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Evaluation of diversity through genetic variability and correlation in gladiolus (*Gladiolus hybrida*) genotypes

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ABSTRACT

Evaluation of diversity through genetic variability and correlation studies on vegetative and floral characters of gladiolus (*Gladiolus hybrida*) genotypes were undertaken at experimental farm, KVK, Sangsanggiri, Tura, West Garo Hills District, Meghalaya during 2014–16.Twenty two gladiolus cultivars, viz. The Queen, Red Majesty, Applause, Charm Glow, Candyman, Interpid, Eight Wonder, Pacifica, Tiger Flame, Souvenier, American Beauty, Oscar,White Prosperity, Wedding Bouquet, Poppy Tears, Morocco Beauty, Summer Sunshine, Wing Wang Sang, Her Majesty, Green Bay, Priscilla and Red Ginger were selected for their evaluation. The range of variation was high in days taken for floret opening (77.53-119.47). However, highest phenotypic (408.38), genotypic variances (404.45), PCV (53.62) and GCV (53.36) were associated with corm weight. The estimates of phenotypic coefficient of variation (PCV) were higher than genotypic coefficient of variation (GCV) for all the traits. Maximum heritability was also noticed in corm weight (99.38), whereas minimum was observed in number of tillers/plant (40.34).The high heritability with genetic advance as percentage of mean for corm weight indicates the possible role of additive gene action. The magnitude of genotypic correlation was higher than their corresponding phenotypic correlation for most of the traits, indicating a strong inherent linkage between various traits under study. At genotypic and phenotypic level, days for sprouting of corms exhibited highly significant and positive correlation with days for spike initiation and days for floret opening. Vase life was highly significant and positively correlated with rachis length, number of florets/spike, fresh weight of spike, spike girth and field life.

Key words: Correlation, Genetic Advance, Genetic Variability, Gladiolus, Heritability

Gladiolus (*Gladiolus hybrida*) is one of the most popular cut flowers in international and domestic markets. It prefers cool and dry conditions and temperature plays a major role in growth and flowering. This crop is grown commercially under open field conditions, all over the country. There are excellent varieties of gladiolus with magnificent inflorescence in exhaustive range of colours, different shades, varying number of florets, arrangement of the florets, spike length, postharvest life and adaptability to different seasons. The florets open in acropetal succession over a long duration and hence possess good keeping quality. Gladiolus cultivation has gained popularity among farmers due to ease of cultivation and good profit. A huge quantum of variability exists in this crop with respect to shape, size, growth habit, flowering behaviour, vase life etc. Various workers evaluated different cultivars/hybrids of gladiolus under different regions (Pandey *et al.* 2009, Pragya *et al.* 2010, Moond *et al.* 2011, Kumar 2015). In spite of such variability, very few are having desirable characters for yield, vase life and flower quality. So, there is an urgent need for selection as well as maintenance of good germplasm. The interrelationship of various characters in the form of correlation is an important aspect in crop breeding. Knowledge of correlation studies helps the plant breeder to ascertain the components of yield and provide an effective basis of selection. The characters contributing significantly to desirable traits can be significantly identified and used as alternate selection criteria in crop improvement programme. For effective breeding programme, knowledge of the mean performance, magnitude of genetic variability, heritability and genetic advance is essential. Heritability gives a measure of transmission of characters from one generation to the other, enabling a plant breeder in isolation of elite selection in the crop. Genotypic and phenotypic coefficient of variation, heritability and genetic advance constitute the important genetic parameters which frequently applied in plant breeding for crop improvement. Genetic parameters like genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance are useful biometrical tools for determination of genetic variability (Aditya *et al*. 2011). Coefficient of variation allows meaningful comparison of the variation of several traits of plants belonging to the same population

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as well as a comparison of the variation of same trait as expressed by different population. Heritability tells us about the additive genetic variance and phenotypic variance (Nyquist 1991). Now a day, climatic condition of north eastern region is highly variable due to climate change and introduced varieties vary in performance. The performance of any crop or variety extensively depends on genotypic and environmental interaction. As a result, cultivars which perform well in one region may not perform same in other regions of varying climatic conditions. Therefore, it becomes essential to develop varieties suited to specific climatic condition which can be further utilized for genetic improvement of gladiolus. However, no systematic efforts were made in the past to identify the suitable genotypes of gladiolus for cut flower production and crop improvement programme under agro-climatic condition of Tura, Meghalaya. Hence, the present study on different varieties was undertaken to assess their genetic variability, heritability, genetic advance, correlation coefficient and suitability in crop improvement under agroc1imatic conditions of Tura,West Garo Hills district, Meghalaya.

