Indian Journal of Agricultural Sciences **94** (4): 399–403, April 2024/Article
https://doi.org/10.56093/ijas.v94i4.101986

Genetic variability and association studies of marketable traits in gladiolus (*Gladiolus hybridus*)

RAKESH KUMAR[1*], AJAY KUMAR SINGH[1], KRISHNA SINGH TOMAR[1], HITESH KUMAR[1], AMIT KUMAR[2] and AISHWARYA MAHESHWARI[1]

Banda University of Agriculture and Technology, Banda, Uttar Pradesh 210 001, India

Received: 04 July 2020; Accepted: 16 January 2024

ABSTRACT

The experiment was conducted during 2017–18 and 2018–19 at instructional farm, College of Horticulture, Banda University of Agriculture and Technology, Banda, Uttar Pradesh, to study the genetic variation, correlation and path analysis in gladiolus (*Gladiolus hybridus* Hort.) in Bundelkhand region of Uttar Pradesh. 14 varieties of gladiolus, viz. Black Star, Peter Pears, Gold Star, Trader Horn, Pink Rose, White Prosperity, Red White, Novalux, Yellow Gold, Candyman, Willas Pink, Jester, Nathan Red and Punjab Morning were planted in randomized block design (RBD). All parameters showed significant differences indicating that genotypes have a lot of variation. Length of the spike varied from 65.07 to 110.65 cm and size of the floret from 8.27 to 9.66 cm. Mean values for time to flowering, size of floret and vase life were 109.38 days, 8.95 cm and 8.95 days, respectively. Length of rachis (19.97 and 15.90), spike (18.49 and 14.40) and florets/spike (14.88 and 12.05) showed moderate values for PCV and GCV. Maximum heritability value was oberved in days to flowering (68.22) and minimal in floret size (35.63). Positive and significant correlations were found between plant height, length of spike and rachis, florets/spike and days to flowering. Path coefficient study revealed that length of spike (1.162), days to spike initiation (0.881) and blooming time (0.392) had biggest positive direct effects on plant height.

Keywords: Correlation, Genetic advance, Heritability, Path analysis

Gladiolus (*Gladiolus hybridus* Hort.) belongs to family Iridaceae is native to Mediterranean region, Asia, and South and Tropical Africa (Kentelky and Szekely-Varga 2021). It is one of the most widely used bulbous ornamentals being utilized in the form of cut flower, flower arrangements, making bouquets and bedding purposes (Cantor and Tolety 2011). Every year, there is addition of new varieties in gladiolus, like other crops (Swaroop *et al*. 2016). Since there is sufficient genetic diversity, thus it is necessary to work on nature and extent of variability, heritability and interactions between different economic traits for gladiolus improvement programme (Kadam *et al*. 2014). The assessment of heritability provides insight into how traits are passed down across generations since stability of selection performance depends on the heritable component of variability, allowing the breeder to isolate crop's elite selection. In order to choose the optimal genotypes, it is crucial to assess heredity and understand yield's level of correlation with its defining characteristics (Sahu and Sharma 2014). Correlation study's findings can be used as a basis for selection, since they show how desired features interact with one another and how traits affect yield. Analysis of path coefficients examines relationships between the variable, which aids in determining relative impact of important characteristics on yield (Vetrivel *et al*. 2018). Principal component analysis can be used to identify the component features that contribute most to the overall variability i.e. PC_1 represents the most variance, PC_2 explains the second most variation and so on (Gupta and Khandelwal 2022, Thakur and Sarma 2023). Due to prevalence of the different agro-climatic conditions in the Bundelkhand region, a study on genotype-environment interaction becomes necessary in gladiolus crop for understanding the genetic control of variability. Current experiment was planned to ascertain variability among varieties, inter-relationship of characters among themselves and their influence on economic and marketable traits in gladiolus.

