E_1)	Polyhouse (E_2)	Shade house (E_3)
1	Days taken for flower bud initiation	-1.94	3.86	-1.91
2	Days taken for buds to display of colour from initiation	-1.79	2.31	-0.52
3	Days taken for 50 per cent flowering	-3.60	3.54	0.06
4	Days taken for 100 per cent flowering	-4.40	5.30	-0.90
5	Duration of flowering	0.30	-3.14	2.83
6	*In situ* longevity of flower	0.13	-1.07	0.93

spite of its significant regression co-efficient.

Days taken for buds to display colour from initiation

A perusal of the data presented in table 3 revealed that there were significant variations in the days taken for bud to show colour among the genotypes and environments. The days taken for bud to show colour varied from 12 days with Scent chamanthi under open field to 33.00 days in Akitha under shade house.

The open field (E_1) was observed to possess relatively higher value for the days taken for buds to show colour among the environments. The genotype Mother Theresa recorded the early showing of colour in the flower buds (13.33 days), which was statistically on par with PAU-B-43(16.33 days) and Scent chamanthi (16.67) whereas, delayed bud colour appearance was observed in Akitha (26.67 days) genotype.

The pooled mean over environments was ranging from as early as 17.22 days in Scent chamanthi to 31.44 days in Akitha for their floral buds to show colour. The genotypes Red Gold (20.33 days), Star White (21.22 days), PAU-B-43 (18 days), BC-6-11 (20.22 days), Reagun Emperor (20.44 days) and Scent chamanthi (17.22 days) exhibited significantly lesser days for the buds to show colour as compared to population mean (21.76 days).

The genotype x environment interaction was not significant for days taken for buds to display of colour from initiation.

Days taken for 50% flowering

Significant variations were noted (Table 4) in the days taken for 50% flowering among the genotypes and environments. The earliest achievement of 50% flowering stage was noticed under polyhouse with Reagun Emperor (108.00 days) genotype maximum delay was in case of Akitha (144.33 days) in the same environment.

The open field (E_1) was found to be highly favourable for 50% flowering since the data were at high magnitude compared to other two environments. The genotype Pusa Aditya recorded the initial 50% flowering with 109.33 days which was statistically on par with Red Gold (112.00 days). The PAU-B-107genotype took maximum number of days for 50% flowering (130.33 days).

The pooled mean over environments documented that the earliest 50% flowering was observed with the genotypes Reagun Emperor (103.24 days) and maximum delay was in case of Akitha (135 days). The genotypes Star White (118.78 days), Mother Theresa (115.78 days), Pusa Aditya (113.33 days), Reagun Emperor (103.24 days) showed significantly lesser number of days for 50% flowering as compared to population mean (122.47 days).

The genotype x environment interaction was not significant for days taken for 50% flowering. The variance due to G x E was also found non-significant for days to 50% flowering in earlier studies made by Hemlanaik *et al*. (2005) in marigold.

Days taken for 100% flowering

The differences (table 4) and (fig. 2) in respect of number of days taken for 100% flowering among the genotypes and across environment were found significant. The days taken for 100% flowering were ranging between 117.00 days in Pusa Aditya genotype under open field and 152.33 days in Akitha under polyhouse.

The open field (E_1) appeared to be more favourable for 100% flowering since the data were at high magnitude compared to other environments. The time taken for 100% flowering was found to be the lowest in the genotype Pusa Aditya with 117 days, which was significantly superior genotype than Mother Theresa (123.00 days). The genotype PAU-B-107 took maximum number of days for 100% flowering with 135.33 days.

The pooled mean over environments detailed on days taken for 100% flowering was at the minimum in the Pusa Aditya (119.78 days) and maximum in Akitha (141.78 days). The genotypes Star White (125.67 days), Mother Theresa (125.33 days), Reagun Emperor (121.56 days), Pusa Aditya (119.78 days) were significantly earlier to achieve 100% flowering stage as compared to population mean (130.80 days).

Pusa Aditya genotype has regression coefficients near to unity with non-significant deviation from linearity

Table 3 : Stability parameters for days taken for bud initiation and buds to display of colour from initiation in chrysanthemum genotypes.