MATERIALS AND METHODS

The study was carried out at experimental farm, KVK, Sangsanggiri, Tura, West Garo Hills district, Meghalaya during October 2014 to May 2016. The experiment was laid out in randomized completely block design (RCBD) with three replications and twenty two treatments namely,The Queen, Red Majesty, Applause, Charm Glow, Candyman, Interpid, Eight Wonder, Pacifica, Tiger Flame, Souvenier, American Beauty, Oscar, White Prosperity, Wedding Bouquet, Poppy Tears, Morocco Beauty, Summer Sunshine, Wing Wang Sang, Her Majesty, Green Bay, Priscilla and Red Ginger for their evaluation under open field condition. Uniform size of gladiolus corms (3.00-4.00 cm diameter) were planted on raised bed at spacing 30cm × 30cm under irrigated condition during second fortnight of October. Uniform package of practices were followed throughout the experiment to grow a healthy crop. Observations were recorded for days for sprouting of corms, plant height, number of leaves/plant, length of leaf, breadth of leaf, number of tillers/plant, days taken for spike emergence after sprouting, days taken to flowering after spike emergence, days to first floret open after colour break, spike length, rachis length, number of florets/spike, diameter of second floret, diameter of flower stalk, fresh weight of spike, corm weight, cormel weight, polar diameter of corm, equatorial diameter of corm, cormel diameter, field life, vase life. The data collected were pooled and analyzed statistically. Phenotypic and genotypic coefficient of variation was calculated as per formula described by Burton (1952) and Burton and Devane (1953). Heritability in broad sense was worked out according to formula suggested by Allard (1960) and genetic advance as per cent of mean was calculated following method by Johnson *et al.* (1955). Phenotypic and genotypic correlation was computed as suggested by Al Jibouri *et al.* (1958).

RESULTS AND DISCUSSION

Mean performance, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability, genetic advance and genetic gain

The extent of variability with respect to twenty quantitative characters in twenty two gladiolus genotypes were measured in terms of mean performance, phenotypic coefficient of variation (PCV), genotypic coefficient of variation (GCV), heritability, genetic advance and genetic gain are presented in Table 1.The range of variation was high in days taken for floret opening (77.53-119.47) followed by days taken for spike initiation (68.58-110.17) and spike length (55.07-109.77), respectively. Highest phenotypic and genotypic variances were observed for corm weight (408.38 and 404.45) followed by spike length (197.06 and 195.83) and days taken for floret opening (145.83 and 141.94) at both the level, respectively, whilst lowest were observed for diameter of flower stalk (0.02 and 0.02) at phenotypic and genotypic level, respectively. Kumar *et al.* (2013) and Balaram and Janakiram (2009) also reported higher phenotypic and genotypic variation with corm weight in gladiolus. The better idea can be gained by comparing the relative amount of phenotypic and genotypic coefficient of variance for the actual strength of variability. The genotypic coefficient of variation provides a valid basis for comparing and accessing the range of genetic diversity for quantitative characters and phenotypic coefficient of variation measures the extent of total variance. Phenotypic coefficient of variation and genotypic coefficient of variation are better indices for comparison of characters. The estimates of phenotypic coefficient of variation were higher than genotypic coefficient of variation for all the traits studied which is an indicator of additive effect of the environment on the expression of the trait. Maximum phenotypic coefficient of variation was observed for corm weight (53.62) followed by cormel weight (34.41) and days for sprouting of corms (31.13), while, minimum was recorded in days taken for floret opening (11.81). The higher PCV and GCV estimates were found for number of daughter corm/mother corm and cormel production in gladiolus (Kumar *et al*. 2013) and Balaram and Janakiram (2009) indicated the presence of considerable variability in these traits and scope for selection and improvement. Kumar *et al.* (2015) also noticed the high value of PCV along with GCV for plant height, corm weight and cormels weight. Genotypic coefficient of variance showed a range of variation from 11.66 to 53.36 in days taken for floret opening and corm weight, respectively. Maximum genotypic coefficient of variance was noticed for corm weight (53.36) followed by cormel weight (33.84) and days for sprouting of corms (30.81). The higher value of phenotypic coefficient of variation and genotypic coefficient of variation were observed by Kadam *et al.* (2014) in gladiolus. Bichoo *et al.* (2002) also observed high genotypic coefficient of variations for corm and cormel weight in gladiolus indicated the presence of sufficient genetic variability for selection.

