Genetic Variability and Heritability Studies in Gladiolus (Gladiolus grandiflorus L.)

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A B S T R A C T

The genetic materials was consisted of eleven gladiolus varieties in randomized block design (RBD) with three replications was used. Experiment was conducted at Farm of Department of Horticulture at Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences Naini, Prayagraj Uttar Pradesh in Rabi season 2019. Mean square due to treatments revealed that significant differences among the genotypes for all the traits except days taken for emergence of flower spike and days taken to show colour of basal floret. The maximum corms yield per plant obtained was American beauty, White propsparity, her majesty and White friendship. High GCV and PCV were exhibited for number of leaves per plant 30 DAS, number of shoot per plant, number of corm produced per mother corm, corms yield per plant, number of cormels per plant, number of cormels per hectare and number of corm per hectare. Therefore, it is concluded that the characters which showed high GCV, PCV and heritability coupled with genetic advance should be considered for direct selection. Here the number of cormels per plant, number of cormels per hectare, number of shoot per plant, vase life, plant height (cm) 90 DAS and plant height (cm) 60 DAS character under study showed high heritability and genetic advance. Thus one should select these characters for direct selection.

Keywords
Gladiolus, Mean performance, Genetic variability and heritability

Introduction

Gladiolus (Gladiolus grandiflorus L.) is an important cut flower in domestic as well as export market (Ganesh et al., 2014). Gladiolus is native to South Africa. Gladiolus has the basic chromosome number n=15. Most member of genus are heteroploids having the very small chromosomes ranging from 2n=30 to 120 (Singh et al., 2017). It is one of the most important bulbous crops grown commercially for cut flower, bouquets, floral arrangements, interior decoration and garden display purposes (Lepcha et al., 2007). In this regard gladiolus has gained much importance as it is the ‘Queen of bulbous flowers’. The latin word ‘Gladius’ means sword and hence, it is often called as ‘sword lily’ because of the shape of its leaves (Mishra et al., 2014). The wild species of gladioli are native to the Mediterranean region, the Middle East, western Asia, Madagascar and (especially) South Africa (Kispotta et al., 2017). Gladiolus can be
grown in a particular agro-climatic region all are not suited for cut flower purposes are for garden display or for exhibition purpose (Bhujbal et al., 2013).

Improvement through selection depends upon the variability existing in the available genotypes, which may be either due to different genetic constitution of cultivars or variations in the growing environments (Amrutha et al., 2014). The spikes are used in vase arrangements, in bouquets and for indoor decorations (Swetha et al., 2020). For a modern and industrialized floriculture, there is always demand and necessity of new varieties. So, there is a great challenge for the scientists to get a new dimension for gladiolus cultivation (Sharma et al., 2018).

Materials and Methods

Location and source of experiment

The present investigation was carried out during Rabi season 2019 at Farm of Department of Horticulture at Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences Naini, Prayagraj Uttar Pradesh. The genetic materials were consisted of eleven varieties (Table-1). The experiment was laid out in Randomized Complete Block design (RCBD) with three replications. Uniform sized corms of each variety were planted at spacing 30cm × 20cm on plot size of 1m ×1m. All the recommended package of practices was followed to get a healthy crop.

Results and Discussion

Analysis of variance revealed that significant differences among the genotypes for all the traits except days taken for emergence of flower spike and days taken to show colour of basal floret under study indicating the presence of substantial genetic variability in Gladiolus (Table-1). Similar results proposed Bhujbal, et al., (2013) Amrutha, et al., (2014), Ganesh et al., (2014) and Kispotta et al., (2020).

Mean Performance of Different varieties

For each of the traits evaluated, the descriptive statistics including the extreme genotype mean values and the means together with their standard errors obtained on the basis of average data are summarized in Table 2. In general, Gladiolus genotypes showed wide range of variability for most of the characters and all the traits exhibited broad spectrum of ranges between the maximum and minimum genotype mean values. For instance, plant height (cm) 30 DAS ranged from 32.90 to 52.56 with mean of 42.72, plant height (cm) 60 DAS ranged from 61.76 to 83.60 with a mean of 72.19, plant height (cm) 90 das ranged varied from 96.76 to 118.46 with mean of 106.83.