Genotypes	Days taken for bud initiation						Days taken for buds to display of colour from initiation					
	Environments				b_i	S^2d_i	Environments				b_i	S^2d_i
	E_1	E_2	E_3	Pooled Mean			E_1	E_2	E_3	Pooled Mean		
Mother Theresa (V1)	65.67	67.67	66.00	**66.44**	0.317	-1.248	19.33	23.33	22.67	**21.78**	0.851	0.628
Pusa Aditya (V2)	61.67	70.00	64.67	**65.44**	1.184	3.083	20.00	24.00	23.67	**22.56**	0.832	1.588
Reagun Emperor (V3)	70.33	80.00	68.67	**73.00**	1.814	0.192	21.33	25.33	14.67	**20.44**	1.444	37.531
Akitha (V4)	87.00	97.00	76.33	**86.78**	2.643**	56.534**	26.67	33.00	34.67	**31.44**	1.187	21.049
PAU-B-107 (V5)	85.00	92.67	81.67	**86.44**	1.611	4.437	20.67	25.67	26.67	**24.33**	0.956	10.450
Red Gold (V6)	73.33	77.33	74.33	**75.00**	0.606	-0.820	13.33	21.33	26.33	**20.33**	1.327	68.300
PAU-B-43 (V7)	94.33	99.00	96.83	**96.72**	0.593	1.776	16.33	23.00	14.67	**18.00**	1.847	6.658
Scent chamanthi (V8)	90.00	97.67	94.67	**94.11**	0.926	9.446	16.67	23.00	12.00	**17.22**	1.937	25.719
Star White (V9)	67.33	69.33	71.00	**69.22**	0.032	5.419	24.67	22.33	16.67	**21.22**	-0.138	31.515
BC-6-11 (V10)	65.67	67.67	66.50	**66.61**	0.274	-0.960	20.67	19.67	20.33	**20.22**	-0.242	-2.169
General mean	**76.03**	**81.83**	**76.07**	**77.98**			**19.97**	**24.07**	**21.23**	**21.76**		
SE(m)	1.51	1.01	0.77	2.13			1.72	1.68	2.04	3.34		
CD @ 5%	4.47	3.00	2.29	6.02			5.13	3.54	4.3	9.44		

*, **, Significant at 5% and 1% level respectively, E_1- Open Field, E_2- Polyhouse, E_3- Shadehouse, b_i – Regression coefficient, S^2d_i – Mean square deviation, CD- Critical Difference.

Table 4 : Stability parameters for days taken for 50% and 100% flowering in chrysanthemum.

Genotypes	Days taken for 50% flowering						Days taken for 100% flowering					
	Environments				b_i	S^2d_i	Environments				b_i	S^2d_i
	E_1	E_2	E_3	Pooled Mean			E_1	E_2	E_3	Pooled Mean		
Mother Theresa(V1)	113.00	122.67	111.67	**115.78**	1.338	-9.640	123.00	132.67	120.33	**125.33**	1.111	23.660**
Pusa Aditya(V2)	109.33	118.00	112.67	**113.33**	1.211	-35.240	117.00	123.33	119.00	**119.78**	0.658	-0.904
Reagun Emperor(V3)	115.33	86.40	108.00	**103.24**	-4.033**	1.669	124.00	122.67	118.00	**121.56**	-0.035	18.837*
Akitha (V4)	125.33	144.33	135.33	**135.00**	2.662	-36.033	132.00	152.33	141.00	**141.78**	2.065*	0.841
PAU-B-107(V5)	130.33	126.67	132.00	**129.67**	-0.505	-27.675	135.33	130.67	142.00	**136.00**	-0.637**	44.360**
Red Gold(V6)	112.00	130.67	129.33	**124.00**	2.634	3.931	120.33	141.67	134.67	**132.22**	2.076*	27.659**
PAU-B-43(V7)	120.67	136.67	131.67	**129.67**	2.248	-30.909	127.67	144.33	137.00	**136.33**	1.656	6.204
Scent chamanthi(V8)	121.00	139.33	124.67	**128.33**	2.553	-14.050	128.67	145.00	132.33	**135.33**	1.725	2.265
Star White (V9)	123.67	115.67	117.00	**118.78**	-1.127*	-31.710	132.00	122.00	123.00	**125.67**	-0.930**	17.936*
BC-6-11(V10)	118.00	139.67	123.00	**126.89**	3.019*	-11.055	124.00	146.33	131.67	**134.00**	2.310**	-0.857
General mean	**118.87**	**126.01**	**122.53**	**122.47**			**126.40**	**136.10**	**129.90**	**130.80**		
SE(m)	1.15	10.33	0.98	2.92			0.82	1.19	0.89	2.73		
CD @ 5%	3.42	30.56	2.94	8.25			2.43	3.52	2.64	7.72		

*, **, Significant at 5% and 1% level respectively, E_1- Open Field, E_2- Polyhouse, E_3- Shadehouse, b_i – Regression coefficient, S^2d_i – Mean square deviation, CD- Critical Difference.

Table 5 : Stability parameters for flower duration and *insitu* longevity of flower in chrysanthemum genotypes.