Table 1 Estimates of variance, coefficient of variation, heritability, genetic advance and genetic gain for different characters of gladiolus varieties

Characters	Range	General mean	Variance (σ^2)		Coefficient of variation		Heritability (Broad sense) %	Genetic advance (GA)	Genetic advance as per cent of mean ($\overline{GA}$)
			Phenotypic (σ^2p)	Genotypic (σ^2g)	PCV (%)	GCV (%)			
Days for sprouting of corms	6.67-29.00	22.58	49.44	48.40	31.13	30.81	97.90	14.18	62.79
Plant height	52.83-90.23	75.75	120.56	118.83	14.49	14.39	98.56	22.29	29.43
Number of leaves/plant	6.07-9.80	7.74	1.20	1.10	14.18	13.55	91.39	3.07	26.68
Length of leaf	38.87-65.47	56.32	47.14	46.09	12.19	12.05	97.77	13.83	24.55
Breadth of leaf	2.73-5.27	4.06	0.41	0.39	15.72	15.47	96.84	1.27	31.37
Number of tillers/plant	1.00-1.78	1.46	0.11	0.05	23.13	14.69	40.34	0.28	19.23
Days taken for spike initiation	68.58-110.17	91.50	140.94	139.60	12.98	12.91	99.05	24.22	26.47
Days taken for floret opening	77.53-119.47	102.22	145.83	141.94	11.81	11.66	97.33	24.21	23.69
Spike length	55.07-109.77	72.43	197.06	195.83	19.38	19.32	99.04	28.74	39.68
Rachis length	29.87-65.50	44.90	67.28	65.69	18.27	18.05	97.64	16.50	36.74
Number of florets/spike	8.40-15.13	11.38	3.82	3.50	17.18	16.45	91.69	3.69	32.44
Fresh weight of spike	38.33-72.67	60.13	112.50	108.65	17.64	17.33	96.58	21.10	35.09
Diameter of second floret	4.70-10.23	7.50	1.61	1.54	16.90	16.56	95.96	2.51	33.42
Diameter of flower stalk	0.34-0.90	0.63	0.02	0.02	24.58	23.74	93.27	0.30	47.23
Corm weight	9.60-96.33	37.69	408.38	404.45	53.62	53.36	99.38	41.23	109.40
Cormel weight	13.51-48.34	28.58	96.74	93.47	34.41	33.84	96.62	19.58	68.49
Polar diameter of corm	1.20-3.37	1.94	0.34	0.30	30.15	28.19	86.92	1.05	53.99
Equatorial diameter of corm	2.73-7.47	4.41	1.66	1.58	29.21	28.52	95.35	2.53	57.37
Field life	7.67-14.10	10.76	3.40	3.24	17.12	16.72	95.31	3.62	33.62
Vase life	6.47-11.73	8.52	2.03	1.90	16.73	16.20	93.67	2.75	32.29

