

Multivariate analysis in fifty cultivars / landraces of 'black pepper' (*Piper nigrum* L.) occurring in Kerala, India

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ABSTRACT: Multivariate analysis in fifty cultivars / landraces of 'black pepper' (*Piper nigrum* L.) occurring in Kerala, India. *Piper nigrum* L. the source of 'Black Pepper' of commerce is considered to have originated in the Western Ghats of Indian Peninsula. Kerala, a southern State of India occupies considerable portion of the Western Ghats and it harbours a major share of the gene pool of the crop, which occurs both in wild and cultivated conditions. It is estimated that 70 distinct cultivars of 'Black Pepper' are under cultivation in Kerala. But the genetic resources of the crop in the region are getting lost for ever, as a result of gene erosion due to diverse factors. The efforts in conserving and utilizing the resource are meager. A clear understanding of the genetic attributes of the taxa and their inter relationships are advantageous for formulating strategies in conservation and utilization programmes of the genetic resource. The present study deals with multivariate analysis in 50 cultivars/landraces of *P.nigrum* occurring in the State based on 15 morphological characters using Mahalanobis D² Statistic. On the basis of relative magnitude of D² values, the genetic diversity between and among the cultivars/landraces were measured and grouped into 12 clusters (I to XII). The number of cultivars/landraces of the clusters ranged from 1 – 24. The D² values between the groups ranged from 20.7 to 177.6. The maximum intercluster distance was noted between the clusters VII and XII and least between the clusters I and IV. Intracluster distance ranged from 0.00 – 19.3. The least distance was observed in six clusters, which were single member clusters. The maximum intracluster distance was noted in cluster V. The results of the study are directly useful in selecting parent strains for hybridization programmes aiming at exploiting hybrid vigour in the crop.

Key words: *Piper nigrum* L., Black pepper, Genetic diversity, D² Statistic

INTRODUCTION

Piper nigrum is believed to have originated in the sub - mountainous tracts of the Western Ghats (Rahiman et al 1979). It is chiefly cultivated in the tropical countries of the world such as India, Sri Lanka, Vietnam, Malaysia, Indonesia, Brazil and West Indies. In India, in the State of Kerala, over 70 distinct cultivars are under cultivation (Mathai et al 1981) both as a mixed crop in homestead gardens and in semi plantation scale. The landraces are arbitrarily named in Malayalam vernacular based on different considerations like the place of origin of the cultivars, striking morphological features etc. Considerable variations exist among the landraces with respect to an array of plant morphological characters giving them the status of distinct plant types, each with its own characteristic features. The Western Ghats also harbour many wild forms of the species in the forests, in addition to the landraces and the traditional cultivars grown by the farmers. There have been some attempts to study intraspecific variability in *Piper*

nigrum (Chandy et al 1984; Kanakaswamy et al 1985; Mathew et al 2001). But no grouping of the cultivars based on D² analysis has been known in cultivars of *Piper nigrum* occurring in the region.

The study aims to measure the genetic distance between the clusters in order to differentiate the genetically similar cultivars and the dissimilar ones. The result of the study is highly useful in planning hybridization programmes for genetic improvement of the crop by facilitating rational selection of parents from genetically divergent groups of the cultivars.

MATERIAL AND METHOD

Fifty cultivars/ landraces of *Piper nigrum* cultivated in the State of Kerala, India were subjected to the present study (Table-1). The cultivars / landraces are known in Malayalam vernacular names. The fifteen morphological characters (quantitative) were selected for the study (Table- 2) by consulting the descriptor of Black pepper (IPGRI, 1995). Field surveys were conducted to various regions of Black Pepper cultivation in Kerala, spread mainly over six

Recebido para publicação em agosto/2004

Aceito para publicação em julho/2006

TABLE 1. Fifty intraspecific variants of *Piper nigrum* and its localities of collection in Kerala State of India