MATERIALS AND METHODS

A study was carried out during 2017–18 and 2018–19 at instructional farm, College of Horticulture, Banda University of Agriculture and Technology, Banda (24°53' and 25°55'N and 80°07'and 81°34'E; altitude of 123 m amsl), Uttar Pradesh. This region located in central India is

[1]Banda University of Agriculture and Technology, Banda, Uttar Pradesh; [2]Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand. *Corresponding author email: rakeshkashav53@gmail.com

characterized by unique type of climatic condition having dry and hot climatic zone, resembling partly with desert and partly with tropical type, dominated by less rainfall as well as ground water. The average annual rainfall of this region was 800–910 mm out of which more than 80% is received during June to September and very little rainfall occurs during October to February months. The maximum temperature may reach as high as 49ºC during summer and minimum may fall to 7ºC during winter. The atmospheric humidity remain high during June to October. Soil condition was stony sandy and rocky with water deficient soil. In the experiment, 14 varieties of gladiolus, viz. Black Star, Peter Pears, Gold Star, Trader Horn, Pink Rose, White Prosperity, Red White, Novalux, Yellow Gold, Candyman, Willas Pink, Jester, Nathan Red and Punjab Morning were procured from CSRI-National Botanical Research Institute, Lucknow, Uttar Pradesh and ICAR-Indian Agricultural Research Institute, New Delhi. The healthy, disease-free corms were planted at 30 cm × 20 cm spacing in three replications with randomized block arrangement (RBD). To prevent any occurrence of disease, corms were soaked in captan 0.2% solution prior to planting. Throughout entire cropping period, all recommended cultural procedures were performed. Five plants from each genotype in each replication were selected at random, and observations were recorded for vegetative, flowering and corm parameters. Data were statistically analyzed as suggested by Panse and Sukhatme (1989). Using Burton and De Vane's (1953) formula, genetic parameters were computed. Fisher (1954) formulas were used to carry out correlation analysis. With the aid of path coefficient analysis (Dewey and Lu 1959), genotypic correlation coefficient was further divided into direct and indirect effects.

RESULTS AND DISCUSSION

For all morphological parameters examined, analysis of variance (ANOVA) showed substantial differences between genotypes, exhibiting a high degree of diversity. Range, general mean, genotypic and phenotypic coefficient of variation and heritability were utilized to quantify degree of variation (Table 1). Basic statistical parameters for spike length ranged 65.07–110.65, followed by plant height 84.22–124.25 and rachis length 30.51–61.51. Smallest range, however, was found for floret size (8.27–9.66). Days to blooming (109.38) exhibited highest general means followed by plant height (99.30) and days to spike initiation (96.25).

Estimates of the genotypic coefficient of variation (GCV) were slightly lower than those of phenotypic coefficient of variation (PCV) for all the characters studied, indicating that genotypes are not the only cause of the apparent variation but also that the environment plays a significant role in how the genotypes are expressed. The same outcomes were reported by Misra and Gupta (2003), Pratap and Rao (2006), Maurya *et al*. (2011), Kumar *et al.* (2012), Vanlalruati *et al.* (2013), Nazir *et al.* (2004), Singh *et al*. (2017), Kispotta *et al.* (2017), Sharma *et al.* (2018), Kumar *et al*. (2019). The combined analysis showed moderate PCV and GCV values for variables such as length of rachis (19.97 and 15.90), spike length (18.49 and 14.40) and florets/spike (14.88 and 12.05). Minimum GCV was observed for time to flowering (4.25). Low PCV and GCV values suggest that genotypes do not differ greatly from one another for these traits. PCV and GCV with moderate values shows that genotypes differ from one another in terms of these traits, but only slightly. Days taken to flowering (0.89) and days taken to spike initiation (1.65) showed a little genetic difference between PCV and GCV. The little genetic difference between PCV and GCV shows that all genotypes' phenotypic expression may be under genetic control and may be less affected by environment (Chauhan *et al.* 2017) and (Balaram and Janakiram 2009) and such characters could not be improved by providing favourable environmental conditions.

Results (Table 1) showed that days to blooming (68.22%), vase life (66.88%), florets/spike (65.63%) and rachis length (63.34%) had highest heritability values,

Table 1 Estimates of range, general mean, genotypic and phenotypic coefficient of variation, heritability, genetic advance and genetic advance as per cent of mean for various characters in gladiolus (pooled over two years)