Burton (1952) has suggested that genetic coefficient of variation together with heritability estimates would give adequate information for extent of advancement through selection. A vast variation was recorded for heritability (broad sense) in different quantitative characters of gladiolus genotypes. The high value of PCV along with GCV indicated that there is more variability in the characters like corm weight and cormels weight. Closeness between PCV and GCV indicated that the phenotypic expression of all the genotypes is mostly under genetic control and environment has less influence on their expression (Singh and Singh 1987). High heritability was observed for all the traits under study. Nair and Shiva (2003) and Chobe *et al.* (2010) also reported high heritability for most of the quantitative traits in gerbera.Maximum heritability was recorded for corm weight (99.38) followed by days taken for spike initiation (99.05), spike length (99.04) and plant height (98.56), whereas minimum heritability was noticed in number of tillers/plant (40.34). Similar findings were observed in gladiolus by Mahanta and Paswan (1995).High heritability showed the possibility of effective base on the phenotypic expression. Corm weight is a potential character for selection in gladiolus cultivars; the environmental influence was considerable for this trait which could be observed from the differences between genotypic and phenotypic coefficient of variation. Most of the traits indicated the dominance of additive gene effect, hence direct selection of such traits may lead to improvement of quality. The minimum genetic advance was recorded in number of tillers/plant (0.28), however, the maximum genetic advance was observed in corm weight (41.23). A range of variation, i.e 19.23 and 99.40 was recorded for number of tillers/plant and corm weight, respectively. High heritability associated with high genetic advance proves more useful for efficient improvement of a character through selection. The high heritability with high genetic advance as percentage of mean associated with corm weight (99.38 and 99.40) indicating the possible role of additive gene action. The similar genetic behaviour had been reported in gladiolus (Balaram and Janakiram 2009, Archana *et al.* 2008).The parallelism between the magnitude of heritability and degree of genetic gain has been due to additive gene playing a predominant role and therefore, this was more reliable for effective selection. The characters, days for sprouting of corms, number of leaves/plant, length of leaves, number of florets/spike, weight of corms and cormels weight/plant exhibited high heritability along with high genetic advance which indicated that, there was additive gene action in expression of these traits and thereby further improvement could be made by selection (Kumar *et al.* 2011). High heritability with high genetic advance was also observed for plant height, days to first floret show colour, weight of corm and cormel production in gladiolus by Kumar *et al*. (2013).

Correlation coefficient analysis

Correlation measures the degree of association between the characters. Information on correlation between the important economic traits are of considerable help in the selection programme, because correlation ensures simultaneous improvement in one or two or more variables and negative correlations bring out the need to obtain a compromise between the desirable traits. The analysis of variance revealed significant variation among all the 22 genotypes of gladiolus for all 20 attributes (Table 2 and 3). In general, phenotypic correlations are smaller than genotypic correlation. This could occur when genes governing two traits are similar and environmental conditions pertaining to the expression of these traits have small and similar effects. A positive correlation between desirable characters is favourable to the plant breeder because it helps in simultaneous improvement of both the characters. High positive correlation between the traits indicates that selection for improvement of one character leads to the simultaneous improvement in the other characters depending upon the magnitude of association between them. The characters are considered to be independent when weak correlation exists between them and selection for a character may not affect the other (Falconer 1981). Whereas, genotypic correlation provides a measure of genetic association between characters and is generally used in selection for one character as a measure of improving another. The genotypic correlation in the true sense may be interpreted as the correlation of breeding value. The magnitude of genotypic correlation was higher than their corresponding phenotypic correlation for most of the traits, indicating thereby, a strong inherent linkage between various traits under study. Similar trend has been observed by Anuradha (1998) in gerbera for most of the characters; these findings indicate that though there is strong inherent association between various characters, the phenotypic expression is reduced under the influences of environment. In some cases, phenotypic and genotypic correlations were very close indicating less environmental influences. Anuradha and Gowda (2002) and Magar *et al.* (2010) have also reported higher genotypic correlation coefficient than phenotypic correlation coefficient among the various traits in gerbera.

