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Stability Analysis for Newly Evolved Genotypes of Chrysanthemum (*Dendranthema grandiflora Tzvelev*) for Loose Flower Production

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Abstract

An experiment was conducted on stability analysis of newly evolved genotypes of chrysanthemum (*Dendranthema grandiflora Tzvelev*) for loose flower production at the experimental farm of Department of Floriculture and Landscape Architecture, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan and ICAR-IARI Regional Station, Katrain, Kullu Valley of H.P for two successive years 2017 and 2018 on nineteen genotypes of chrysanthemum, including cultivar 'Surf' as check for loose flower production. For character like plant height genotypes 'UHFSChr113' and 'UHFSChr114', genotypes 'UHFSChr125', 'UHFSChr128'and 'UHFSChr131' for days taken to flowering and for flower diameter genotypes 'UHFSChr111', 'UHFSChr122', 'UHFSChr132' for number of side shoots genotype 'UHFSChr121' were found stable. These genotypes were not influenced much by the season as well as environment and stable across the location and season.

Keywords

Loose flower, Analysis, Squared deviation, Eberhart and Russel model, Genotypes

Introduction

Chrysanthemum (*Dendranthema grandiflora* Tzvelev) belongs to family Asteraceae [1]. It is commonly known as guldaudi/autumn queen/queen of East. It is native to northern hemisphere chiefly Europe and Asia. Species in the genus chrysanthemum varies from 100 to 200. It ranks second after rose in spray and seventh in standard type of flower production and also ranked second in loose flower production after marigold [2]. In India, Karnataka is the most prominent chrysanthemum growing state with an area of 5,453 ha with production of 59,543 MT and productivity of 10.92 t/ha. In India during 2016-2017 the area under chrysanthemum was 20090 hectare and production of loose flower was 185240 MT [3]. Chrysanthemum has wide range of flower colour, growth habit, size and shape. It is used for making garlands, Venis, gajras and religious offering.

There are large numbers of germplasm available but could not fulfill the requirements in terms of new colors, forms, types and various characteristics. However; there is always a demand of superior and new flowers over the existing cultivars. Therefore, there is urgent need to identify stable genotypes having wider adaptability and easy availability to the growers at cheaper rate. Therefore, an investigation was conducted on "Stability analysis in chrysanthemum (*Dendranthema grandiflora* Tzvelev) as 'stability' reflects the suitability of genotype for general cultivation over wide range of environment for loose flower production", in breeding for wide adaptation, the aim is to obtain a variety, which perform well in nearly all environment [4]. The present study was therefore aimed to evaluate chrysanthemum for their stability of performance for yield and yields components across different environments.

Materials and Methods

To assess the stability performance of newly evolved genotypes of chrysanthemum for loose flower production trial was conducted at experimental farm of Department of Floriculture and Landscape Architecture, Dr. Yashwant

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Singh Parmar University of Horticulture and Forestry, Nauni, Solan and ICAR-IARI, Regional Station, Katrain, Kullu Valley of H.P. for two successive years 2017 and 2018 on nineteen genotypes of chrysanthemum. Genotypes namely 'UHFSChr111', 'UHFSChr113', 'UHFSChr114', 'UHFSChr115', 'UHFSChr117', 'UHFSChr118', 'UHFSChr120', 'UHFSChr121', 'UHFSChr122', 'UHFSChr123', 'UHFSChr124', 'UHFSChr125', 'UHFSChr126', 'UHFSChr128', 'UHFSChr129', 'UHFSChr130', 'UHFSChr131', 'UHFSChr132' including 'Surf' as check. The plants were planted in three replications in Randomized Block Design in open field conditions using FYM 5 kg/m^2 and half dose of nitrogen and full dose of phosphorus and potassium were also mixed in the soil at the time of bed preparation. The remaining half dose of nitrogen was applied 45 days after transplanting. Data were recorded in terms of different plant parameters viz., days taken for flowering, plant height (cm) recorded at the time of flowering and measured from bottom to tip of the plant, number of plants and flowers per plant, flower diameter (cm) and duration of flowering, flower weight per plant and flower weight per square meter. The data was subjected to stability analysis by using [5]. The model involves the estimation of mean, regression coefficient and deviation from regression.

