ISSN: 3065-0380

Columbia Journal of Agricultural and Environmental Sciences

Research Article

A COMPREHENSIVE MORPHOLOGICAL STUDY OF GENETIC DIVERSITY IN WEST JAVA "MULI" BANANAS

[1]Michael Johnson, [2]Emily Davis and [3]Daniel Smith

[1]Student of Doctoral Program of Agricultural Science Faculty of Agriculture, Padjadjaran University, Jatinangor 45363

[2]Member of Postgraduate Promoter Team of Faculty of Agriculture, Padjadjaran University, Jatinangor 45363 3

[3]Chairman of Postgraduate Promoter Team of Faculty of Agriculture, Padjadjaran University, Jatinangor 45363

DOI: 10.5281/zenodo.14724154

Abstract

West Java, Indonesia, stands out as a hub of banana diversity, serving as the national center for banana cultivation and seed production. This province boasts an extensive array of banana genotypes, including banana muli, king, kepok, horn, and more, with over half of the region dedicated to banana production. Despite this rich diversity, many banana genotypes remain poorly characterized, leaving a vast potential genetic resource untapped. Among these diverse banana varieties, banana muli stands out for its myriad benefits. Notably, it serves as an excellent energy source due to its high-calorie content, rapidly absorbed by the body. Additionally, banana muli varieties are rich in essential minerals, vitamins, iron, and folic acid. Furthermore, they possess significant levels of resistant starch, classified as prebiotics, which remain undigested and promote the growth of beneficial gut bacteria. This study aims to shed light on the genetic diversity of banana muli in West Java, providing valuable insights into its potential applications and benefits. By characterizing this banana genotype, we contribute to the broader understanding of this vital crop's genetic resources and its potential for various uses, including as functional food.

Keywords: West Java, banana genotype, genetic diversity, banana muli, resistant starch, functional food.

Introduction

West Java is one of the provinces where there is a high diversity of banana genotype. This is evidenced by West Java which became the center of banana planting and became the region with the national banana seed producer (West Java Food Crops Agency, 2012). In addition, in West Java, the types of bananas are also very diverse, ranging from banana muli, king, kepok, horn and many more scattered in banana production centers, and more than half the area in West Java is a banana-producing region (Suyanti and Supriadi, 2008). This has led to many genotypes that have not been characterized so that many sources of potential genetic diversity of bananas are not yet known.

Banana muli is one of the many bananas spread in West Java. But until now unknown information related to genetic diversity. Though the benefits of banana muli varieties very much. Banana muli varieties can be used as a good source of energy because it contains calories quickly absorbed by the body. In addition to this banana muli varieties contain minerals, vitamins, iron, Fe and folic acid are quite high. Banana muli varieties can also be said as functional food because it has resistant starch (resistant starch). Potential resistant starch as prebiotics (Haralampu, 2000 in Mustita, 2009) is undigested food and serves as a substrate for growth or selection of beneficial bacteria growing in the human gut.

In general, differences in environmental conditions of an area with other areas may have an effect on the genotype seen in phenotypic appearance. The phenotypic appearance of a character is an expression that is influenced by genetic, environmental, and interaction between the two (Cardenas et al., 1972).

Characterization activities can be an initial basis before further research is undertaken. In germplasm management, characterization activities are used to construct descriptions of a variety in the selection of elders. Characterization on banana plants not only identifies species or varieties, but determines the genetic or kinship relationship between the banana accession and aims to obtain a picture of the accessions tested (Sukartini, 2008).

The purpose of this research is to identify muli banana based on agronomic and morphological character in three ecosystems in West Java as the basis for the development of muli banana breeding in the next effort to breed banana plant to get superior seeds.

Materials and Methods

Data Collection: Survey and characterization were conducted in 10 regencies in West Java, among others Sukabumi, Cianjur, Garut, Ciamis, Banjar, Tasikmalaya, Pangandaran, Purwakarta, Sumedang and West Bandung. The study was conducted on November 2018 until April 2019. Characterization was carried out at the location of banana plantations in West Java grown in all environments, both in smallholder plantations, fields, homegarden, and intercropping areas, representing lowland, medium land, and high land. Location of characterization is listed in Table 1. There are 72 points of observation location spread over 10 regencies in West Java. Total banana plants observed were 726 accessions.