Genotypic level

At genotypic level, days for sprouting of corms (Table 2) exhibited positive significant correlation with fresh weight of spike (0.253) and attained highly significant positive correlation with days for spike initiation (0.744) and days for floret opening (0.768), while on the other hand showed significant negative correlation with number of leaves (-0.276), diameter of second floret (-0.261) and spike girth (-0.261) and highly significant negative correlation with spike length (-0.359), polar diameter of corm (-0.354) and equatorial diameter of corm (-0.318). Pal and Singh (2012) also noticed similar correlation coefficients among characters in gladiolus. Plant height was highly significant and positively correlated with number of leaves (0.772), leaf length (0.871), leaf breadth (0.532), number of tillers/plant (0.363), spike length (0.351), rachis length (0.388), number of florets/spike (0.433), fresh weight of spike (0.443), spike girth (0.444) and field life (0.404), whereas significant and positive correlation with diameter of second floret (0.256), corm weight (0.251) and vase life (0.257) but highly significant negative correlation with days for spike initiation (-0.338) and days for floret opening (-0.357) was observed. Significant and positive correlation of plant height with number of leaves/plant, spike length, rachis length and diameter of florets indicating that with the increase of plant height these associated characters could be improved (Kumar *et al.* 2011).The significant and positive association of plant height with spike length in gladiolus was also reported by Gowda, (1989), Kumar *et al*. (2012), (2013) and Kumar and Kumar (2010) in snapdragon. The number of leaves showed highly significant and positive correlation with leaf length (0.605), leaf breadth (0.414), number of tillers (0.521), spike length (0.316), rachis length (0.433), number of florets/spike (0.351), fresh weight of spike (0.431), corm weight (0.451), equatorial diameter of corm (0.331) and field life (0.321), while, significant positive correlation was observed with spike girth (0.251) and vase life (0.249). Anuradha and Gowda (2002**)** also observed positive correlation of flower yield with number of leaves in gerbera. However, highly significant negative correlation with days for spike initiation (-0.409) and days for floret opening (-0.433) was noticed.

Leaf length showed highly significant and positive correlation with leaf breadth (0.734), number of tillers/plant (0.464) and fresh weight of spike (0.371), while, significant and positive correlation with rachis length (0.311). Kumar (2015) also reported significant and positive correlation of leaf length with rachis length in gladiolus. Leaf breadth was highly significant and positively correlated with number of tillers/plant (0.597), cormel weight (0.532) and polar diameter of the corm (0.331), whereas number of tillers/plant was significant and negatively correlated with days for floret opening (-0.293).

Days for spike initiation exhibited highly significant negative correlation with spike length (-0.318) and equatorial diameter of corm (-0.331), whereas highly significant and positive correlation with days for floret opening (0.994) was observed. Days for floret opening had highly significant but negative correlation with spike length (-0.333), but significant and negative correlation with equatorial diameter of corm (-0.292). Spike length showed highly significant and positive correlation with rachis length (0.837), diameter of second floret (0.612), spike girth (0.562) and corm weight (0.315) and attained significantly positive correlation with

Table 2 Inter character association (genotypic correlation) between different gladiolus varieties

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1	-0.187	-0.276*	-0.069	-0.222	-0.008	0.744**	0.768**	-0.359**	-0.155	0.017	0.253*	-0.261*	-0.261*	-0.243	-0.146	-0.354**	-0.318**	0.049	0.242
2		1	0.772**	0.871**	0.532**	0.363**	-0.338**	-0.357**	0.351**	0.388**	0.433**	0.443**	0.256*	0.444**	0.251*	0.081	0.132	0.132	0.404**	0.257*
3			1	0.605**	0.414**	0.521**	-0.409**	-0.433**	0.316**	0.433**	0.351**	0.431**	0.113	0.251*	0.451**	0.041	0.232	0.331**	0.321**	0.249*
4				1	0.734**	0.464**	-0.208	-0.216	0.241	0.311*	0.241	0.371**	0.027	0.241	0.182	0.169	0.162	0.106	0.226	0.065
5					1	0.597**	-0.187	-0.201	-0.053	-0.013	0.048	0.069	-0.058	0.141	0.043	0.532**	0.331**	0.213	0.003	-0.146
6						1	-0.223	-0.293*	-0.017	0.052	-0.179	0.206	0.015	-0.011	-0.024	0.145	-0.115	-0.012	-0.216	-0.158
7							1	0.994**	-0.318**	-0.032	-0.035	0.222	-0.174	-0.209	-0.182	0.109	-0.159	-0.331**	0.002	0.117
8								1	-0.333**	-0.065	-0.081	0.171	-0.221	-0.231	-0.161	0.102	-0.148	-0.292*	-0.039	0.078
9									1	0.837**	0.292*	-0.101	0.612**	0.562**	0.315**	0.016	0.118	0.105	0.254*	0.156
10										1	0.467**	0.314**	0.479**	0.497**	0.547**	0.189	0.227	0.172	0.451**	0.336**
11											1	0.471**	0.368**	0.441**	0.185	0.163	0.166	-0.045	0.984**	0.776**
12												1	-0.085	-0.015	0.155	-0.047	-0.173	-0.149	0.542**	0.523**
13													1	0.936**	-0.151	0.236	0.004	-0.146	0.317**	0.321**
14														1	-0.012	0.361**	0.179	0.041	0.398**	0.378**
15															1	0.232	0.681**	0.809**	0.191	0.137
16																1	0.388**	0.313**	0.157	0.089
17																	1	0.825**	0.131	0.052
18																		1	-0.031	0.077
19																			1	0.859**
20																				1