Sl.No.	Landrace	Locality	District
1.	'Ampirian'	Kulathupuzha	Kollam
2.	'Angamali'	Kodolippuram	Kannur
3.	'Arakkulamundy'	Pulpally	Wayanad
4.	'Areepadappan'	Kulathupuzha	Kollam
5.	'Arivally'	Kodolippuram	Kollam
6.	'Balancotta'	Kalpetta	Wayanad
7.	'Cheriyakaniyakkadan'	Veliyambra	Kannur
8.	'Cheriyauthiran'	Naiketty	Wayanad
9.	'Cherumany'	Naiketty	Wayanad
10.	'Chombala'	Mattannoor	Kannur
11.	'Jeerakamundy'	Peerumade	Idukki
12.	'Kallubalankotta'	Kodolippuram	Kannur
13.	'Kallumany'	Periya	Wayanad
14.	'Kalluvally'	Periya	Wayanad
15.	'Kalyanamandiram'	Kalpetta	Wayanad
16.	'Kaniyakkadan'	Kulathupuzha	Kollam
17.	'Kanjiramkodan'	Kalpetta	Wayanad
18.	'Kareelanchi'	Kulathupuzha	Kollam
19.	'Karimkottavally'	Kalpetta	Wayanad
20.	'Karimunda'	Peruvanthanam	Idukki
21.	'Karimundy'	Pulpally	Wayanad
22.	'Karivally'	Porora	Kannur
23.	'Kottanadan'	Peringamala	Trivandrum
24.	'Kuruvantherivally'	Kodolippuram	Kannur
25.	'Kuthiravaaly'	Kodolippuram	Kannur
26.	'Maniyamcode'	Kalpetta	Wayanad
27.	'Manjavallypadappan'	Peringamala	Trivandrum
28.	'Menonvally'	Kodolippuram	Kannur
29.	'Mundy'	Aralam	Kannur
30.	'Murithothan'	Kulathupuzha	Trivandrum
31.	'Muttiyaramundy'	Pulpally	Wayanad
32.	'Narayakodi'	Pathamuttom	Kottayam
33.	'Neelamundy'	Vandiperiyar	Idukki
34.	'Orumaniyan'	Vandiperiyar	Idukki
35.	'Pala'	Palode	Trivandrum
36.	'Panickaruvally'	Naiketty	Wayanad
37.	'Panniyur-I' ¹	Naiketty	Wayanad
38.	'Peringamala'	Peringamala	Trivandrum
39.	'Perumkodi'	Pulpally	Wayanad
40.	'Poonjarmunda'	Kodolippuram	Kannur
41.	'Thevanmundy'	Peerumade	Idukki
42.	'Thirimuriyan'	Kalpetta	Wayanad
43.	'Uthiran'	Kalpetta	Wayanad
44.	'Uthirankotta'	Kodolippuram	Kannur
45.	'Vadakkan'	Vandiperiyar	Idukki
46.	'Valiyauthiran'	Naiketty	Wayanad
47.	'Valiyapadappan'	Kulathupuzha	Trivandrum
48.	'Vattamundi'	Vallakkadavu	Idukki
49.	'Vellamundy'	Vallakkadavu	Idukki
50.	'Velutha uthiri'	Porora	Kannur

¹ hybrid cultivar

TABLE 2. Range and Frequency of character states of the fifteen quantitative characters in 50 cultivars/landraces of *Piper nigrum*

Sl. No.	Character	Character state	Range	Frequency
1.	Leaf length	Low	8.35 – 11.45 cm	9
		Medium	11.46 – 15.12 cm	31
		High	15.13 – 17.50 cm	10
2.	Leaf breadth	Low	3.70 – 6.07 cm	5
		Medium	6.08 – 8.84 cm	30
		High	8.85 – 9.89 cm	15
3.	Leaf area	Low	26.60 – 63.76 cm ²	12
		Medium	63.77 – 93.33 cm ²	28
		High	93.34–139.60 cm ²	10
4.	Leaf perimeter	Low	21.60 – 29.04 cm	8
		Medium	29.05 – 36.20 cm	33
		High	36.21 – 44.00 cm	9
5.	Leaf fresh weight	Low	6.13 – 7.78 g	24
		Medium	7.79 – 8.23 g	1
		High	8.24 – 22.33 g	25
6.	Leaf dry weight	Low	0.97 – 2.55 g	23
		Medium	2.56 – 2.94 g	6
		High	2.95 – 5.61 g	21
7.	Petiole length	Low	0.95 – 1.30 cm	9
		Medium	1.31 – 2.03 cm	36
		High	2.04 – 2.32 cm	5
8.	Internode length	Low	3.20 – 6.28 cm	8
		Medium	6.29 – 9.56 cm	33
		High	9.57 – 13.40 cm	9
9.	Fruiting spike length	Low	6.35 – 8.60 cm	15
		Medium	8.61 – 11.17 cm	19
		High	11.18 – 15.20 cm	16
10.	Spike stalk length	Low	0.75 – 0.94 cm	4
		Medium	0.95 – 1.53 cm	40
		High	1.54 – 1.70 cm	6
11.	Fruit number/ spike	Low	5 – 25 nos.	15
		Medium	26 – 59 nos.	25
		High	60 – 110 nos.	10
12.	Fruit fresh weight	Low	8.00 – 13.55 g	26
		Medium	13.56 – 14.28 g	10
		High	14.29 – 21.00 g	14
13.	Fruit dry weight	Low	1.88 – 3.99 g	26
		Medium	4.00 – 4.24 g	7
		High	4.25 – 7.28 g	17
14.	Fruit horizontal length	Low	5.50 – 5.89 mm	36
		Medium	5.90 – 6.17 mm	3
		High	6.18 – 7.25 mm	11
15.	Fruit vertical length	Low	5.50 – 6.13 mm	28
		Medium	6.14 – 6.44 mm	2
		High	6.45 – 7.00 mm	20

TABLE 3 . Intra and inter cluster distance of cultivars of *Piper nigrum* L.

