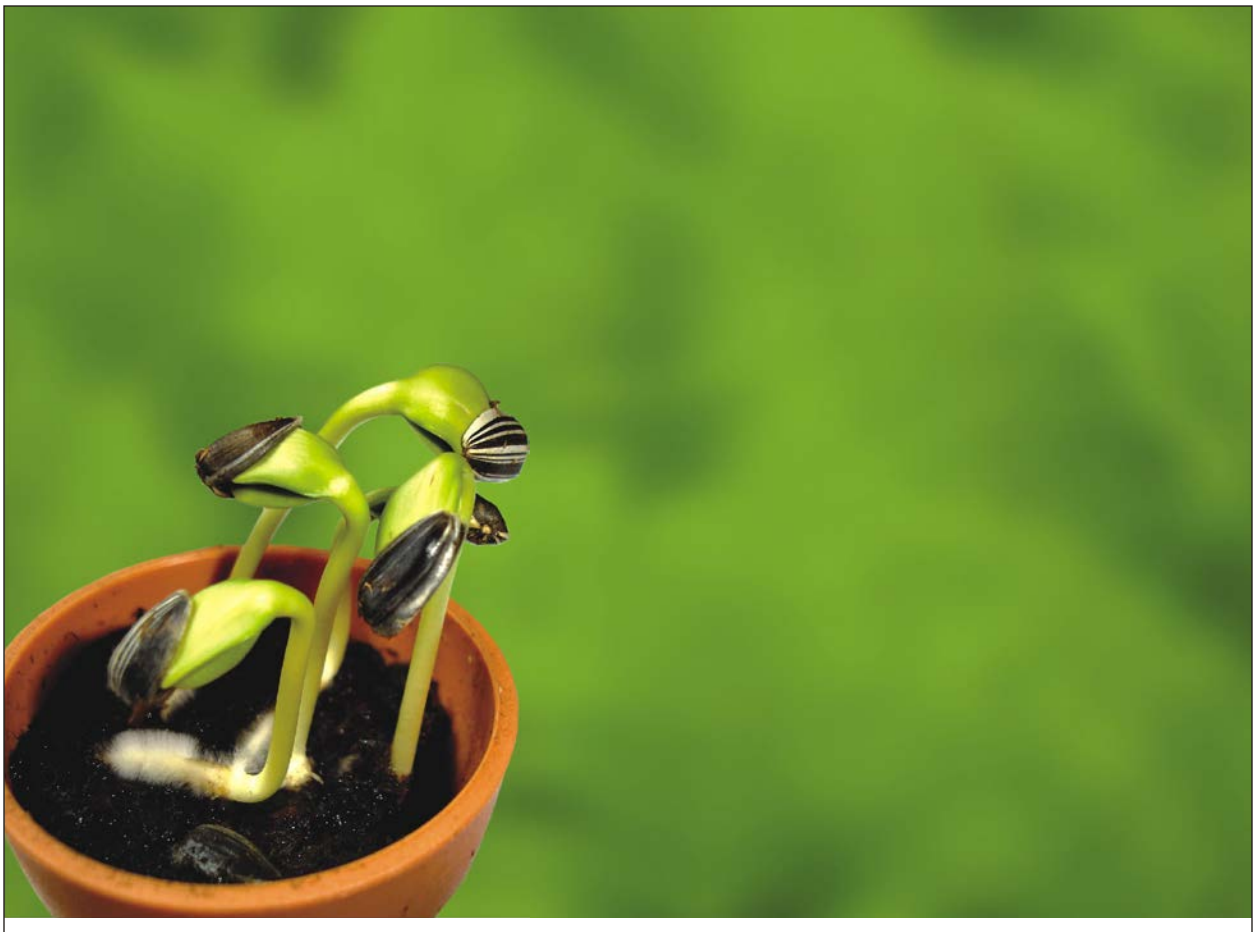

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A Study of the Association of Agronomic Characters in *Vanilla planifolia* Andrews