Plant material: The materials used in this study are various types of *Musa acuminata cola* (the local name is Muli) that have been fruitful found in the district of observation location (in situ characterization). The tools used include Global Positioning System (GPS) to know the coordinates and altitude, IPGRI banana descriptor (International Plant Genetic Resources Institute, 1984) to find out the characters of agronomy and morphology (Table 2), digital cameras for documentation and stationery.

Statistical and Data Analysis: This research was conducted by descriptive research using survey method. Sampling is determined by purposive sampling. The purposive sampling technique is one of the sampling technique that is done to choose the location that will be used to do the research intentionally and determine the samples taken by themselves (Tongco, 2007). Vegetation analysis was conducted to obtain information on the distribution of bananas in a region so as to obtain Important Value Index (IVI). The result of this research data is qualitative and quantitative data of vegetative and generative character. The data were analyzed using NTSYS PC 2.1. softwere to calculate the genetic distance based on similarity between the objects studied, then compiled in one unit (cluster analysis). The end of this analysis will form a dendogram depicting the extent to which the relationship between the genotypes is observed. PCA (Principal Component Analysis) analysis using NTSYS PC 2.1. softwere, is used to determine the extent of the contribution of a character to the banana appearance of the muli varieties found. The PCA (Principal Component Analysis) analysis results are displayed in the form of a biplot graph that connects the component scores as axis, then arranged in a single (cluster analysis) on the types of bananas of muli varieties found. The analysis results are presented in the form of dendogram (Rohlf, 2001).

Table1. Banana Sample Collection/Characterization Sites

No.	Code	Banana Growing District	Name of Village/Places where specimen were investigated/collected	Number of banana cultivars collected
1	SB1	Sukabumi	Cijabun Sidangresmi	18
2	SB2		Ciasahan Jampang Tengah	21
3	SB3		Tegal Buleud	19
4	SB4		Argabinta	20
5	SB5		Wangunjaya	20
6	SB6		Sukamaju Sukalarang	4
7	CR1	Cianjur	Ciranjang	8
8	CR2		Naringgul	22
9	CR3		Cidaun	18
10	CR4		Sindangbarang	10
11	CR5		Cikadu	10
12	CR6		Rajamandala	5
13	CR7		Cicanglek	7
14	CR8		Cipanas	4
15	GR1	Garut	Cibatu	10
16	GR2		Majasari	11
17	GR3		Cibiuk	12
18	GR4		Limbangan Tengah	17
19	GR5		Sukamerang	23
20	GR6		Wanaraja	22
21	GR7		Bojong Pameungpeuk	16
22	GR8		Mancagahar Pameungpeuk	13

23	GR9		Karyamukti Cibalong	10
24	GR10		Karyasari Cibalong	15
25	GR11		Mekarsari Cibalong	9
26	GR12		Cikelet	5
27	GR13		Rancamaya	10
28	GR14		Karamatwangi Cisurupan	8
29	GR15		Bungbulang	6
30	GR16		Caringin	20
31	GR17		Rancabuaya	5
32	CS1	Ciamis	Sukanagara Lakbok	4
33	CS2		Jagabaya Panawangan	8
34	CS3		Bangunjaya Panawangan	6
35	CS4		Rajadesa	8
36	CS5		Rancah	5
37	CS6		Cirahong	9
38	BJ1	Banjar	Langensari	11
39	BJ2		Banjarsari	15
40	BJ3		Karyamukti Pataruman	20
41	BJ4		Karangmulya Padaherang	15
42	BJ5		Sindangwangi Padaherang	6
43	TM1	Tasikmalaya	Sukaharja Singaparna	8
44	TM2		Sindangkerta Cipatujah	7
45	TM3		Cikawung Ading Cipatujah	6
46	TM4		Sukamulih Singaparna	10
47	PD1	Pangandaran	Parigi	5
48	PD2		Cijulang	8
49	PW1	Purwakarta	Kertajaya	10
50	PW2		Pasawahan	6
51	PW3		Sawit	4
52	PW4		Wanayasa	7
53	PW5		Parakan Salam	15
54	SM1	Sumedang	Pasirbiru Rancakalong	11
55	SM2		Rancakalong	5