Characters 1.Days for sprouting of corms, 2.Plant Height, 3.Number of leaves, 4.Leaf length, 5.Leaf breadth, 6.Number of tillers/plant, 7. Days for spike initiation, 8.Days for floret opening, 9.Spike length, 10. Rachis length, 11.Number of florets/spike, 12.Fresh weight of spike, 13.Diameter of second floret, 14. Spike girth, 15.Corm weight, 16.Cormel weight, 17.Polar diameter of corm, 18.Equatorial diameter of corm, 19.Field life, 20.Vase life.

Table 3 Inter character association (phenotypic correlation) between different gladiolus varieties

Character	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1	-0.191	-0.276*	-0.068	-0.201	-0.014	0.717**	0.749**	-0.342**	-0.147	0.026	0.241	-0.248*	-0.243	-0.238	-0.131	-0.305*	-0.299*	0.061	0.241
2		1	0.735**	0.857**	0.517**	0.214	-0.337**	-0.353**	0.343**	0.385**	0.409**	0.435**	0.251*	0.423**	0.249*	0.075	0.135	0.133	0.386**	0.237
3			1	0.576**	0.382**	0.361**	-0.393**	-0.421**	0.297*	0.404**	0.316**	0.409**	0.115	0.231	0.424**	0.039	0.228	0.296*	0.298*	0.226
4				1	0.714**	0.303*	-0.204	-0.211	0.234	0.301*	0.227	0.361**	0.021	0.234	0.177	0.161	0.144	0.108	0.219	0.063
5					1	0.366**	-0.183	-0.191	-0.052	-0.015	0.033	0.069	-0.061	0.138	0.043	0.513**	0.313**	0.201	-0.002	-0.143
6						1	-0.132	-0.143	-0.006	0.023	-0.111	0.089	0.001	-0.004	-0.021	0.086	-0.041	-0.029	-0.126	-0.084
7							1	0.983**	-0.314**	-0.035	-0.032	0.217	-0.167	-0.206	-0.181	0.106	-0.151	-0.316**	0.006	0.111
8								1	-0.327**	-0.066	-0.071	0.157	-0.212	-0.222	-0.161	0.092	-0.139	-0.283*	-0.035	0.071
9									1	0.824**	0.286*	-0.097	0.594**	0.540**	0.314**	0.021	0.106	0.105	0.252*	0.156
10										1	0.456**	0.309*	0.458**	0.474**	0.541**	0.185	0.215	0.169	0.435**	0.325**
11											1	0.459**	0.334**	0.394**	0.177	0.149	0.137	-0.022	0.947**	0.752**
12												1	-0.086	-0.025	0.155	-0.044	-0.164	-0.134	0.526**	0.501**
13													1	0.893**	-0.148	0.229	0.011	-0.148	0.292*	0.299*
14														1	-0.009	0.357**	0.173	0.016	0.359**	0.338**
15															1	0.228	0.636**	0.791**	0.183	0.131
16																1	0.357**	0.292**	0.148	0.091
17																	1	0.758**	0.109	0.022
18																		1	-0.013	0.081
19																			1	0.833**
20																				1