Similarly, Number of leaves/plant 30 DAS ranged from 2.05 to 4.86 and number of leaves/plant 90 DAS ranged varied from 9.54 to 13.18 respectively while, number of shoot per plant ranged varied from 1.22 to 2.25 with mean of 1.62. Days for 50% flowering varied from 95.68 to 84.84 with mean of 91.08.

Days taken for emergence of flower spike ranged from 74.08 to 83.22 with mean of 79.28, for days taken to show colour of basal floret ranged varied from 80.83 to 92.64 with mean value of 87.29 and number of florets per spike ranged varied from 9.45 to 14.81 with average value 12.22. Similarly number of spikes per plant ranged varied from 1.23 to 1.88 with mean of 1.48, floret length (cm) from 9.64 to 12.33 with average value of 10.91 and floret diameter (cm) ranged varied from 8.44 to 11.46 with mean of 9.99. Duration of flowering ranged varied from8.31 to 11.63 with mean of 9.65 and
number of spikes per meter square also ranged varied from 13.44 to 20.60 with mean value of 16.18.

Number of spikes per ha ranged from 1411200.00 to 2163000.00 with mean of 1699218.00, for corm diameter (cm) ranged varied from 4.29 to 7.26 with mean value of 5.30 and vase life (days) ranged varied from 5.33 to 10.25 with average value of 8.01. The maximum Corms yield per plant (g) obtained was American beauty (103.37g) followed by White propsparity (101.44), Her majesty (97.11) and White friendship (92.22) and it ranged varied from 47.41 to 103.37 with mean of 78.64. Thus, it is possible to succeed in improving Corms yield per by direct selection. Similar results reported by Sharma et al., (2018), Singh and Singh (2018), Kumar et al., (2019) and Swetha et al., (2020).

**Genetic parameters for different characters in different gladiolus varieties**

High GCV and PCV were exhibited for Number of leaves/plant 30 DAS (31.86 and 34.08), number of shoot per plant (24.90 and 25.19), number of corm produced per mother corm (27.96 and 32.13), corms yield per plant (23.67 and 29.34), number of cormels per plant, number of cormels per hectare (37.74 and 37.973) and Number of corms per hectare (27.96 and 32.13).

The moderate genotypic and phenotypic coefficient of variation was recorded for the characters Cormel diameter (18.07 and 19.78) followed by number of leaves per plant 60 DAS (17.45 and 18.57), vase life (17.27 and 17.52), weight of single corm (14.99 and 15.95), Corm diameter (14.91 and 15.87), plant Height (cm) 30 DAS (13.45 and 14.569) and rachis length (11.58 and 13.14). However, lowest GCV and PCV were recorded for days taken for emergence of flower spike (3.52 and 3.89), Days for 50% flowering (3.74 and 4.02), days taken to show colour of basal floret (3.91 and 4.15) and plant height (cm) 90 DAS (5.93 and 6.05).

High estimate of heritability were exhibited for number of cormels per plant (98.80) followed by number of cormels per hectare (98.80), number of shoot per plant (97.70), vase life (97.20), plant height (cm) 90 DAS (96.20) and plant height (cm) 60 DAS (89.90) the character under study. Moderate heritability was expressed in number of spikes per meter square (57.60) followed number of spikes per ha (57.60) and number of spikes per plant (57.50), while none of traits had exhibited lowest heritability.