56	SM3		Lamping Rancakalong	8
57	SM4		Sukasirna Rancakalong	6
58	SM5		Sukamaju Rancakalong	9
59	SM6		Cibungur Rancakalong	16
60	SM7		Cileleus Pamulihan	12
61	SM8		Ciptasari Pamulihan	10
62	SM9		Mekarsari Tanjungsari	6
63	SM10		Jatiroke Jatinangor	8
64	SM11		Ciparanje Jatinangor	5
65	SM12		Cijengjing Jatigede	7
66	SM13		Cipicung Jatiged	4
67	SM14		Cintajaya Jatigede	6
68	BB1	Bandung Barat	Parongpong	7
69	BB2		Citatah Cipatat	3
70	BB3		Mandalawangi Cipatat	3
71	BB4		Mekarwangi Lembang	5
72	BB5		Cikahuripan Lembang	4
Total Sample Characterized				726

Table 2. Morphological Traits used in Characterization of Banana Accessions

No	Code	Characters	Character States
1	A	Leaf habit	1 Erect, 2 Intermediate, 3 Drooping, 4 Other
2	B	Leaf blade: shape of base	1 Both sides rounded, 2 One side rounded, one pointed, 3 Both sides pointed
3	C	Leaf blade length [cm]	Measured at its maximum point: 1 <170 cm, 2 171 to 220 cm, 3 221 to 260 cm, 4 >261 cm
4	D	Leaf blade width [cm]	Measured at its maximum point. 1 <70 cm, 2 71 to 80 cm, 3 81 to 90 cm, 4 >91 cm
5	E	Pseudostem colour	1 Green-yellow, 2 Medium green, 3 Green, 4 Dark green, 5 Green-red, 6 Red, 7 Red-purple, 8 Blue, 9 Chimerical, 10 Other
6	F	Petiole length [cm]	Recorded from the pseudostem to the lamina. 1 <50 cm, 2 51 to 70 cm, 3 >71 cm
7	G	Petiole widht [cm]	1 <1 cm, 2 >1 cm, 3 Cannot be defined

8 H Petiole margin color 1 Green, 2 Pink-purple to red, 3 Purple to blue
4 Other
9 I Pseudostem height [m] 1 <2, 2 2.1 to 2.9, 3 >3
10 J Male inflorescence: shape Should be assessed in cross section at harvest time. Only for varieties with "Male inflorescence: persistence: present". 1. Lanceolate, 2. narrow ovate, 3. medium ovate, 4. broad ovate
11 K Diameter Male inflorescence Length and maximum diameter of male bud at harvest. 1 <20 cm, 2 21 to 30 cm, 3 >31 cm
12 L Number of suckers Record the number of suckers from soil level to point of emergence of the last leaf (>30 cm height). Recorded only if no desuckering has taken place
13 M Number of fruits Observed on the mid-hand of the bunch: 1
<12, 2 13-16, 3 >17
14 N Number of bunch Record the number of bunch
15 O Fruit length [cm] Measured as the internal arc of the fruit,
without pedicel: 1 □15 cm, 2 16- 20 cm, 3 21- 25 cm, 4 26- 30 cm, 5 □31 cm
16 P Dwarfism 1 Normal: leaves not overlapped and leaf ratio
inferior to 2.5, 2 Dwarf type: leaves strongly overlapped and leaf ratio superior
17 Q Pseudostem appearance 1 Dull (waxy), 2 Shiny (not waxy)
18 R Wax on leaf sheaths 1 Very little or no visible sign of wax, 2 Very few wax, 3 Moderately waxy, 4 Very waxy
19 S Development of suckers 1 Taller than parent plant, 2 More than 3/4 of the height of the parent plant, 3 Between 1/4 and 3/4 of the height of the parent plant, 4 Inhibited
20 T Position of suckers 1 Far from parent plant (emerging >50 cm from parent plant), 2 Close to parent (vertical growth), 3 Close to parent (growing at an angle)
21 U Blotches at the petiole base 1 Sparse blotching, 2 Small blotches, 3 Large blotches, 4 Extensive pigmentation, 5 Without pigmentation
22 V Blotches colour 1 Brown, 2 Dark brown, 3 Brown-black, 4 Black-purple, 5 Other
23 W Appearance of leaf upper 1 Dull, 2 Shiny
surface
24 X Colour of leaf lower surface (Wax removed). 1 Green-yellow 5 Blue
2 Medium green 6 Red-purple
3 Green 7 Other 25 Y Appearance of leaf lower 1 Dull, 2 Shiny
surface
26 Z Wax on leaves Recorded on the lower surface. 1 Very little or