Character	Range	General mean ± SE	PCV	GCV	Heritability (h^2) %	Genetic advance	Genetic advance as per cent of mean
Days taken to spike initiation	90.50–108.05	96.25±2.48	6.86	5.21	57.60	7.84	8.15
Days taken to flowering	105.00–119.75	109.38±1.83	5.14	4.25	68.22	7.90	7.22
Plant height (cm)	84.22–124.25	99.30±5.56	14.11	10.25	52.71	15.22	15.33
Spike length (cm)	65.07–110.65	80.70±5.40	18.49	14.40	60.71	18.65	23.11
Rachis length (cm)	30.51–61.51	45.15±3.15	19.97	15.90	63.34	11.77	26.07
Duration of flowering (days)	13.28–18.61	15.68±0.92	13.02	8.16	39.31	1.65	10.52
No. of florets per spike	10.56–19.95	16.36±0.82	14.88	12.05	65.63	3.29	20.11
Size of floret (cm)	8.27–9.66	8.95±0.33	7.84	4.68	35.63	0.52	5.81
No. of florets open at one time	5.28–7.61	6.31±0.40	14.14	8.85	39.17	0.72	11.41
Vase life (days)	7.11–10.22	8.95±0.42	14.24	11.65	66.88	1.76	19.66

PCV, Phenotypic coefficient of variation; GCV, Genotypic coefficient of variation.

while size of floret (35.63%) had lowest heritability values. Pattanaik *et al.* (2015), Kispotta *et al.* (2017), Singh *et al.* (2017), Sharma *et al.* (2018), Kumar *et al*. (2019) also reported same work. These traits are highly heritable, according to heritability estimations, means their expression is less influenced by the environment. Therefore, there is a lot of chances for these characters to be improved by direct selection. In contrast to spike length, which showed strong heritability (60.71%) and high genetic progress (18.65), vase life demonstrated strong heritability (66.88%) and little genetic progress (1.76). It will be very beneficial to choose parameters that have a high heritability and genetic advancement because these appear to be regulated by additive gene action. Selection for traits with high heritability and little genetic progress, however, may be ineffective since such traits could be governed by non-additive gene activity. Similar outcomes were reported by Kumar *et al*. (2012), Vanlalruati *et al.* (2013), Chauhan *et al.* (2017), Sharma *et al.* (2018) and Kumar *et al*. (2019). This also suggests that high genetic advancement is not always linked to high heritability (Pant and Lal 1991).

Correlation coefficient analysis is used to analyze the mutual relationship between several morphological qualities and to identify the component characters that are used in the selection of a given character. A positive correlation between desired traits is advantageous for the breeder since it facilitates the simultaneous improvement of both traits (Kumar *et al*. 2011). Correlation coefficients for 10 characters in the study were calculated in all conceivable combinations for the first season (higher values) and second season (lower values) (Table 2). In the first season, days to spike initiation and days to blooming were found to be extremely significant and positively correlated. Plant height exhibited a significantly high and positive association with length of spike (0.965). However, there was a substantial and positive association of plant height with length of rachis (0.798), flowering duration (0.714) and florets/spike (0.639). The association of length of rachis was highly significant and positive with flowering duration (0.846) and florets/spike (0.832). Radhakrishna *et al.* (2004) and Balaram and Janakiram (2009) also showed a positive correlation between length of the rachis and number of florets/spike. Duration of flowering exhibited substantial and positive association with florets number/spike (0.811) and negative association with florets opened at one time (0.244) and vase life (0.321). Vase life had a weak negative correlation with each character.

Table 2 Genotypic and phenotypic correlation coefficient among 10 quantitative and qualitative traits in gladiolus