Genotypes	Flower duration						*In situ* longevity of flower					
	Environments				b_i	S^2d_i	Environments				b_i	S^2d_i
	E_1	E_2	E_3	Pooled Mean			E_1	E_2	E_3	Pooled Mean		
Mother Theresa(V1)	41.00	37.67	43.67	**40.78**	1.003	-0.651	10.67	10.33	11.67	**10.89**	0.636	-0.074
Pusa Aditya(V2)	42.33	40.52	45.33	**42.73**	0.790*	-0.054	12.00	11.33	12.33	**11.89**	0.504**	-0.214
Reagun Emperor(V3)	43.67	40.67	46.33	**43.56**	0.945	-0.615	13.67	12.67	14.00	**13.44**	0.680	-0.191
Akitha (V4)	35.67	32.33	36.67	**34.89**	0.740**	-0.196	15.00	14.33	16.00	**15.11**	0.811	-0.144
PAU-B-107(V5)	47.67	43.21	50.67	**47.18**	1.251**	-0.643	17.00	15.00	17.33	**16.44**	1.206	0.020
Red Gold(V6)	45.67	42.19	47.33	**45.06**	0.871	-0.484	16.00	15.33	17.33	**16.22**	0.965	-0.030
PAU-B-43(V7)	43.67	41.00	45.67	**43.44**	0.781*	-0.661	18.67	17.00	19.67	**18.44**	1.338	-0.214
Scent chamanthi(V8)	36.00	33.51	39.00	**36.17**	0.908	-0.362	19.33	17.67	20.67	**19.22**	1.491**	-0.205
Star White (V9)	35.00	30.67	38.67	**34.78**	1.335**	-0.612	22.33	21.00	23.33	**22.22**	1.162	-0.214
BC-6-11(V10)	47.33	41.85	50.00	**46.40**	1.378**	-0.248	23.67	21.67	24.00	**23.11**	1.206	0.020
General mean	**41.80**	**38.36**	**44.33**	**41.50**	**1.000**		**16.83**	**15.63**	**17.63**	**16.70**	**1.000**	
SE(m)	0.84	0.86	0.72	0.32	0.108		0.40	0.55	0.42	0.21	0.214	
CD @ 5%	2.50	2.58	2.14	0.90			1.68	2.31	1.76	0.59		

*, **, Significant at 5% and 1% level respectively, E_1- Open Field, E_2- Polyhouse, E_3- Shadehouse, b_i – Regression coefficient, S^2d_i – Mean square deviation, CD- Critical Difference.

(S^2d_i). In this regard, it can be specified here that these genotypes were well adaptable to different environments with average stability. The genotypes Reagun Emperor, Red Gold, Star White and PAU-B-107 could be considered as unpredictable as they recorded significant deviation from linearity.

Duration of flowering

Significant variations were noted (table 5) in the duration of flowering among the genotypes and across the environments. The flowering duration was found maximum in PAU-B-107 genotype with 50.67 days under shade house and minimum in Star White (30.67 days) under polyhouse.

The shade house (E_3) exhibited more favourable environment for flowering duration as compared to other two environments. The PAU-B-107 genotype recorded the highest number of days for flowering duration with 50.67 days which was statistically on par with BC-6-11 (50.00 days) whereas the least number of days was noticed by Star White with 38.67 days under the same environment.

The pooled mean over environments showed the lowest flowering duration with the genotype PAU-B-107 (47.18 days) and highest flowering duration in the Star White with 34.78 days. The genotypes PAU-B-107 (47.18 days), BC-6-11 (46.40 days), Red Gold (45.06 days), Reagun Emperor (43.56 days), PAU-B-43(43.44 days) and Pusa Aditya (42.73 days) were exhibited significantly higher flower duration as compared to population mean (41.50 days).

The genotype x environment interaction was not significant for duration of flowering, so further interpretation has not been made.

***In situ* longevity of flower**

The i*n situ* longevity of flower exhibited significant variations due to genotypes and environments (table 5). The longest retention of flower on the plant was noticed in genotype BC-6-11 with 23.67 days in open field and shortest duration of flower on the plant was recorded in Mother Theresa with 10.33 days under polyhouse.

The shade house (E_3) was observed to possess relatively higher value for *in situ* longevity of flower among the environments. The genotype BC-6-11 flowers lasted longer on the plant with 24.00 days. It was statistically on par with Star White (23.33 days). Flowers produced on Mother Theresa genotype had the shortest life on the plant (11.67 days).

The pooled mean over environments for *in situ* longevity of flower was maximum with the genotype BC-6-11 (23.11 days) and minimum with Mother Theresa (10.89 days). The genotypes PAU-B-43 (18.44 days), Scent Chamanthi (19.22 days), Star White (22.22 days) and BC-6-11(23.11 days) exhibited significantly greater longevity values as compared to population mean (16.70 days).

The genotype x environment interaction was found non-significant for *in situ* longevity of flower on the plant.

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