**Table 1** Details of different varieties of Gladiolus

| S. No. | Variety symbol | Genotypes          | Source                     |
|-------|----------------|--------------------|----------------------------|
| 1     | V₁             | White Prosperity   | Sheel biotech, New Delhi   |
| 2     | V₂             | Candyman           | Sheel biotech, New Delhi   |
| 3     | V₃             | Friendship pink    | Sheel biotech, New Delhi   |
| 4     | V₄             | American Beauty    | Sheel biotech, New Delhi   |
| 5     | V₅             | True yellow        | Sheel biotech, New Delhi   |
| 6     | V₆             | Her Majesty        | Sheel biotech, New Delhi   |
| 7     | V₇             | Red majesty        | Sheel biotech, New Delhi   |
| 8     | V₈             | Novulax            | Sheel biotech, New Delhi   |
| 9     | V₉             | Advantage          | Sheel biotech, New Delhi   |
| 10    | V₁₀            | Sovenior saffron   | Sheel biotech, New Delhi   |
| 11    | V₁₁            | White friendship   | Sheel biotech, New Delhi   |
### Table 2: Mean performance of 11 different varieties for various traits in gladiolus

| Varieties           | Plant Height (cm) 30 DAS | Plant Height (cm) 60 DAS | Plant Height (cm) 90 DAS | Number of leaves/plant 30 DAS | Number of leaves/plant 60 DAS | Number of leaves/plant 90 DAS | Number of shoots/plant | Days for 50% flowering | Rachis length (cm) | Days taken for emergence of flower spike | Days taken to show colour of basal floret | Number of florets per spike | Number of spikes per plant |
|---------------------|--------------------------|--------------------------|--------------------------|------------------------------|------------------------------|------------------------------|--------------------------|------------------------|---------------------|------------------------------------------|------------------------------------------|---------------------------|-------------------------------|
| White propsparity   | 52.56                    | 83.60                    | 118.46                   | 2.93                         | 6.81                         | 10.99                        | 1.22                     | 84.84                  | 55.50               | 74.08                          | 80.83                          | 14.81                     | 1.88                          |
| Candy man           | 45.03                    | 75.35                    | 110.17                   | 4.87                         | 8.86                         | 13.04                        | 1.35                     | 88.15                  | 51.10               | 76.41                          | 84.74                          | 12.96                     | 1.71                          |
| Friendship pink     | 44.37                    | 73.67                    | 108.57                   | 4.25                         | 6.27                         | 10.50                        | 2.19                     | 92.35                  | 43.50               | 80.54                          | 88.68                          | 12.18                     | 1.46                          |
| American beauty     | 36.16                    | 65.38                    | 101.17                   | 2.05                         | 5.34                         | 9.54                         | 2.20                     | 89.28                  | 44.70               | 77.04                          | 85.32                          | 9.45                      | 1.31                          |
| True yellow         | 40.18                    | 69.09                    | 103.42                   | 3.47                         | 7.37                         | 11.56                        | 1.38                     | 93.79                  | 41.19               | 79.69                          | 88.27                          | 11.75                     | 1.38                          |
| Her majesty         | 46.72                    | 75.83                    | 110.30                   | 4.83                         | 8.94                         | 13.18                        | 2.25                     | 91.86                  | 52.12               | 80.24                          | 87.92                          | 12.80                     | 1.54                          |
| Red majesty         | 50.47                    | 81.13                    | 114.93                   | 2.20                         | 5.74                         | 9.96                         | 1.52                     | 93.56                  | 46.99               | 81.25                          | 89.79                          | 11.45                     | 1.40                          |
| Novalux             | 41.58                    | 70.38                    | 105.26                   | 2.27                         | 6.12                         | 10.34                        | 1.71                     | 95.68                  | 42.35               | 83.22                          | 92.64                          | 12.59                     | 1.55                          |
| Advantage           | 32.90                    | 61.76                    | 96.76                    | 4.62                         | 8.57                         | 12.79                        | 1.35                     | 94.77                  | 40.30               | 82.71                          | 91.28                          | 11.20                     | 1.46                          |