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ABSTRACT

Natural vanillin is a flavouring agent of high esteem. This is obtained from the processed beans of three species of the orchid genus *Vanilla* among which *Vanilla planifolia* Andrews is the most popular and it yields vanillin of superior quality. In spite of its overwhelming importance, studies on the diversity and improvement of the crop are very limited. Most of the agronomic characters of vanilla are polygenic in nature and they show different levels of interrelationship due to sharing of common genes. This phenomenon leads to different levels of interrelationship and association of these characters. The most important agronomic characters of this plant have been analyzed presently for their association by factor analysis so as to group them in to groups with maximum gene sharing and also to identify the lead characters. Eleven accessions/genotypes of *Vanilla planifolia* collected from the major vanilla growing areas of Kerala State and adjacent states of India were utilized for the present study. The plants were grown in randomized block design with three replications and 12 plants per plot and maintained as per the recommendations of Spices Board, India. Vanilla vine cuttings of 33 cm length were used for planting and live *Gliricidia* plants pruned and maintained permitting 50% light to penetrate were used as standards to train the vanilla vines. The plants started to flower in the third year. Artificial hand pollination was carried out to ensure pod setting. Yield got stabilized by the fifth year after planting and the data collected during the fifth year have been used for the present analysis. Internodal length, vine length, number of inflorescences per plant and leaf area have been identified as lead characters in the present study. Due weightage can be given to these characters in further studies on the diversity and improvement of this species.

Key words: *Vanilla planifolia*, vanilla, character association, agronomic characters, factor analysis

INTRODUCTION

The genus *Vanilla* Mill (Plum. Ex.L) belongs to the orchid family, Orchidaceae, which is the largest family of flowering plants, with about 700 genera and 20,000 species. Orchidaceae comprises of a very natural, distinctive and highly advanced group of monocotyledons. They are perennial herbs which are widely distributed throughout the world with the greatest number in the tropics. They exhibit a wide range of life forms and have terrestrial, climbing, epiphytic and saprophytic species (Purseglove *et al*., 1981). The genus *Vanilla* Mill. was first described by Miller in 1754 taking the name from the Spanish vainilla (small pod) in reference to the long, slender, pod like fruit. The members of the genus are stout, terrestrial, climbing, branched herbs; branches

giving rise to adventitious roots; leafy or leafless. Leaves when present are coriaceous or fleshy. Racemes usually axillary, sub sessile or peduncled. Flowers are large, sepals and petals sub equal, spreading. Lip is adnate by a claw to the base of the column and embracing it in its concave limb, entire or 3-lobed. Column is elongate. Anthers are incumbent, cells separate and pollen granular. Capsules are long, fleshy and one celled (Fisher, 1928). Withner *et al.* (1974) pointed out that evolutionary development of the vining habit of *Vanilla* perhaps depended up on the greater efficiency for water conduction by vessel elements as compared to the basic tracheids. Recent studies have indicated that interspecific hybridization and polyploidization might have played an important role in the evolution of the genus. Mating system diversity exists in *Vanilla* and this genus could be a good model to study the role of fragrance in orchid evolution (Bory *et al.*, 2008).