Results and Discussion

Plant height revealed that genotypes 'UHFSChr114' (114.42 cm), 'UHFSChr115' (113.33 cm), 'UHFSChr117' (113.33 cm), 'UHFSChr130' (87.17 cm), 'UHFSChr125' (86.08 cm), and 'UHFSChr122' (83.97 cm) exhibited high mean values than overall mean (83.39 cm). Among above mentioned genotypes 'UHFSChr114' and 'UHFSChr113' recorded phenotypic index (pi) 29.96, 23.38, regression coefficient (bi) 0.98, 1.32 and squared deviation from regression (S^2di) 0.24, -1.07 respectively. Hence, these genotypes observed to be stable for trait under study (Table 1).

Among all nineteen genotypes days taken to flower bud formation 'UHFSChr129'(129.30 days), 'UHFSChr115'(126.25 days), 'UHFSChr113' (125.85 days), 'UHFSChr118' (125.05 days), 'UHFSChr131' (125.05 days), 'UHFSChr130' (124.94 days), 'UHFSChr126' (124.80 days), 'UHFSChr121' (124.12 days), 'UHFSChr117' (123.90 days), 'UHFSChr128' (123.70 days), 'UHFSChr111' (122.90 days), 'UHFSChr125' (122.56 days), 'UHFSChr114' (122.33 days) and 'UHFSChr120' (122.02 days) recorded more mean values than overall mean (121.73 days) over all environments. Genotype 'UHFSChr128' recorded phenotypic index (pi) 21.78, regression coefficient (bi) 1.03, square deviation from regression (S^2di) 0.32 was found to be most stable genotype for this character.

Perusal of data presented in Table 2 revealed that days taken to flowering genotypes 'UHFSChr129' (169.18 days), 'UHFSChr126' (164.53 days), 'UHFSChr111' (164.38 days),

Table 1: Estimation of stability parameters in chrysanthemum for plant height (cm), days taken to flower bud formation (days).

Genotype	Plant height (cm)				Days taken to flower bud formation			
	Mean	pi	bi	S^2 di	Mean	pi	bi	S^2 di
UHFSChr 111	68.77	-6.42	0.64	20.89	122.90	56.81	1.02	7.95
UHFSChr 113	81.33	42.05	0.46	-2.25	125.85	217.29	0.99	1.58
UHFSChr 114	114.42	29.96	0.98	-0.24	122.33	-2647.78	1.05	-0.81
UHFSChr 115	113.43	23.53	-0.79	4.84	126.25	-602.62	1.15	2.36
UHFSChr 117	113.33	23.38	1.32	-1.07	123.90	-312.30	1.09	3.10
UHFSChr 118	76.20	-8.69	2.05	1.84	125.05	-45.81	1.04	0.38
UHFSChr 120	75.77	-77.54	1.82	41.00	122.02	-1082.05	1.22	41.67
UHFSChr 121	81.73	26.30	0.62	4.71	124.12	-57.52	1.04	3.22
UHFSChr 122	83.97	-89.26	2.20	38.78	123.30	318.54	0.96	8.77
UHFSChr 123	81.33	15.38	0.92	7.67	120.42	-1260.30	1.25	32.04
UHFSChr 124	67.75	-21.15	1.41	19.90	124.83	-46.73	1.04	2.62
UHFSChr 125	86.08	26.85	0.93	1.83	122.56	337.85	0.96	1.54
UHFSChr 126	78.42	-11.59	1.04	19.90	124.80	-446.79	1.12	1.34
UHFSChr 128	82.17	21.49	1.01	3.67	123.70	21.78	1.03	0.32
UHFSChr 129	82.42	37.96	0.42	-0.02	129.30	203.57	0.99	2.25
UHFSChr 130	87.17	-26.79	1.19	25.70	124.94	48.63	1.02	-0.50
UHFSChr 131	82.95	12.34	1.47	2.15	125.05	-64.55	1.04	10.37
UHFSChr 132	83.15	-15.20	-0.09	27.44	121.23	278.81	0.97	1.82
Surf	44.03	-2.59	1.38	11.09	80.40	2517.80	0.02	22.07
Pooled Mean	83.39		S.E = 2.20 Mean of b = 1.0 SE of b = 1.17			121.73	S.E = 1.71 SE of b = 0.06 Mean of b = 1.00	

Table 2: Estimation of stability parameters in chrysanthemum for days taken to flowering and plant spread.