Character		Days taken to spike initiation	Days taken to flowering	Plant height (cm)	Spike length (cm)	Rachis length (cm)	Duration of flowering	No. of florets per spike	Floret size (cm)	No. of florets open at one time	Vase life (days)
Days taken to spike initiation	2017–18	1.0000	0.9887**	0.4916	0.6241	0.4858	0.3767	0.4461	-0.3721	0.0222	-0.6884
	2018–19	1.0000	0.8657**	0.4249	0.5355	0.4508	0.1497	0.3347	-0.2508	0.0543	-0.5641
Days taken to flowering	2017–18		1.0000	0.4643	0.5889	0.4479	0.3879	0.4284	-0.3977	0.0231	-0.6517
	2018–19		1.0000	0.5192	0.6026	0.4570	0.2271	0.3327	-0.3644	-0.1278	-0.3915
Plant height (cm)	2017–18			1.0000	0.9649**	0.7976*	0.7138*	0.6385*	0.2171	-0.2115	-0.4571
	2018–19			1.0000	0.9783**	0.8275**	0.5843	0.6608*	0.2353	-0.2466	-0.4291
Spike length (cm)	2017–18				1.0000	0.8070*	0.7052*	0.6604*	0.1563	-0.1196	-0.5956
	2018–19				1.0000	0.8078*	0.5557	0.6590*	0.1191	-0.2883	-0.5288
Rachis length (cm)	2017–18					1.0000	0.8455**	0.8315**	0.3522	-0.0247	-0.5071
	2018–19					1.0000	0.6462*	0.7975*	0.4160	-0.0474	-0.3110
Duration of flowering	2017–18						1.0000	0.8113*	0.2964	-0.2441	-0.3209
	2018–19						1.0000	0.7907*	0.4931	-0.0399	0.0578
No. of florets per spike	2017–18							1.0000	0.0782	0.0089	-0.3876
	2018–19							1.0000	0.3135	0.0001	-0.2252
Floret size (cm)	2017–18								1.0000	-0.1218	-0.2070
	2018–19								1.0000	0.2608	0.0664
No. of florets opened at one time	2017–18									1.0000	-0.1482
	2018–19									1.0000	0.0474
Vase life (days)	2017–18										1.0000
	2018–19										1.0000

* Indicates significance at *P*=0.05; ** Indicates significance at *P*=0.01.

During second season, days to spike initiation is significantly and positively correlated with days to flowering (0.866). In contrast, plant height showed a significant and positive association with florets/spike (0.661) and a significantly high and positive association with length of spike (0.978), rachis (0.827) and florets/spike (0.661) as well as a negative and non-significant correlation with the number of florets that were opened at once (0.247) and vase life (0.429). Length of spike exhibited a substantial and positive association with length of rachis (0.808) and florets/spike (0.659), whereas rachis length showed a significant and positive correlation with blooming time (0.646) and florets/spike (0.798). Duration of flowering is significantly correlated with florets/spike (0.791), but not with the florets opened simultaneously (0.040). Similar works were also reported by Kumar and Kumar (2010) in snapdragon and Pattanaik *et al.* (2015) and Vetrivel *et al.* (2018) in gladiolus.

The relative contribution of each trait to the overall variability was ascertained using principal component analysis (PCA), which also served as a selection guide for the traits (Thakur and Sarma 2023). Generally, principal component analysis reduces variables that are responsible for the maximum proportion of total variation presented in recorded data. In present experiment, principal component analysis transformed whole recorded data into 10 variables (PCs). The first five PCs explained 82.40% of the total variance among the 14 genotypes (Supplementary Table 1). Maximum variance with more than one Eigen value was contributed by PC_1 (2.635) followed by PC_2 (1.924), PC_3 (1.375) and PC_4 (1.223). Maximum (26.4%) positive contribution to the total variance in PC_1 was given by days taken to spike initiation. PC_2 added 19.2% of the total variance which was contributed by duration of flowering while days taken to spike initiation contributed negatively. PC_3 was positively related to days to flowering, vase life, florets opened at one time, floret size, plant height and length of spike; and accounted for 13.8% of the total variance whereas length of rachis and florets/spike depicted negative contribution. PC_4 added 12.2% of the total variance and traits in this component were floret size, height of plant, length of rachis, florets opened at once and vase life. PC_5 explained 10.8% of the total variance by length of spike, florets opened at one time, vase life and size of floret whereas days to flowering, plant height, rachis length, florets/spike depicted negative contribution (Supplementary Table 2).

Path coefficient study revealed that at genotypic level, spike length (1.162), days to spike initiation (0.881) and blooming time (0.392) had greatest positive direct influence on plant height. However, florets opened at once showed the least beneficial direct influence (0.097). However, number of days till flowering (-1.127), florets/spike (-0.364), size of florets (-0.237) all had a negative direct impact on plant height (Table 3). Similar findings were also reported by Raja and Bagle (2008) and Sahu and Sharma (2014). High and significant indirect effect on height of plant was attributed by days to initiation of spike via length of spike, duration of flowering, rachis length and floret size; days to flowering via days to initiation of spike, duration of flowering and size of floret; vase life via days to flowering and florets/spike; spike length via duration of flowering; rachis length via spike length, days to initiation of spike and flowering duration; duration of flowering via length of spike and days to spike initiation; florets/spike via spike length, days taken to initiation of spike and duration of flowering. Average positive effect on height of plant was exhibited by length of spike (0.983) followed by length of rachis (0.835), duration of flowering (0.722), florets per spike (0.670), days to flowering (0.531), days to spike initiation (0.484) and floret size (0.201). However, vase life (-0.499) and florets opened at once (-0.246) had average negative effect. Similar outcomes were observed by Vetrivel *et al*. (2018) as well.