The genus *Vanilla* consists of about 110 species. Three species of *Vanilla* namely *Vanilla planifolia* Andrews, *Vanilla tahitensis* J.W. Moore and *Vanilla pompona* Schiede are commercially exploited and cultivated. Of these, *Vanilla planifolia* is the most preferred commercially and hence, widely cultivated and the two other species are occasionally cultivated and yield an inferior product (Purseglove *et al.*, 1981). *Vanilla planifolia* is native to the humid tropical rain forests of South Eastern Mexico, Central America, the West Indies and the northern part of South America. *Vanilla tahitensis* is indigenous to Tahiti, the French Oceania group of islands in the Pacific Ocean and *Vanilla pompona* is indigenous to South Eastern Mexico, Central America, Trinidad and North and South America (Correll, 1953; Purseglove *et al.*, 1981). *Vanilla planifolia* Andrews is a herbaceous perennial vine, climbing up trees or other supports to a height of 10-15 m by means of adventitious roots. In cultivation it is trained to a height which will facilitate hand pollination and harvesting. Long, whitish, aerial adventitious roots of about 2 mm in diameter are produced singly opposite the leaves and adhere firmly to the support plant. The roots at the base ramify in the humus or mulch layer. The stem is long, cylindrical, succulent and branched. It is 1-2 cm in diameter and is dark green and photosynthetic with stomata. The internodes are 5-15 cm in length. Leaves are large, flat, fleshy, sub sessile, alternate, oblong-elliptic to lanceolate. They are 8-25 cm long and 2-8 cm broad. The tip is acute to acuminate and the base somewhat rounded. Venation is parallel and the veins are distinct. The petiole is thick, short and canalized above. Flowers are large, waxy, fragrant, pale greenish yellow, bisexual and zygomorphic. Perianth lobes are six in number (3+3) and they look alike. The lower petal of the inner whorl is short, broad and it is modified into a labellum. The lower part of the labellum envelops a central structure called the column (gynostemium) (Purseglove *et al.*, 1981). Gynostemium is formed by the union of stamen, style and stigma (Lawrence, 1951). A tuft of hairs is seen in the middle of the disc. The tip of the column bears a single stamen with two pollen masses (pollinia) covered by a cap or hood like structure called rostellum which prevents natural pollination. The slender stalk like portion is the ovary, which is 4-7 cm in length and 3-5 mm in diameter. The fruit is a capsule, which is dehiscent in *Vanilla planifolia* and in trade it is known as a bean. The bean is pendulous, narrowly cylindrical, obscurely three angled, 10-25 cm long and 5-15 mm in diameter. Each bean when ripe contains thousands of minute globose seeds, which are liberated by longitudinal splitting of the capsule (Purseglove *et al.*, 1981). The product from *Vanilla planifolia* is known as Mexican vanilla, Bourbon vanilla or Indonesian vanilla based on the method of processing (George, 1989).

Vanilla is one of the most valuable spices and is often referred to as the prince of spices. Natural vanillin could find wide application in confectioneries, cakes, beverages, puddings, chocolates, ice creams, perfumery and pharmaceuticals. Most of the agronomic characters of crop plants are

Table 1: Accessions of *Vanilla planifolia* studied for character association

Accession No.	Source
CUV 5	Kallar, Tamil Nadu State, India
CUV 6	Kuzhithodu, Kerala State, India
CUV 9	Sringeri, Karnataka State, India
CUV 10	Puthoor, Karnataka State, India
CUV 12	Combayar, Kerala State, India
CUV 14	Combayar, Kerala State, India
CUV 15	Combayar, Kerala State, India
CUV 17	Sanniasiyoda, Kerala State, India
CUV 18	Mundiyeruma, Kerala State, India
CUV 19	Kailasanadu, Kerala State, India
CUV 20	Udumpanchola, Kerala State, India

Table 2: Factor analysis in the case of *Vanilla planifolia*- factor loadings

	Factors		
Characters	1	2	3
Vine length	0.494857	0.276944	0.386037
Vine girth	-0.868670	-0.302535	0.187451
Number of nodes per metre	-0.846768	0.106079	-0.299318
Leaf thickness	-0.312193	-0.517858	0.099677
Leaf area	-0.311232	-0.529812	0.725625
Internodal length	0.684611	0.067987	0.618451
Length of velamen roots	-0.581599	0.042266	0.289229
Thickness of velamen roots	-0.922776	0.051473	0.135590
No. of inflorescences per plant	-0.346053	0.862237	0.265687
No. of flowers per inflorescence	0.058413	-0.199173	0.489805
Yield per plant	-0.349886	0.860402	0.261314

polygenic in nature and the same is the condition in vanilla also. Such characters show different levels of association based on the quantum of genes shared by them. The present experiment was carried out to find out the association of characters in *Vanilla planifolia* and also to identify the lead characters among them so that future experiments can be based on such lead characters. Eleven agronomical characters were analyzed for the present study based on the observations collected form eleven accessions of *Vanilla planifolia* collected from different vanilla growing regions of South India (Table 1, 2).