Genotype	Days taken to flowering				Plant spread (cm)			
	Mean	pi	bi	S^2 di	Mean	pi	bi	S^2 di
UHFSChr 111	164.38	83.68	0.98	10.97	36.85	-13.78	-0.57	13.40
UHFSChr 113	161.02	73.44	0.99	4.47	37.50	-35.09	-3.54	17.92
UHFSChr 114	159.88	-2108.39	1.02	4.88	36.25	-2.08	1.20	-2.18
UHFSChr 115	161.87	-251.37	1.06	14.41	36.22	-18.56	3.36	10.30
UHFSChr 117	159.17	-121.20	1.04	1.31	37.39	3.85	3.73	-2.25
UHFSChr 118	161.92	-65.49	1.02	2.34	34.18	-22.94	2.94	13.81
UHFSChr 120	162.83	88.58	0.98	7.27	35.94	13.14	-1.71	-1.37
UHFSChr 121	156.50	-434.39	1.11	1.20	35.76	4.94	1.98	2.24
UHFSChr 122	156.82	-474.96	1.12	-0.77	37.28	11.69	0.54	0.68
UHFSChr 123	159.07	-468.12	1.11	16.50	35.83	-0.42	-0.90	6.48
UHFSChr 124	163.17	508.58	0.87	14.29	27.47	15.12	-1.55	-2.09
UHFSChr 125	161.28	263.05	0.94	0.82	37.24	-7.64	4.67	-0.42
UHFSChr 126	164.53	-60.81	1.01	22.11	35.10	6.54	2.06	1.27
UHFSChr 128	160.80	26.98	1.00	-1.25	37.98	13.48	0.78	-0.37
UHFSChr 129	169.18	991.60	0.72	11.91	33.33	10.13	-0.20	1.59
UHFSChr 130	159.96	-0.62	1.01	-1.11	33.07	17.02	0.33	-1.90
UHFSChr 131	160.84	1.23	1.01	-0.66	34.87	11.16	2.27	-1.50
UHFSChr 132	162.58	-30.78	1.01	7.46	37.28	8.67	-0.07	2.33
Surf	135.81	-87.50	1.02	11.15	35.06	-33.58	3.67	16.69
Pooled Mean	160.08		S.E = 1.63 SE of b = 0.06 Mean of b = 1.00		35.50		S.E(m) = 1.46 S.E of b = 2.53 Mean of b = 1.00	

'UHFSChr120' (162.83 days), 'UHFSChr132' (162.58 days), 'UHFSChr118' (161.92 days), 'UHFSChr115' (161.92 days), 'UHFSChr125' (161.28 days), 'UHFSChr113' (161.02 days) and 'UHFSChr131' (160.84 days) exhibited maximum mean values than overall mean (160.08 days). Genotypes 'UHFSChr125' 'UHFSChr128' and 'UHFSChr131' exhibited phenotypic index (pi) 263.05, 26.98, 1.23, regression coefficient (bi) 0.94, 1.00, 1.01, squared deviation from regression (S^2di) 0.82, -1.25, -0.66 respectively were found to be stable with days taken to flowering.

Data presented in Table 2 revealed that genotypes 'UHFSChr128' (37.98 cm), 'UHFSChr113'(37.50 cm), 'UHFSChr117' (37.39 cm), 'UHFSChr122' (37.76 cm), 'UHFSChr132' (37.28 cm), 'UHFSChr111' (36.85 cm), 'UHFSChr114' (36.25 cm), 'UHFSChr115' (36.22 cm) 'UHFSChr126' (35.94 cm), 'UHFSChr123' (35.83 cm), and 'UHFSChr121' (35.76 cm) recorded maximum mean value than overall mean (35.50 cm) for plant spread. The above mentioned genotypes did not qualify the stability criteria, hence revealed their unstable performance for plant spread.