| Sovenior saffron    | 38.20                    | 67.15                    | 101.65                   | 4.41                         | 8.30                         | 12.57                        | 1.30                     | 91.08                  | 38.64               | 80.48                          | 87.29                          | 12.58                     | 1.33                          |
| White friendship    | 41.78                    | 70.73                    | 104.47                   | 3.42                         | 7.25                         | 11.52                        | 1.33                     | 86.55                  | 41.36               | 76.46                          | 83.42                          | 12.64                     | 1.23                          |
| Mean                | 42.72                    | 72.19                    | 106.83                   | 3.41                         | 7.23                         | 11.45                        | 1.62                     | 91.08                  | 45.25               | 79.28                          | 87.29                          | 12.22                     | 1.48                          |
| C.V.                | 5.60                     | 2.99                     | 1.18                     | 12.10                        | 6.36                         | 4.08                         | 3.81                     | 1.49                   | 6.21               | 1.67                          | 1.40                           | 3.99                      | 9.80                          |
| S.E.                | 1.38                     | 1.25                     | 0.73                     | 0.24                         | 0.27                         | 0.27                         | 0.04                     | 0.78                   | 1.62               | 0.77                          | 0.71                           | 0.28                      | 0.08                          |
| C.D. 5%             | 4.07                     | 3.68                     | 2.16                     | 0.70                         | 0.78                         | 0.80                         | 0.11                     | 2.30                   | 4.79               | 2.26                          | 2.09                           | 0.83                      | 0.25                          |
| C.D. 1%             | 5.56                     | 5.02                     | 2.94                     | 0.96                         | 1.07                         | 1.08                         | 0.14                     | 3.14                   | 6.53               | 3.09                          | 2.84                           | 1.13                      | 0.34                          |
| Range Lowest        | 32.90                    | 61.76                    | 96.76                    | 2.05                         | 5.34                         | 9.54                         | 1.22                     | 84.84                  | 38.64               | 74.08                          | 80.83                          | 9.45                      | 1.23                          |
| Range Highest       | 52.56                    | 83.60                    | 118.46                   | 4.87                         | 8.94                         | 13.18                        | 2.25                     | 95.68                  | 55.50               | 83.22                          | 92.64                          | 14.81                     | 1.88                          |
| Varieties             | Floret length (cm) | Floret diameter (cm) | Duration of flowering (days) | Number of spikes per meter square | Number of Corm produce d per mother Corm | Corm diameter (cm) | Weight of single Corm (gm) | Corms yield/plant (g) | Number of Corms/Plant | Cormel diameter (cm) | Number of Corms per hectare | Number of Cormels/ Hectare | Vase life (days) |
|----------------------|--------------------|----------------------|-------------------------------|-----------------------------------|-----------------------------------------|-------------------|----------------------------|------------------------|-----------------------|----------------------|----------------------------|--------------------------|-------------------|
| White propsparity    | 10.46              | 10.11                | 9.54                          | 20.60                             | 2.49                                    | 5.31              | 40.68                      | 101.44                 | 42.60                 | 1.21                 | 261100                    | 4472650                  | 9.57              |
| Candy man            | 12.33              | 11.46                | 10.48                         | 18.72                             | 1.53                                    | 7.26              | 54.25                      | 82.51                  | 25.67                 | 1.09                 | 161000                    | 2695350                  | 10.25             |
| Friendship pink      | 11.57              | 10.49                | 8.88                          | 15.93                             | 1.46                                    | 5.49              | 37.91                      | 55.40                  | 19.75                 | 1.20                 | 153300                    | 2074100                  | 8.22              |