MATERIALS AND METHODS

The experiment was carried out in the Genetics and Plant Breeding Division of the Department of Botany of University of Calicut, Kerala, India during 2003-2007. The experimental field is located at 11°25'-11°45' N latitude and 75°45'-75°50' E longitude and it enjoys an annual rainfall of about 300 cm. Eleven accessions/genotypes of *Vanilla planifolia* collected from the major vanilla growing areas of Kerala State and adjacent states of India have been utilized for the present study (Table 1). The plants were grown in randomized block design with three replications and 12 plants per plot and maintained as per the recommendations of Spices Board, India (Anonymous, 2002). Vanilla vine cuttings of 33 cm length were used for planting and live *Gliricidia* plants pruned and maintained permitting 50% light to penetrate were used as standards to train the vanilla vines. The

plants started to flower in the third year. Artificial hand pollination was carried out to ensure pod setting. Yield got stabilized by the fifth year after planting and the data collected during the fifth year have been used for the present analysis. Association of agronomical characters of the species has been studied presently by factor analysis as suggested by Sneath and Sokal (1973) based on 8 growth characters and 3 yield characters (Table 2). The statistical software STATISTICA was used for the analysis.

RESULTS AND DISCUSSION

The agronomic characters of many crop plants show polygenic type of genetic control and as a result they show different levels of interrelationships and association. The level of association will depend on the extent of gene sharing. Study of these aspects in any crop is highly important since this information will provide the foundation for further breeding and improvement programmes in it. Eleven such characters of *Vanilla planifolia* have been studied presently for character association by factor analysis. The characters could be grouped into three factors based on factor loading (Table 2-4). The first factor group consisted of the characters internodal length and vine length. The second factor group consisted of three characters namely, number of inflorescences per plant, yield per plant and number of nodes per metre. Six characters namely, leaf area, number of flowers per inflorescence, length of velamen roots, vine girth, thickness of velamen roots and leaf thickness were grouped under the third factor. Internodal length showed the maximum factor loading in the first group, number of inflorescences per plant in the second group and leaf area in the third group. These characters can be considered the lead characters in the respective groups and it shows that internodal length, number of inflorescences per plant and leaf area can be considered the most important characters in *Vanilla planifolia* while practicing selection and other crop improvement programmes. Vine length is also an important character in *Vanilla planifolia* since it also shows comparatively high factor loading. The percentage of variance contributed by the characters coming under the first factor is 34.68, that contributed by the characters coming under the second factor is 20.55 and that contributed by the characters coming under the third factor is 15.21. These three factors cumulatively contribute 70.45% of the total variance in the case of the characters studied presently.

Factor analysis can be used as an efficient tool to study character association and also to group variables so as to effect data reduction by identifying the lead variables of each group. This method has been used for data reduction, grouping of variables and also to find out the lead variables in different crops like cardamom (Radhakrishnan *et al*., 2004; Hrideek *et al*., 2008) and coffee

Table 3: Factor analysis in the case of *Vanilla planifolia*- eigen values, percentages of total variance, cumulative eigen values and cumulative percentages of variance

Factors	Eigen value	% of total variance	Cumulative eigen value	Cumulative % of variance
1	3.814866	34.68060	3.814866	34.68060
2	2.260827	20.55297	6.075694	55.23358
3	1.673524	15.21386	7.749218	70.44743

Table 4: Factor analysis in the case of *Vanilla planifolia*- characters associated as per factor analysis

Factors	Characters
1	Internodal length, Vine length
2	No. of inflorescences per plant, yield per plant, number of nodes per metre
3	Leaf area, number of flowers per inflorescence, length of velamen roots, vine girth, thickness of velamen roots, leaf thickness

(Nikhila *et al*., 2008). Their studies have contributed significantly towards finding out lead variables in the crops and also towards reduction of multiplicity of variables and concentrating on the lead variables for crop improvement programmes.