Therefore, it may be concluded that White Prosperity, Trader's Horn and Willas Pink were adaptive to Bundelkhand environmental conditions. Parameters like days to flowering,

Table 3 Path analysis showing direct and indirect influence of important traits on plant height of 14 genotypes of gladiolus

Character	Days taken to spike initiation	Days taken to flowering	Vase life	Spike length	Rachis length	Duration of flowering	No. of florets per spike	Floret size	No. of florets open at one time
Days taken to spike initiation	**0.881**	0.868	-0.596	0.534	0.477	0.232	0.363	-0.303	0.062
Days taken to flowering	-1.110	**-1.127**	0.629	-0.701	-0.588	-0.395	-0.475	0.476	-0.022
Vase life	-0.089	-0.073	**0.132**	-0.077	-0.062	-0.027	-0.048	-0.018	-0.027
Spike length	0.704	0.722	-0.679	**1.162**	0.967	0.838	0.818	0.134	-0.262
Rachis length	0.057	0.055	-0.049	0.087	**0.105**	0.093	0.093	0.037	-0.007
Duration of flowering	0.103	0.138	-0.080	0.283	0.350	**0.392**	0.322	0.172	-0.035
No. of florets per spike	-0.150	-0.153	0.134	-0.256	-0.324	-0.298	**-0.364**	-0.072	-0.026
Floret size	0.082	0.100	0.032	-0.027	-0.083	-0.104	-0.047	**-0.237**	-0.026
No. of florets open at one time	0.007	0.002	-0.020	-0.022	-0.007	-0.009	0.007	0.011	**0.097**
Plant height (Total effect)	**0.484**	**0.531**	**-0.499**	**0.983**	**0.835**	**0.722**	**0.670**	**0.201**	**-0.246**

Residual effect = 0.1995; Direct effect on main diagonal (Bold figure).

vase life, florets/spike and rachis length are largely heritable traits with little environmental effect. Hence, these traits can be improved through direct selection. It is possible that additive gene activity regulates spike length, and selection for such traits will be particularly successful.

ACKNOWLEDGMENT

Authors are grateful to the Banda University of Agriculture and Technology, Banda, Uttar Pradesh for providing financial grant and experimental farm facility.

REFERENCES

Balaram M V and Janakiram T. 2009. Genetic variability in gladiolus genotypes for corm characters. *Journal of Ornamental Horticulture* **12**(2): 123–26.

Burton G W and De Vane E M. 1953. Estimating heritability in fall fescue (*Festuca circunclinaceae*) from replicated clonal material. *Agronomy Journal* **45**: 478–81.

Cantor M and Tolety J. 2011. Gladiolus. *Wild Crop Relatives: Genomic and Breeding Resources*, pp. 133–59. Springer: Berlin/Heidelberg, Germany.

Chauhan P, Dhiman S R, Gupta Y C, Kashyap B, Gupta R K and Dogra R K. 2017. Evaluation and variability studies in carnation genotypes. *Journal of Ornamental Horticulture* **20**(1–2): 54–60.

Dewey D R and Lu K H. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal* **51**: 515–18.

Fisher R A. 1954. *Statistical Methods for Research Workers*. Din Oliver and Boyd Ltd. London, United Kingdom.

Gupta D and Khandelwal V. 2022. Principal component analysis for yield and its attributing characters of pearl millet (*Pennisetum glaucum* [L.] R.Br.). *Annals of Plant and Soil Research* **24**(3): 408–14.

Kadam G B, Kumar G, Saha T N, Tiwari A K and Kumar R. 2014. Varietal evaluation and genetic variability studies on gladiolus. *Indian Journal of Horticulture* **71**(3): 379–84.

Kentelky E and Szekely-Varga Z. 2021. Impact of foliar fertilization on growth, flowering, and corms production of five gladiolus varieties. *Plants* **10**(9): 1963.