| American beauty      | 10.83              | 9.84                 | 10.34                         | 14.28                             | 2.83                                    | 4.29              | 36.62                      | 103.37                 | 33.45                 | 1.23                 | 297500                    | 3512250                  | 7.83              |
| True yellow          | 10.56              | 9.79                 | 11.63                         | 15.13                             | 1.47                                    | 4.59              | 45.25                      | 65.96                  | 44.43                 | 0.74                 | 154350                    | 4665500                  | 8.12              |
| Her majesty          | 11.56              | 10.52                | 9.22                          | 16.88                             | 2.70                                    | 5.35              | 35.97                      | 97.11                  | 42.59                 | 1.24                 | 283500                    | 4472300                  | 7.43              |
| Red majesty          | 11.29              | 10.21                | 9.25                          | 15.38                             | 2.39                                    | 5.90              | 37.13                      | 89.02                  | 58.54                 | 0.93                 | 251300                    | 6146350                  | 8.18              |
| Novalux              | 10.44              | 9.75                 | 9.62                          | 17.04                             | 2.11                                    | 4.59              | 36.46                      | 76.93                  | 68.07                 | 0.68                 | 221550                    | 7147000                  | 9.34              |
| Advantage            | 9.64               | 8.44                 | 8.52                          | 15.98                             | 1.47                                    | 5.32              | 32.17                      | 47.41                  | 29.17                 | 1.11                 | 154000                    | 3063200                  | 5.33              |
| Sovenior saffron     | 10.43              | 9.58                 | 8.31                          | 14.62                             | 1.20                                    | 5.44              | 44.90                      | 53.65                  | 24.59                 | 1.23                 | 126350                    | 2581600                  | 6.62              |
| White friendship     | 10.91              | 9.81                 | 10.35                         | 13.44                             | 2.44                                    | 4.80              | 37.75                      | 92.21                  | 49.94                 | 1.13                 | 256550                    | 5243350                  | 7.25              |
| Mean                 | 10.91              | 10.00                | 9.65                          | 16.18                             | 2.01                                    | 5.30              | 39.92                      | 78.64                  | 39.89                 | 1.07                 | 210954                    | 4188514                  | 8.01              |
| C.V.                 | 2.51               | 3.33                 | 3.59                          | 9.80                               | 15.84                                   | 5.44              | 5.45                       | 17.33                  | 4.18                  | 8.03                 | 15.84                      | 4.18                     | 2.95              |
| S.E.                 | 0.16               | 0.19                 | 0.20                          | 0.92                               | 0.18                                    | 0.17              | 1.26                       | 7.87                   | 0.96                  | 0.05                 | 19288                      | 101005                   | 0.14              |
| C.D. 5%              | 0.47               | 0.57                 | 0.59                          | 2.70                               | 0.54                                    | 0.49              | 3.70                       | 23.21                  | 2.84                  | 0.15                 | 56900                      | 297963                   | 0.40              |
| C.D. 1%              | 0.64               | 0.77                 | 0.80                          | 3.68                               | 0.74                                    | 0.67              | 5.05                       | 31.67                  | 3.87                  | 0.20                 | 77615                      | 406439.                   | 0.55              |
| Range Lowest         | 9.64               | 8.44                 | 8.31                          | 13.44                             | 1.20                                    | 4.29              | 32.17                      | 47.41                  | 19.75                 | 0.68                 | 126350                    | 2074100                  | 5.33              |
| Range Highest        | 12.33              | 11.46                | 11.63                         | 20.60                             | 2.83                                    | 7.26              | 54.25                      | 103.37                 | 68.07                 | 1.24                 | 297500                    | 714700                   | 10.25             |
Table 3 Estimates of variability, heritability and genetic advance as percentage of mean for different varieties of Gladiolus