no visible sign of wax, 2 Few wax, 3 Moderately waxy, 4 Very waxy
27 AA Peduncle length [cm] Measured from the leaf crown to the first hand of fruit. 1 <30 cm, 2 31 - 60 cm, 3 >61 cm
28 AB Peduncle width [cm] Recorded at mid-length. 1 < 6 cm, 2 7 - 12 cm, 3 >13 cm
29 AC Peduncle colour Descriptor state 4 (red/or pink-purple) is green homogeneously tinged with red (purple green appearance). When pigmentation is scattered, use state 5. 1 Light green, 2 Green, 3 Dark green, 4 Red or pink/purple, 5 With purplebrown to blue blotches, 6 Other
30 AD Peduncle hairiness 1 Hairless, 2 Slightly hairy, 3 Very hairy, short hairs (similar to velvet touch), 4 Very hairy, long hairs (>2 mm)
31 AE Bunch position (Position of the fruit-bearing part). Angle from vertical to the general axis of the bunch. 1 Hanging vertically, 2 Slightly angled, 3 Hanging at angle 45°, 4 Horizontal, 5 Erect
32 AF Bunch shape 1 Cylindrical, 2 Truncated cone shape, 3
Asymmetric - Bunch axis is nearly straight, 4 With a curve in the bunch axis, 5 Spiral (all fruit is attached to a unique crown coiled around the stalk)

---

33 AG Bunch appearance 1 Lax (one can easily place one's hand between the hands of fruit), 2 Compact (one can place one's finger, but not one's hand, between the hands of fruit), 3 Very compact (one cannot place one's finger between the hands of fruit)
34 AH Rachis type 1 Truncated, no bract scar below the last hand
of fruit, 2 Present and male bud may be degenerated or persistent
35 AI Rachis position 1 Falling vertically, 2 At an angle, 3 With a curve, 4 Horizontal, 5 Erect
36 AJ Male bud shape Note the general shape of the male bud at
harvest. 1 Like a top 4 Ovoid, 2 Lanceolate 5 Rounded, 3 Intermediate
37 AK Male bud size [cm] Length and maximum diameter of male bud at
harvest. 1 <20 cm, 2 21 to 30 cm, 3 >31 cm
38 AL Bract base shape 1 Small shoulder, 2 Medium, 3 Large shoulder
39 AM Bract apex shape Flatten the apex of the bract to observe its
shape. 1 Pointed, 2 Slightly pointed, 3
Intermediate, 4 Obtuse, 5 Obtuse and split
40 AN Male inflorescence: persistence 1 Absent, 2 present
41 AO Fruit: persistence of floral organs 1 Absent, 2 present
42 AP Fruit shape (longitudinal 1 Straight (or slightly curved), 2 Straight in the

curvature) distal part, 3 Curved (sharp curve), 4 Curved in
„S‟ shape (double curvature), 5 Other
43 AQ Fruit apex Observed at the distal end of the fruit: 1
Pointed, 2 Lengthily pointed, 3 Blunt-tipped, 4
Bottle-necked, 5 Rounded
44 AR Fruit pedicel length [mm] 1 <10 mm, 2 11 to 20 mm, 3 >21 mm
45 AS Fruit pedicel width [mm] 1 <5 mm, 2 5 to 10 mm, 3 >10 mm
46 AT Pedicel surface 1 Hairless, 2 Hairy
47 AU Male inflorescence: opening of 1 closed or slightly open, 2 moderately open, 3
bracts very open