	Clusters											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
I	13.8*	31.9	38.3	20.7	46.6	32.7	53.8	23.4	29.7	55.3	24.9	55.7
II		13.6*	25.0	32.0	46.6	79.0	49.1	38.2	38.8	27.8	38.5	81.7
III			11.7*	47.7	26.1	99.5	25.0	62.6	62.2	39.2	28.4	118.4
IV				1.9*	36.4	40.2	89.0	37.3	27.8	79.9	52.4	23.7
V					19.3*	78.4	57.4	68.1	73.0	90.4	39.1	96.2
VI						19.3*	117.0	41.4	42.0	114.7	70.4	52.4
VII							0.0*	67.2	84.7	34.0	20.9	177.6
VIII								0.0*	50.0	55.0	31.2	56.7
IX									0.0*	54.1	60.2	48.6
X										0.0*	38.6	137.2
XI											0.0*	108.1
XII												0.0*

TABLE 4. Composition of clusters of cultivars of *Piper nigrum* L. based on D² analysis

Clus. No.	No. of cvs.	Names of cultivars
I	24	Angamali, Balankotta, Cheriyaithiran, Cherum any, Kaniyakadan, Kanjiramkoda, Kaareelanchi, Karivally, Karimkottavally, Karuvantherivally, Maniyamcode, Manjavallypadappan, Menonvally, Mundy, Murithothan, Muttiyaramudy, Neelam undy, Thevanmudy, Thirimuriyan, Uthiran, Uthiramkotta, Vadakkan, Vellamundy, Veluthauthiri
II	8	Panickaruvally, Poonjarmunda, Kallum any, Perumkody, Kottanadan, Peringamala, Valyapadappan, Valiyauthiran
III	6	Arakulam undy, Cheriya kaniakadan, Jeerakam undy, Karimunda, Karimundy, Narayakodi
IV	2	Ampirian, Vattamundy
V	2	Areepadappan, Pala
VI	2	Kalyanam andiram, Kalluvally
VII	1	Arivally
VIII	1	Chombala
IX	1	Kallubalankotta
X	1	Kuthiravaaly
XI	1	Orum anyan
XII	1	Panniyur-I

TABLE 5. Cluster means of quantitative characters in cultivars of *Piper nigrum* L.

Sl. No	Character	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1	L.l. (cm)	13.8	13.4	10.9	12.4	10.1	16.9	13.6	16.2	17.3	14.5	10.6	12.1
2	L.b. (cm)	7.3	8.7	6.2	8.2	7.7	9.2	6.0	10.2	8.0	7.0	3.7	8.9
3	L.a. (cm)	72.1	99.9	68.4	109.0	63.3	79.7	27.4	43.8	139.6	88.6	26.6	132.4
4	L.p. (cm)	32.0	35.3	31.3	36.4	31.5	36.4	21.8	23.2	44.0	34.8	21.6	39.2
5	L.f.wt. (g)	11.9	16.5	9.0	14.0	7.1	15.3	6.5	13.5	14.7	11.5	8.9	22.1
6	L.d.wt.(g)	2.5	3.7	2.2	3.6	2.0	3.1	1.0	3.2	3.7	3.9	1.3	3.7
7	P.l. (cm)	1.7	1.4	1.1	1.9	1.5	2.2	1.1	2.0	1.7	1.2	1.4	2.3
8	I.l. (cm)	8.3	7.0	6.6	7.1	4.4	11.2	10.4	8.5	10.7	9.7	8.2	8.1
9	S.l. (cm)	9.4	11.9	8.6	8.2	5.5	8.6	8.5	13.3	10.4	15.2	10.7	11.4
10	S.s.l. (cm)	1.2	1.3	1.3	0.9	1.4	1.0	1.0	1.3	1.4	1.1	1.3	1.6
11	F.no.	41.3	52.8	42.7	69.5	41.5	22.0	42.0	53.0	36.0	71.0	22.0	110.0
12	F.f. wt.(g)	14.0	13.3	12.6	13.4	12.6	15.3	12.0	9.0	14.0	10.0	20.0	12.5
13	F.d.wt.(g)	4.5	4.0	4.2	4.4	3.0	4.5	3.6	3.8	3.5	2.9	4.9	3.2
14	F.h.l. mm)	6.2	5.8	5.7	5.5	6.0	7.0	6.0	6.0	6.0	6.0	6.0	6.0
15	F.v.l. mm)	6.8	6.0	5.7	6.5	6.0	7.0	6.0	6.0	6.5	5.0	6.0	7.0