| Traits                              | Var Genotypical | Var Phenotypical | GCV   | PCV   | $h^2$ (Broad Sense) | Genetic Advancement | Gen. Adv as % of Mean 5% |
|-------------------------------------|----------------|-----------------|-------|-------|-------------------|----------------------|------------------------|
| Plant Height (cm) 30 DAS            | 33.02          | 38.74           | 13.45 | 14.56 | 85.2              | 10.92                | 25.58                  |
| Plant Height (cm) 60 DAS            | 41.56          | 46.23           | 8.93  | 9.41  | 89.9              | 12.59                | 17.44                  |
| Plant Height (cm) 90 DAS            | 40.15          | 41.75           | 5.93  | 6.04  | 96.2              | 12.80                | 11.98                  |
| Number of leaves/plant 30 DAS       | 1.18           | 1.35            | 31.86 | 34.08 | 87.4              | 2.09                 | 61.36                  |
| Number of leaves/plant 60 DAS       | 1.59           | 1.80            | 17.45 | 18.57 | 88.3              | 2.44                 | 33.77                  |
| Number of leaves/plant 90 DAS       | 1.60           | 1.82            | 11.07 | 11.80 | 88.1              | 2.45                 | 21.41                  |
| Number of shoot/plant               | 0.16           | 0.16            | 24.90 | 25.19 | 97.7              | 0.82                 | 50.71                  |
| Days for 50% flowering              | 11.57          | 13.41           | 3.73  | 4.02  | 86.3              | 6.51                 | 7.15                   |
| Rachis length (cm)                  | 27.45          | 35.36           | 11.57 | 13.14 | 77.6              | 9.51                 | 21.01                  |
| Days taken for emergence of flower spike | 7.76          | 9.53            | 3.51  | 3.89  | 81.5              | 5.18                 | 6.53                   |
| Days taken to show colour of basal floret | 11.62        | 13.11           | 3.90  | 4.14  | 88.6              | 6.60                 | 7.57                   |
| Number of florets per spike         | 1.67           | 1.91            | 10.59 | 11.32 | 87.6              | 2.49                 | 20.43                  |
| Number of spikes per plant          | 0.02           | 0.04            | 11.39 | 15.02 | 57.5              | 0.26                 | 17.79                  |
| Floret length (cm)                  | 0.51           | 0.59            | 6.58  | 7.04  | 87.3              | 1.38                 | 12.67                  |
| Floret diameter (cm)                | 0.51           | 0.62            | 7.15  | 7.88  | 82.2              | 1.33                 | 13.36                  |
| Duration of flowering (days)        | 0.92           | 1.04            | 9.94  | 10.36 | 88.5              | 1.85                 | 19.25                  |
| Number of spikes per meter square   | 3.42           | 5.93            | 11.42 | 15.05 | 57.6              | 2.89                 | 17.86                  |
| Number of spikes/ha                 | 37704970000    | 65436390000     | 11.42 | 15.05 | 57.6              | 303638               | 17.86                  |
| Number of corm produced per mother corm | 0.31          | 0.41            | 27.96 | 32.13 | 75.7              | 1.007                | 50.11                  |
| Corm diameter (cm)                  | 0.62           | 0.70            | 14.90 | 15.86 | 88.2              | 1.52                 | 28.84                  |
| Weight of single corm (gm)          | 35.83          | 40.56           | 14.99 | 15.95 | 88.3              | 11.589               | 29.03                  |
| Corms yield/plant (g)               | 346.37         | 532.14          | 23.66 | 29.33 | 65.1              | 30.931               | 39.33                  |
| Number of Cormels/plant             | 226.67         | 229.45          | 37.74 | 37.97 | 98.8              | 30.827               | 77.279                 |
| Cormel diameter (cm)                | 0.03           | 0.045           | 18.07 | 19.77 | 83.5              | 0.365                | 34.01                  |
| Number of corms per hectare         | 34791390000    | 4595267000      | 27.96 | 32.13 | 75.7              | 105726.5             | 50.11                  |
| Number of cormels/hectare           | 2499133000000.00 | 2529739000000.00 | 37.74 | 37.97 | 98.8              | 3236821              | 77.27                  |
| Vase life (days)                    | 1.91           | 1.97            | 17.26 | 17.51 | 97.2              | 2.809                | 35.06                  |
High heritability values indicate that the characters under study are less influenced by environment in their expression. The plant breeder, therefore adopt simple selection method on the basis of the phenotype of the characters which ultimately improves the genetic background of these traits. Similar results were also quoted by Mishra et al., (2014), Sharma et al., (2018), Singh and Singh (2018), Kumar et al., (2019), Swetha et al., (2020) and Kispotta et al., (2020).

In conclusion the highly significant varietal differences revealed the presence of high amount of variability for all characters except days taken for emergence of flower spike, days taken to show colour of basal floret. Highly Therefore, it is concluded that the characters which showed high GCV, PCV and heritability coupled with genetic advance should be considered for direct selection. Here the number of cormels per plant, number of cormels per hectare, number of shoot per plant, vase life, plant height (cm) 90 DAS and plant height (cm) 60 DAS character under study showed high heritability and genetic advance. Thus one should select these characters for direct selection.

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