Characters 1.Days for sprouting of corms, 2.Plant Height, 3.Number of leaves, 4.Leaf length, 5.Leaf breadth, 6.Number of tillers/plant, 7. Days for spike initiation, 8.Days for floret opening, 9.Spike length, 10. Rachis length, 11.Number of florets/spike, 12.Fresh weight of spike, 13.Diameter of second floret, 14. Spike girth, 15.Corm weight, 16.Cormel weight, 17.Polar diameter of corm, 18.Equatorial diameter of corm, 19.Field life, 20.Vase life.

number of florets/spike (0.292) and field life (0.254). Kumar and Kumar (2010) also noticed significant and positive correlation of spike length with rachis length and number of florets/spike in snapdragon. Rachis length observed highly significant and positive correlation with number of florets/spike (0.467), fresh weight of spike (0.314), diameter of second floret (0.479), spike girth (0.497), corm weight (0.547), field life (0.451) and vase life (0.336). Similar results were observed in gladiolus which reveals that floret diameter exhibited significant and positive correlation with marketable spikes/corm and number of daughter corm/ mother corms (Kumar *et al.* 2013).

However, number of florets/spike had highly significant and positive correlation with plant height (0.409), number of leaves (0.316), fresh weight of spike (0.471), diameter of second floret (0.368), spike girth (0.441), field life (0.984) and vase life (0.776). Misra and Saini (1990) also reported positive significant correlations of number of florets/spike with plant height, number of leaves and durability of spike. Fresh weight of spike showed highly significant and positive correlation with field life (0.542) and vase life (0.523). Diameter of second floret also recorded highly significant positive correlation with spike girth (0.936), field life (0.317) and vase life (0.321). Spike girth attained highly significant and positive correlation with cormel weight (0.361), field life (0.398) and vase life (378).Both corm weight and cormel weight attained highly significant and positive correlation with polar diameter of corm (0.681 and 0.388) and equatorial diameter of corm (0.809 and 0.313). Positive significant correlations were also observed for corm weight and corm diameter in gladiolus at both genotypic and phenotypic levels (Archana *et al*. 2008).Polar diameter of corm was highly significant and positively correlated with equatorial diameter of corm (0.825), while field life showed highly significant positive correlation with vase life (0.859).However, the vase life showed highly significant and positive correlation with rachis length, number of florets per spike, fresh weight of spikediameter of second floret, spike girth and field life, but, significant and positive correlation with plant height and number of leaves. Similar results corroborate with the findings as vase life was highly positive correlated with rachis length in *Dendrobium* orchid (Kumar and Sharma 2013).

Phenotypic level

At phenotypic level days for sprouting of corms (Table 3) exhibited highly significant positive correlation with days for spike initiation (0.717) and days for floret opening (0.749), however, highly significant but negative correlation with spike length (-0.342) and significant negative correlation with number of leaves (-0.276), diameter of second floret (-0.248), polar diameter of corm (-0.305) and equatorial diameter of corm (-0.299) was observed. Whereas, plant height attained highly significant and positive correlation with number of leaves (0.735), leaf length (0.857), leaf breadth (0.517), spike length (0.343), rachis length (0.385), number of florets/spike (0.409), fresh weight of spike (0.435), spike girth (0.423) and field life (0.386). Kumar *et al*. (2011) also observed that plant height was significantly and positively correlated with number of leaves per plant in gladiolus. Significant and positive correlation of plant height with diameter of second floret (0.251) and corm weight (0.249) was also observed, while, it was highly significant but negatively correlated to days for spike initiation (-0.337) and days for floret opening (-0.353). Highly significant and positive correlation of number of leaves with leaf length (0.576), leaf breadth (0.382), number of tillers/plant (0.361), rachis length (0.404), number of florets/spike (0.316), fresh weight of spike (0.409) and corm weight (0.424) was observed, but significant and positive correlation was associated with spike length (0.297), equatorial diameter of corm (0.296) and field life (0.298). Similar findings were observed by Kumar *et al.* (2012) in gerbera which reveals that cut flower production can be increased by selecting for number of leaves. However, highly significant but negative correlation of number of leaves with days for spike initiation (-0.393) and days for floret opening (-0.421) was obtained. Leaf length was highly significant and positively correlated with leaf breadth (0.714) and fresh weight of spike (0.361), but significant and positive correlation with number of tillers/ plant (0.303) and rachis length (0.301). There were highly significant and positive correlation of leaf breadth with number of tillers/plant (0.366), cormel weight (0.513) and polar diameter of corm (0.313). No significant correlation for number of tillers/plant was observed with any of the other characters.