L.l.-Leaf length; L.b- Leaf breadth; L.a- Leaf area; L.p- Leaf perimeter; L.f.wt.- Leaf fresh weight; L.d wt.- Leaf dry weight; P.l- Petiole length; I.l Internode length; S.l-Spike length; S.s l-Spike stalk length; F.no.- Fruit no./ spike; F.f wt.-Fruit fresh weight; F.d wt.- Fruit dry weight; F.h l- Fruit horizontal Length; F.v l- Fruit vertical length

districts of the State - Trivandrum, Kollam, Kottayam, Idukki, Kannur and Wayanad - during 1993 – 1996, in the three seasons of Black pepper production. The data were collected from plants of uniform age (4-5 years). Simple random sampling method was followed for collecting the data. Five plants per cultivar, each from five different holdings were used for observing and recording the details of the characters. Five observations were taken for each character from a plant. Leaf characters were scored from fruiting branches, and internode length from climbing stem from a length of 1.5 m. Herbarium specimens of all the cultivars were prepared and voucher specimens deposited in the Herbarium of Tropical Botanic Garden and Research Institute (TBGT). The quantitative characters were divided into three classes based on the property of normal distribution, 95% confidence intervals being used for the purpose as below.

Low = Mean - 2SE

Medium = Mean \pm 2SE

High = Mean + 2SE

The multivariate analysis using Mahalanobis D² statistic is used in the present study to group the

cultivars of *P. nigrum*. This is a useful technique for measuring the diversity in the available germplasm. A measure of group distance based on multiple characters was given by Mahalanobis (1928). Mahalanobis D² statistic is defined as follows:-

$$pD^2 + b_1d_1 + b_2d_2 + \dots + b_p d_p$$

where b_i (i= 1,2,.....p) values are to be estimated such that the ratio of variance between populations to the variance within populations is maximized.

RESULT AND DISCUSSION

Based on relative magnitude of the D² values, the 50 cultivars were clustered into 12 groups, the composition of which is presented in Table-4. The number of cultivars in the different groups ranges from 1- 24. Cluster- I being the largest, holding 24 cultivars, while 6 clusters have only one member each. The inter and intracluster distances concerning the 12 clusters are furnished in Table- 3. The maximum intercluster distance of 177.6 is between clusters VII and XI, and the least between I and IV (20.7).

Intracluster distance ranged from 0.0 to 19.3; the maximum being in cluster V, and the minimum in six clusters, which are single member clusters. The cluster means of the 15 quantitative characters are computed and furnished in Table-5.

D² analysis is a method for grouping genetically similar taxa. Genetic diversity has been analysed in other crops by using this method. It has been pointed out that for developing varieties, it is desirable to classify the germplasm on the basis of diversity of the different characters and to make crosses between groups sharing maximum diversity (Narasimhayya & Venkata Rao 1974). Theoretically, the maximum amount of heterosis of recombination can be expected involving parents belonging to most divergent clusters.

The divergence between the clusters was reflected in their cluster means. (Table -5). The most divergent clusters VII and XII differ significantly with respect to their means of 8 characters, whereas the least divergent clusters differ significantly only in a very few characters. The study showed that the parents of the successful hybrid cultivar of *Piper nigrum* – ‘Panniyur-I’ – ‘Uthirankotta’ (female parent) and ‘Cheriyakaniyakadan’ (male parent) belong to the clusters I and III respectively of the present grouping, which exhibits fairly good intercluster distance of 38.3. The better performance of the hybrid cultivar can be attributed to the fairly good genetic divergence of its parents as evident in the study.

ACKNOWLEDGEMENT

The first author is grateful to Mr. C. J. Jose, IAS, Chairman, Spices Board, Government of India and Chairman, International Pepper Community, Jakarta, Indonesia for extending financial support to meet the Air fare to Brazil enabling him to participate and present the paper in the International Symposium on

Breeding Research on Medicinal and Aromatic plants held at Campinas, Brazil from 5 – 8 July 2004. The first author is also thankful for financial assistance received from Ms. Nalini Gupta, General Manager – India, South African Airways, Mumbai, Sir Ratan Tata Trust, Mumbai and the Western Ghats Development Cell (through project funding), Planning Board, Govt. of Kerala. The authors are thankful to Dr. G.M. Nair, Director, Tropical Botanic Garden & Research Institute for facilities.

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