Data related to duration of flowering revealed that genotypes such as 'UHFSChr132' (33.67 days), 'UHFSChr126' (33.25 days), 'UHFSChr111' (33.08 days), 'UHFSChr130' (32.67 days), 'Surf' (32.33 days), 'UHFSChr120' (32.17 days), 'UHFSChr124' (32.00 days), exhibited maximum mean values than the overall mean (29.16 days). However, the above mentioned genotypes did not fulfill the criteria of stability so; they were found unstable for this trait (Table 3).

Perusal of data presented in Table 4 revealed that genotypes 'UHFSChr124' (10.26 cm), 'Surf' (6.42), 'UHFSChr115' (6.24 cm), UHFSChr113' (5.71 cm), 'UHFSChr123' (5.65 cm), 'UHFSChr132' (5.49 cm), 'UHFSChr120' (5.46 cm), 'UHFSChr111' (5.43 cm), and 'UHFSChr129' (5.30 cm) recorded maximum mean values than overall mean (5.27 cm). Genotypes UHFSChr111', 'UHFSChr122'and 'UHFSChr132' recorded phenotypic index (pi) 0.21, 0.12, 0.19, regression coefficient (bi) 7.95, 8.77, 1.82, squared deviation from regression (S^2di) 7.95, 8.77, 1.82 were found to be most stable genotypes with respect to flower diameter.

Data related to number of side shoots per plant showed that genotypes 'UHFSChr114', 'UHFSChr115', (6.16), UHFSChr122' (6.02), 'UHFSChr125' (5.93),'UHFSChr117' (5.92), 'UHFSChr131' (5.85) 'UHFSChr123' (5.63), 'UHFSChr132' (5.75)', 'UHFSChr126' (5.50) exhibited high mean values than overall mean (5.50). Genotypes 'UHFSChr121' observed phenotypic index (pi) 0.93, with regression coefficient (bi) 0.98, and squared deviation from regression (S^2di) 0.60 was found to be most stable for this genotype for this trait.

Genotypes 'UHFSChr122' (752.74g), 'UHFSChr117' (659.47g), 'UHFSChr132,' (645.83g), 'UHFSChr111'

Table 3: Estimation of stability parameters in chrysanthemum for duration of flowering (days) and flower diameter (cm).

Genotype	Duration of flowering (days)				Flower diameter (cm)			
	Mean	pi	bi	S^2di	Mean	pi	bi	S^2 di
UHFSChr 111	33.08	-0.38	-0.51	0.50	5.43	0.21	1.27	-0.04
UHFSChr 113	27.08	-0.60	-1.39	0.41	5.71	-0.24	3.17	-0.01
UHFSChr 114	25.92	-7.19	3.17	1.26	4.68	-0.17	-1.86	-0.05
UHFSChr 115	27.00	2.82	0.89	-1.16	6.24	-0.28	3.28	-0.01
UHFSChr 117	27.83	2.93	-0.13	-1.13	3.68	0.26	0.34	-0.03
UHFSChr 118	26.75	1.62	2.41	-1.14	3.34	0.09	-0.96	0.03
UHFSChr 120	32.17	0.04	-1.01	0.20	5.46	-0.03	-0.59	0.11
UHFSChr 121	25.92	0.95	2.79	-1.04	4.63	0.01	2.21	-0.02
UHFSChr 122	27.50	-2.63	4.05	-0.25	5.43	0.12	0.99	0.02
UHFSChr 123	27.08	-1.71	3.80	-0.48	5.65	0.17	0.86	0.00
UHFSChr 124	32.00	-1.18	-1.39	0.70	10.26	0.30	0.26	-0.05
UHFSChr 125	26.08	0.07	2.66	-0.51	4.48	0.09	-0.02	0.06
UHFSChr 126	33.25	0.95	-1.27	-0.33	4.91	0.20	-0.69	-0.01
UHFSChr 128	27.08	-0.60	1.52	0.37	3.07	-0.33	3.33	0.01
UHFSChr 129	27.75	-1.93	2.66	0.49	5.30	-0.29	3.41	-0.02
UHFSChr 130	32.67	1.48	-0.38	-0.42	5.03	-0.85	4.25	0.11
UHFSChr 131	28.83	1.59	0.89	-0.55	4.90	0.27	0.55	-0.04
UHFSChr 132	33.67	-1.41	-0.51	1.01	5.49	0.19	1.31	-0.03
Surf	32.33	2.15	0.76	-0.81	6.42	-0.05	-2.11	0.02
Pooled Mean	29.16		S.E(m) = 0.59 Mean of b = 1.00 S.E of b = 2.11		5.27		S.E = 0.14 SE of b = 1.13 Mean of b = 1.00	

Table 4: Estimation of stability parameters in chrysanthemum for number of side shoots per plant and number of flowers per plant.