Kispotta L M, Jha K K, Horo P, Tirkey S K, Misra S and Sengupta S. 2017. Genetic variability and heritability in *Gladiolus hybridus*. *International Journal of Environmental Science and Technology* **6**(1): 519–28.

Kumar A, Kumar A and Kumar A. 2019. Genetic variability, heritability, genetic advance and genetic divergence for yield and its contributing traits in gladiolus (*Gladiolus grandiflorus* L.). *International Journal of Current Microbiology and Applied Sciences* **8**(1): 689–701.

Kumar P, Maurya R K, Chakraborty B, Mer R and Mishra D S. 2011. Genetic variability and correlation studies in *Gladiolus hybrida* L. under tarai condition of Uttarakhand. *Progressive Horticulture* **43**(2): 323–27.

Kumar R and Kumar S. 2010. Correlation studies in snapdragon (*Antirrhinum majus* L.). *Journal of Ornamental Horticulture* **13**(2): 133–37.

Kumar R, Kumar S and Singh A K. 2012. Genetic variability and diversity studies in snapdragon (*Antirrhinum majus*) under tarai conditions of Uttarakhand. *The Indian Journal of Agricultural Sciences* **82**(6): 535–37.

Maurya P K, Kumar R, Chakraborty B, Mer R and Mishra D S. 2011. Genetic variability and correlation studies in *Gladiolus hybridus* (L.) under tarai condition of Uttarakhand. *Progressive Horticulture* **43**(2): 323–27.

Misra S and Gupta Y C. 2003. Genetic variability in carnation. *Journal of Ornamental Horticulture* **6**(1): 20–23.

Nazir M, Dwivedi V K and Bhat K L. 2004. Genetic variability in gladiolus. *Journal of Ornamental Horticulture* **7**(3–4): 75–80.

Panse V G and Sukhatme P V. 1989. *Statistical Methods for Agricultural Workers*. 5th edn., ICAR, New Delhi.

Pant C C and Lal S D. 1991. Genetic variability in gladiolus. *Progressive Horticulture* **23**: 1–4.

Pattanaik S, Paul A and Lenka P C. 2015. Genotypic and phenotypic variability studies in gladiolus. *Journal of Crop and Weed* **11**(1): 113–19.

Pratap M and Rao A M. 2006. Assessment and variability studies in gladiolus. *Journal of Ornamental Horticulture* **9**(2): 145–47.

Radhakrishna K N, Janakiram T and Srinivas M. 2004. Correlation studies in tuberose (*Polianthes tuberosa* L.). *Journal of Ornamental Horticulture* **7**: 110–16.

Raja S and Bagle B G. 2008. Variability and inter-relationship among characters and path coefficient analysis in annual marigold. *Indian Journal of Horticulture* **49**(4): 434–40.

Sahu M and Sharma G. 2014. Genetic variability, correlation and path analysis for yield and its attributing traits in small flowered chrysanthemum. *Journal of Ornamental Horticulture* **17**(1–2): 32–37.

Sharma S, Prasad V M and Singh D. 2018. Studies on genetic variability parameters in gladiolus grown under Allahabad agro-climatic conditions. *International Journal of Chemical Studies* **6**(4): 1604–607.

Singh D, Mishra A and Meena B. 2017. Genetic variability studies in gladiolus (*Gladiolus hybridus* Hort.) under sub-humid condition of Rajasthan. *International Journal of Agricultural Science and Research* **7**(1): 523–28.

Swaroop K, Singh K P, Kumar P and Janakiram T. 2016. Genetic diversity and response of gladiolus (*Gladiolus hybridus*) hybrids for growth, flowering and corms traits under ecological conditions of Delhi. *The Indian Journal of Agricultural Sciences* **86**(12): 1606–612.

Thakur K and Sarma M K. 2023. Genetic diversity and principal component analysis in cultivated rice (*Oryza sativa*) varieties of Assam. *The Indian Journal of Agricultural Sciences* **93**(2): 145–50.

Vanlalruati, Mandal T and Pradhan S. 2013. Correlation and path coefficient analysis in tuberose. *Journal of Crop and Weed* **9**(2): 44–49.

Vetrivel T, Lakshmanan V and Jawaharlal M. 2018. Correlation and path analysis studies in gladiolus (*Gladiolus hybridus* Hort.). *Journal of Applied and Natural Science* **10**(1): 216–21.