The Pharma Innovation Journal 2022; 11(8): 646-648

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(8): 646-648
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www.thepharmajournal.com
Received: 04-06-2022
Accepted: 05-07-2022

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Studies on genetic variability, heritability and genetic advance for the vegetative characters in *Dendrobium* orchids

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Abstract
Twenty genotypes of *Dendrobium* having cut flower qualities with desirable traits and widespread market acceptance were evaluated using completely randomized design. The analysis of variance revealed that significant difference exists among the parental genotypes with respect to the majority of biometric characters studied. Vegetative characters such as plant height, number of leaves per shoot, thickness of the shoot, internodal length, length of the leaf, width of the leaf and thickness of leaf exhibited the highest estimates of variance at both genotypic and phenotypic levels. The thickness of leaf exhibited the highest GCV (66.16%) and PCV (69.54%). High heritability coupled with high genetic advance was recorded for plant height, number of leaves per shoot, number of aerial roots, length of aerial roots, thickness of the shoot, internodal length, length of the leaf and leaf area which indicated that these traits were controlled by additive gene action. High heritability (>60%) combined with high genetic advance (>20%) was exhibited by majority of the characters under study indicating additive gene action for these characters and it provides a scope for further improvement of these traits in advance generations.

Keywords: Orchids, *Dendrobium*, GCV, PCV, heritability, genetic advance

1. Introduction
Orchids, comprise a unique group of plants and with their fascinating range of floral forms and beautiful colour combinations rank high in the international floriculture industry. The family Orchidaceae includes more than 25,000 species, and the genus *Dendrobium* consists of over 1,450 species around the world. Orchids exhibit an incredible range of diversity in size, shape, and colour of their flowers. They occupy top position among all the flowering plants valued for cut flower production and as potted plants. They are known for their long-lasting and beautiful flowers which fetch a very high price in the national and international markets.
Among orchids, *Dendrobiums* reign as the supreme floricultural plants due to the beauty and diversity of their long-lasting and colourful flowers. In view of the ease in management practices and ready availability of hybrids from private importers, *Dendrobiums* now occupy the maximum area under orchid cultivation in the country (Sugapriya *et al*., 2012) [17]. The contribution to international trade from horticultural plants is very high. They command a high demand and price as cut-flowers and potted plants and form the basis of a multimillion-dollar horticultural industry in several countries of the world. But research work on the evaluation of commercial hybrids and varieties for suitability to our condition is very limited. In the USA, Japan, Italy, Europe, and Germany, *Dendrobium* cut flowers and pot plants are in high demand (Mirani *et al*., 2017) [10]. However, developing nations like Malaysia and Singapore are vying to overtake developed nations on the global market and operate the *Dendrobium* cut-flower business cooperatively. The majority of *Dendrobiums* orchids grown now are hybrids of *Dendrobium*.

2. Materials and Methods
The research programme was undertaken in the Department of Plant Breeding and Genetics, College of Agriculture, Vellayani. The research materials for the study were maintained in the green house and observations on vegetative characters were taken. The experiment was laid out in Completely Randomized Design (CRD) with twenty genotypes of *Dendrobium* orchids namely *D.* White, *D.* Fairy Red, *D.* Pearl Red Lip, *D.* Thong Dang Yellow, *D.* Rabit Gold, *D.*

Burana Pearl x D. Burana White, *D.* Angle Two Town, *D.* Indigo Green, *D.* Crystal Blue, *D.* Yellow Red Lip, *D.* Sonia White, *D.* Pink bfc, *D.* Yellow, *D.* Popeyes, *D.* Yaya, *D.* King Dragon. Important cultural practices were carried out timely as per package of practices (KAU, 2016) [12]. The selected materials were evaluated by recording observations on their vegetative characters. The co-efficient of variations were computed using standard measures. Estimates of heritability and genetic advance as percentage of mean were also calculated.

3. Results and Discussion

The analysis of variance revealed significant differences among the twenty *Dendrobium* orchid genotypes for the vegetative traits *viz*., plant height, number of leaves per shoot, number of aerial roots, length of aerial roots, thickness of the shoot, internodal length, length of the leaf, width of the leaf, thickness of leaf and leaf area indicating the presence of considerable genetic variability (Table 1).

The coefficients of variation at genotypic and phenotypic levels were studied. The vegetative characters such as thickness of leaf (GCV= 66.17%, PCV= 69.53%), number of leaves per shoot (GCV= 36.78%, PCV= 37.85%), internodal length (GCV= 34.48, PCV= 38.81%), thickness of the shoot (GCV= 32.55%, PCV= 37.32%), plant height (GCV= 28.50%, PCV= 28.63%), width of the leaf (GCV= 23.51, PCV= 31.68), length of leaf (GCV= 23.25, PCV= 23.95), leaf area (GCV= 17.06, PCV= 17.18), number of aerial roots (GCV= 13.92, PCV= 15.08) and length of aerial roots (GCV= 13.51, PCV= 14.75) exhibited the highest estimates of variance at both genotypic and phenotypic levels in the decreasing order. The phenotypic coefficient of variation was found to be higher than the genotypic coefficient of variation for all the characters studied indicating significant influence of environment in the expression of these characters.