Days for spike initiation had highly significant and positive correlation with days for floret opening (0.983), while it was highly significant and negatively correlated to spike length (-0.314) and equatorial diameter of corm (-0.316). Days for floret opening was observed to be highly significant and negatively correlated to spike length (-0.327) and significant negative correlation with equatorial diameter of corm (-0.283).Spike length attained highly significant and positive correlation with rachis length (0.824), diameter of second floret (0.594), spike girth (0.540) and corm weight (0.314), while significant and positive correlation with number of florets/spike (0.286) and field life (0.252). Balaram and Janakiram (2009) also reported positive and significant relationship of floret diameter with spike length in gladiolus. Number of florets/spike (0.456), diameter of second floret (0.458), spike girth (0.474), corm weight (0.541), field life (0.435) and vase life (0.325) attained highly significant and positive correlation with rachis length, whilst there was a significant and positive correlation between rachis length and fresh weight of spike (0.309). However, highly significant and positive correlation for number of florets/spike with plant height (0.409), number of leaves (0.316), rachis length (0.459), fresh weight of spike (0.459), diameter of second floret (0.334), spike girth (0.394), field life (0.947) and vase life (0.752), while, significant and positive correlation with spike length (0.286) was attained. Positive association of the number of florets/spike with the number of leaves, spike length and spike diameter in gladiolus was also observed (Rathore 2014).

Fresh weight of spike was highly significant and positively correlated to field life (0.526) and vase life (0.501). Diameter of second floret showed significant positive correlation with field life (0.292) and vase life (0.299), however, attained highly significant and positive correlation with spike girth (0.893).Kumar (2014) also noticed that diameter of flower had highly significant and positive association with diameter of flower stalk in gerbera.

Highly significant and positive correlation of spike girth was observed with cormel weight (0.357), field life (0.359) and vase life (0.338).Both corm weight and cormel weight exhibited highly significant and positive correlation with polar diameter (0.636 and 0.357) and equatorial diameter of corm (0.791 and 0.292), while, corm weight showed significant and positive correlation with plant height (0.249), whereas highly significant and positive correlation with number of leaves (0.424), spike length (0.314) and rachis length (0.541). Positive correlation was also recorded for corm weight with plant height and spike length in gladiolus (Kumar *et al.* 2012).Highly significant and positive correlation of corm diameter with corm weight and polar diameter of corm was also noticed in gladiolus (Kumar *et al*. 2015).Field life showed highly significant positive correlation with vase life (0.833). It has been observed that both field life and vase life attained highly significant and positive correlation with rachis length, number of florets/spike, fresh weight of spike and spike girth. Similar results were also obtained in *Dendrobium* orchid (Kumar and Sharma 2013).

The expression of desirable traits exists in a complex association with different characteristics in the plant system and the characters do not exist in isolation. Correlation measures the degree of association between these characters. In the present study, it was observed that for most of the characters genotypic correlation coefficients were higher than phenotypic correlation coefficients. There is strong inherent association between various characters; the phenotypic expression is lessened under the influence of environment. Thus, during the entire investigation on evaluation of 22 cultivars of gladiolus and their genetic variability and correlation coefficient, it was observed that Candyman, Interpid, Eight Wonder, Priscilla, Charm Glow and Wedding Bouquet may have scope for evolving noble colour and elite varieties in Tura, West Garo Hills District, Meghalaya.

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