Genotype	Number of side shoots per plant				Number of flowers per plant			
	Mean	pi	bi	S^2di	Mean	pi	bi	S^2di
UHFSChr 111	5.30	0.46	-0.93	0.08	243.33	1787.70	-0.49	-85.63
UHFSChr 113	5.08	0.75	1.12	-0.08	230.75	1863.39	-0.12	-113.38
UHFSChr 114	5.67	0.83	0.54	-0.07	314.33	-3942.89	-5.60	423.10
UHFSChr 115	6.16	0.08	2.07	0.09	199.67	1777.92	-0.70	-92.13
UHFSChr 117	5.92	0.97	0.19	-0.13	412.17	1583.81	-0.48	16.69
UHFSChr 118	4.75	-1.03	0.51	0.86	139.17	1377.59	0.99	86.17
UHFSChr 120	5.60	1.03	-0.07	-0.16	179.83	6.03	3.44	283.10
UHFSChr 121	5.19	0.93	0.98	-0.16	243.50	1466.48	1.66	-38.98
UHFSChr 122	6.02	0.16	2.72	-0.11	326.08	-2813.05	4.81	1181.53
UHFSChr 123	5.63	-1.52	-0.02	1.12	66.00	1804.81	-0.03	-83.50
UHFSChr 124	4.17	-0.17	-1.03	0.39	30.25	1893.61	0.36	-133.81
UHFSChr 125	5.93	-0.52	0.60	0.60	241.17	1727.81	-0.06	-45.12
UHFSChr 126	5.50	0.72	0.70	-0.03	216.42	1592.28	-0.86	-10.64
UHFSChr 128	5.83	-0.17	2.23	0.18	427.08	-13246.61	7.85	4662.40
UHFSChr 129	5.25	-0.59	2.17	0.40	109.83	1782.48	0.39	-79.21
UHFSChr 130	5.80	-0.36	3.45	-0.09	113.92	1882.06	0.42	-129.98
UHFSChr 131	5.85	0.47	2.33	-0.16	259.50	1486.48	1.77	-64.86

UHFSChr 132	5.75	-0.59	1.02	0.60	405.33	-5768.97	5.98	2092.03
Surf	5.11	-1.44	0.41	1.07	114.58	1833.39	-0.32	-102.48
Pooled Mean	5.50		SE (m) = 2.24 SE(b) = 2.24 Mean of b = 1.00		224.89		SE = 13.45 SE of b = 2.45 Mean of b = 1.00	

Table 5: Estimation of stability parameters in chrysanthemum for flower weight per plant (g) and flower weight per square meter (g).