Heritability per cent was categorized as suggested by Allard as low (<30), moderate (30-60) and high (>60). Vegetative characters like plant height, number of leaves per shoot, number of aerial roots, length of aerial roots, thickness of the shoot, internodal length, length of the leaf and leaf area exhibited high heritability (>60%) indicating additive gene action for these characters. This suggests that improvement can be attained by practices selection based on the above traits. According to Robinson *et al.*, characters with values >20% were considered to have high genetic advance. Majority of the characters exhibited high genetic advance. The highest value was observed for number of leaves per shoot (73.63%) followed by internodal length (63.12%). High heritability (>70%) combined with high genetic advance (>20%) was exhibited by majority of the characters studied like plant height, number of leaves per shoot, number of aerial roots, length of aerial roots, thickness of the shoot, internodal length, length of the leaf and leaf area. Moderate heritability with high genetic advance was observed for width of the leaf.

Table 1: Analysis of variance of CRD for different characters in *Dendrobium* orchids

Sl. No.	S. V	Mean sum of square	
		Genotype	Error
1	Plant height (cm)	142.18**	0.44
2	Number of leaves per shoot	32.05**	0.62
3	Number of aerial roots	13.21**	1.72
4	Length of aerial roots (cm)	10.01**	0.59
5	Thickness of the shoot (cm)	6.92**	0.65
6	Internodal length (cm)	7.52**	0.62
7	Length of the leaf (cm)	31.56**	0.64
8	Width of the leaf (cm)	3.53**	0.75
9	Thickness of leaf (cm)	1.11**	0.30
10	Leaf area (cm2)	162.06**	0.80

** Significant at 1 percent level

Table 2: Components of variance and genetic parameters for different vegetative characters

Sl. No.	Characters	GCV	PCV	Heritability (%)	Genetic advance (%)
1	Plant height	28.50	28.63	99.10	58.44
2	Number of leaves per shoot	36.78	37.85	94.44	73.63
3	Number of aerial roots	13.92	15.08	85.30	26.50
4	Length of aerial roots	13.51	14.75	84.00	25.52
5	Thickness of the shoot	32.55	37.32	76.12	58.50
6	Internodal length	34.48	38.81	78.90	63.12
7	Length of the leaf	23.25	23.95	94.10	46.47
8	Width of the leaf	23.51	31.68	55.10	35.96
9	Thickness of leaf	66.17	69.53	27.10	38.76
10	Leaf area	17.06	17.18	98.50	34.88

Understanding the diversity found in the genus *Dendrobium* and choosing the parents for an effective hybridization programme depend on a thorough study of the vegetative characters. Robust hybrids produce bigger, better blossoms and have a more floriferous nature with more substantial flowers, highlighting the significance of vegetative vigour (McDonald). Higher order multigeneric hybrids of orchids displayed a wider range of character variation than lower order primary hybrids (Hurst,). The majority of the traits in the current study had high heritability and genetic advances, which was consistent with studies in a number of *Dendrobium* orchid genotypes.

For all the characters observed PCV values were greater than GCV values, indicating that environmental factors may have influenced the characters expression of the traits. Similar results of the coefficients of variation for genotypic and phenotypic traits have also reported it in orchids (Pramanik *et al*., 2020). It's GCV provides a clearer view of heritability estimates and the rate of genetic advancement that can be anticipated from phenotypic selection (Burton, 1952) [3]. For every attribute examined, PCV was a little higher than GCV. This demonstrated that the phenotypic expression of the traits was somewhat influenced by the environment. The outcome was consistent with Sultana (2003) [16], Faroque (2003) [5], and Roychowdhury *et al*., 2011 [15] in orchid and carnation. All of these variables showed high heritability (broad sense) estimates in *Dendrobium* orchids by Moniruzzaman *et al*., 2012 [11].

Heritability features assist the breeder for selection on the phenotypic performance of the plant by determining how much a plant's phenotype serves as a reference to its genotype (Kumar *et al*., 2012) [8]. High estimates of heritability were found for the traits like plant height, number of leaves per shoot, number of aerial roots, length of aerial roots, thickness of the shoot, internodal length, length of the leaf and leaf area. Width of the leaf showed moderate heritability, Dewanti *et al*.,2019 [4] in orchids indicating that a large portion of the phenotypic variability is found in these traits.

The potential for improvement through direct selection was indicated by high heritability with high genetic advances for plant height, number of leaves per shoot, number of aerial roots, length of aerial roots, thickness of the shoot, internodal length, length of the leaf and leaf area. High genetic progress and heritability for certain qualities may be the result of an additive gene impact (Bhatia, 2004) [2]

4. Conclusion

Greater genetic variability increases the chances for selection of better genotypes. High estimates of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) on plant height, number of leaves per shoot, thickness of the shoot, internodal length, length of the leaf, width of the leaf and thickness of leaf provide information about the magnitude of variability present in these characters in a genetic population. High heritability along with high genetic advance in the traits such as plant height, number of leaves per shoot, number of aerial roots, length of aerial roots, thickness of the shoot, internodal length, length of the leaf and leaf area indicated additive gene action, predicting genetic gain under selection, than heritability estimates alone.According to the preliminary analysis, it is evident that a wide range of variation exists among the twenty genotypes of *Dendrobium* studied, for most of the vegetative characters evaluated. The genotypes can be chosen and used as parents in various breeding programmes to create improved hybrids due to their (high/ moderate) heritability and genetic advance.

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