The present study in *Vanilla planifolia* has been useful to group the major agronomic characters of the crop in to three groups based on factor loading, to assess the extent of variability contributed by them and also to identify the lead variables from each group. Internodal length, vine length, number of inflorescences per plant and leaf area have been identified as lead characters in the present study. These lead variables are important since they are interlinked the maximum with other agronomic characters. Study of the genetics, genetic variability and extent of diversity of the gene pools in the crop has been attempted very limitedly. The works of Verma *et al*. (2008) and Divakaran *et al*. (2008) are some such efforts carried out recently and they have emphasized the importance of developing conservation strategies for the crop. The present study emphasizes the need of reorienting crop improvement programmes in the crop based on analysis of lead variables among the agronomically important characters. It looks in to the interrelationship of the agronomic characters of the crop so as to have a better idea on sharing of genes by them.

REFERENCES

Anonymous, 2002. Vanilla- Package of Practices. Spices Board, Ministry of Commerce and Industry, Government of India, India, pp: 14.

Bory, S., M. Grisoni, M.F. Duval and P. Besse, 2008. Biodiversity and preservation of vanilla: Present state of knowledge. Genet. Resourc. Crop Evolut., 55: 551-571.

Correll, D.S., 1953. Vanilla-its history, cultivation and economic importance. Econ. Bot., 7: 291-358.

Divakaran, M., V.N. Jayakumar, S.S. Veena, J. Vimala and A. Basha *et al*., 2008. Genetic variations and interrelationships in *Vanilla planifolia* and few related species as expressed by RAPD polymorphism. Genet. Resourc. Crop Evolut., 55: 459-470.

Fisher, C.E.C., 1928. Flora of the Presidency of Madras Part VIII: Ulmaceae to Xyridaceae. Allard and Son Ltd., Hart Street, WC, London, pp: 2017.

George, C.K., 1989. Quality of vanilla beans. Spice India, 2: 3-4.

Hrideek, T.K., V.V. Radhakrishnan, K.V. Mohanan, K.M. Kuruvilla, K.J. Madhusoodanan and J. Thomas, 2008. A study of character association in small cardamom (*Elettaria cardamomum* Maton). Int. J. Plant Breed. Genet., 2: 42-46.

Lawrence, G.H., 1951. Taxonomy of Vascular Plants. Prentice Hall, New Jersey, USA.

Nikhila, K.R., V.B. Sureshkumar, K.V. Mohanan and A. Santaram, 2008. Association of agronomic characters in robusta coffee (*Coffea canephora* Pierre ex Froehner). Int. J. Plant Breed. Genet., 2: 47-50.

Purseglove, J.W., E.G. Brown, C.L. Green and S.R.J. Robbins, 1981. Spices (Volume II): Tropical Agricultural Series. Longman Scientific and Technical Publisher, London, New York, pp: 447-813.

Radhakrishnan, V.V., Priya P. Menon, K.J. Madhusoodanan, K.M. Kuruvilla and J. Thomas, 2004. Factor analysis in cardamom (*Elettaria cardamomum* Maton). J. Spices Aromatic Crops, 13: 37-39.

Sneath, P.H.A. and R.R. Sokal, 1973. Numerical Taxonomy. 1st Edn., Freeman, San Francisco, USA., pp: 573.

Verma, P.C., D. Chakrabarty, S.N. Jena, D.K. Mishra and P.R. Tuli, 2008. The extent of genetic diversity among *Vanilla* species: Comparative results for RAPD and ISSR. Ind. Crops Products, 29: 581-589.

Withner, C.L., P.K. Nelson and P.J. Wejksnora, 1974. The Anatomy of Orchids. In: The Orchids: Scientific Studies, Withner, C.L. (Ed.). John Wiley and Sons, New York, pp: 267-348.