Genotype		Flower weight per plant (g)			Flower weight per square meter (g)			
	Mean	pi	bi	S^2di	Mean	pi	bi	S^2di
UHFSChr 111	511.00	3522.74	-0.36	-243.26	4599.00	286145.26	-0.37	-20308.86
UHFSChr 113	459.17	3929.90	0.21	-433.05	4132.50	319125.04	0.21	-35537.22
UHFSChr 114	377.20	-5677.76	-2.95	913.64	3394.80	-459898.56	-2.93	73111.54
UHFSChr 115	419.30	3479.62	-0.65	-271.22	3753.38	264387.86	-0.45	-10370.80
UHFSChr 117	659.47	3219.08	-0.10	-71.81	5941.88	265202.60	-0.15	-8312.79
UHFSChr 118	133.05	3585.80	0.50	-294.25	1197.48	291252.73	0.51	-24512.86
UHFSChr 120	192.42	1868.59	1.88	17.24	1731.75	152147.96	1.89	-230.78
UHFSChr 121	358.78	3073.92	1.61	-425.28	3228.98	249790.59	1.60	-35037.87
UHFSChr 122	572.74	-14171.14	5.79	3054.19	5154.64	-1147058.96	5.80	240034.30
UHFSChr 123	191.40	3194.64	0.30	-72.85	1722.60	259569.52	0.30	-6392.12
UHFSChr 124	220.83	3399.20	1.34	-458.52	1987.43	276138.45	1.33	-37557.16
UHFSChr 125	219.04	3685.09	-0.21	-310.70	1971.15	299216.23	-0.20	-25570.56
UHFSChr 126	244.50	3314.84	-1.12	-325.98	2200.50	269305.68	-1.11	-26752.53
UHFSChr 128	279.53	-13079.47	6.33	1435.81	2515.66	-1059048.92	6.25	122410.04
UHFSChr 129	329.50	2934.12	0.80	-34.58	2965.50	238467.04	0.78	-2873.44
UHFSChr 130	170.88	3989.93	0.32	-472.81	1537.50	323854.54	0.32	-38723.05
UHFSChr 131	413.19	2904.03	1.65	-364.77	3718.73	236029.41	1.65	-30492.40
UHFSChr 132	645.83	-18295.03	4.15	7827.10	5812.50	-1481093.84	4.07	639287.54
Surf	733.30	1078.77	-0.49	959.74	6599.68	88171.32	-0.48	77403.15
Pooled Mean	375.32		S.E(m) = 18.54 S.E of b = 1.76 Mean of b = 1.00		3377.14		S.E(m) = 167.60 Mean of b = 1.00 S.E of b = 1.75	

(511.00g), 'UHFSChr113' (459.17g), 'UHFSChr115' (419.30g) 'UHFSChr131' (413.19g), 'UHFSChr114' (377.20g) and 'UHFSChr121' (358.78g) recorded mean value maximum than the overall mean (375.32g). However, the above mentioned genotypes did not fulfill the stability criteria hence revealed that their unstable performance for flower weight per plant (Table 5).

Flower weight per square meter indicated that genotypes 'Surf' (6599.68g), 'UHFSChr117' (5941.88g), 'UHFSChr132' (5812.50g), 'UHFSChr122' (5154.64g), UHFSChr111 (4599g), 'UHFSChr113' (4132.50g), 'UHFSChr115' (3753.38g), 'UHFSChr131' (3718.73g), 'UHFSChr114' (3394.80g) and recorded maximum mean values than overall mean (3377.14).

However, the above said genotypes did not fulfill the stability criteria hence showed that their unstable performance for flower weight per square meter.

The character wise stable genotypes are presented for different characters are given in Table 6. For loose flower stable performance found with genotypes, For character like plant height genotypes 'UHFSChr113' and 'UHFSChr114' genotypes 'UHFSChr125', 'UHFSChr128' and 'UHFSChr131' for days taken to flowering and for flower diameter genotypes 'UHFSChr111', 'UHFSChr122', 'UHFSChr132', and genotype 'UHFSChr121' found stable for number of side shoots were not influenced much by the season as well as environment and stable across the location and season. Similar finding were also reported by: Vaidya [6], Priyanka [7] and Kumar, et al. [8] in chrysanthemum; Ramberg and Chirva [9], Arora and Sharma (1991), Desh Raj and Misra [10,11], Pant and Lal (1998) in gladiolus; Misra, et al. [12] carnation; Naik [13], Patil, et al. [14] in marigold.

Table 6: Character wise stable performance of chrysanthemum genotype.

Sr No.	Characters	Loose flower
	Plant height (cm)	UHFSChr 114, UHFSChr 113
	Days taken to flower bud formation	UHFSChr 128
	Days taken to flowering	UHFSChr 125 UHFSChr 128 UHFSChr 131
	Plant spread (cm)	-
	Duration of flowering (days)	-
	Flower diameter (cm)	UHFSChr 111, UHFSChr 122 UHFSChr 132
	Number of shoots per plant	UHFSChr 121
	Number of flowers per plant	UHFSChr 121 UHFSChr 131
	Flower weight per plant (g)	-
	Flower weight per square meter	-

Conclusion

For loose flower stable performance found with genotypes,'UHFSChr113', 'UHFSChr114' 'UHFSChr125', 'UHFSChr121', 'UHFSChr128' and 'UHFSChr131' can be selected for further breeding programme.

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