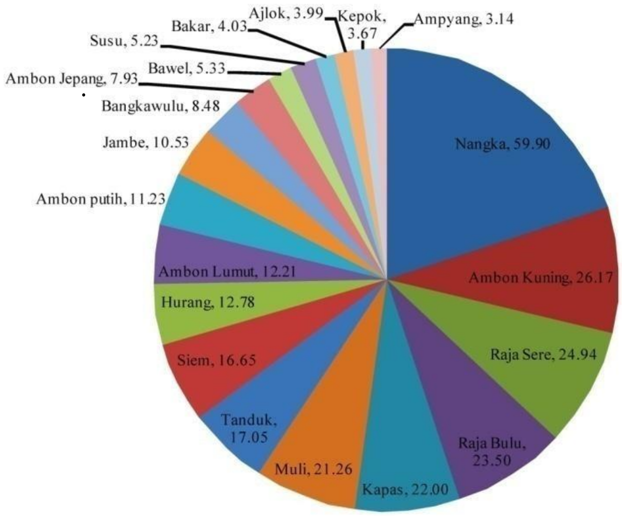
Results and Discussion

Based on the analysis of vegetation on each plain obtained the results as in Figure 1. Division based on the height shows in the lowlands there are 20 types of bananas where Ampyang banana has the lowest important value index of 3.14% and Nangka has the highest Important Value Index (IVI) of 59.90% . The medium plain area shows there are 23 types of bananas where Jambe banana has the lowest IVI value of 3.07% and the highest IVI is owned by Ambon Kuning with IVI value of 43.95%. Bananas that have the lowest IVI value in the highlands are Lalay and Hurang with IVI value of 1.67% and the type that has the highest IVI value in the highlands is Ambon Kuning with 109.27% value. High IVI values indicate that the status of the species in an environment has a high degree of spread.

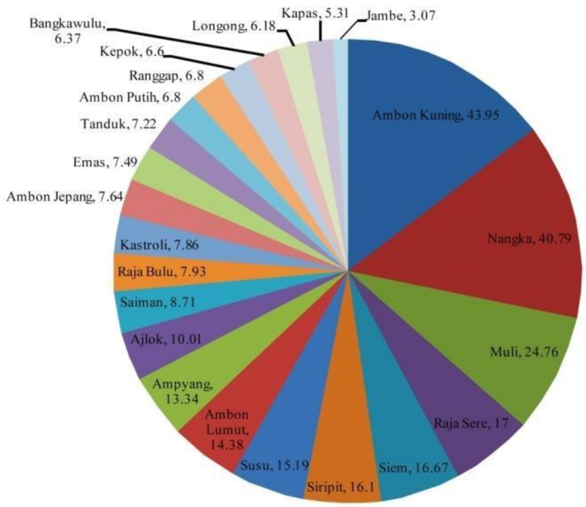
Result of analysis of lowland banana vegetation (Figure 1a) shows that Nangka has the highest IVI with value 59,90%. The second IVI was occupied by Ambon Kuning with a value of 26.17%, and the third IVI value is the Raja Sere which is 24.94%. Based on vegetation analysis on each plain, the result shown in Figure1. Distribution based on altitude shows that there are 20 types of banana in lowland area where Ampyang has the lowest IVI of 3.14% and Nangka has the highest IVI of 59.90%. The medium plain area shows there are 23 types of bananas where Jambe has the lowest IVI value of 3.07% and the highest IVI is owned by Ambon Kuning with IVI value of 43.95%. Bananas that have the lowest IVI value in the highlands are Lalay banana and Hurang with IVI value of 1.67% and the type that has the highest IVI value in the highlands is Ambon Kuning with 109.27% value. High IVI values indicate that the position of the species in a community has a high magnitude. The result of analysis of lowland banana vegetation (Figure 1a) shows that Nangka has the highest IVI with value 59,90%. The second IVI was occupied by Ambon Kuning with a value of 26.17%, and the third IVI value is the Raja Sere Banana which is 24.94%. The value of IVI Nangka and Ambon Kuning are high because each has a relative density and high relative frequency. The frequency indicates the distribution of a species within an area. The high frequency values indicate that the distribution of the species is more evenly distributed.

Bananas that have a high spread in the medium land in a row are Ambon Kuning, Nangka, and Siem with IVI values respectively are 43.95%, 40.79%, and 24.76% (Fig. 1b). The type that has the lowest IVI value in medium land is Jambe type with IVI value 2,29%. The Ambon Kuning in both the lowlands and the medium land has a high density, type, and dominance, so it has a high IVI value. Increasing IVI values indicate that the species has a larger role in a community (Kainde et al., 2011). Results of vegetation analysis in the highlands there are 20 types of bananas found (Figure 1c). The type that has the highest IVI value in the highlands is the Ambon Kuning with an IVI value of 109.27%.

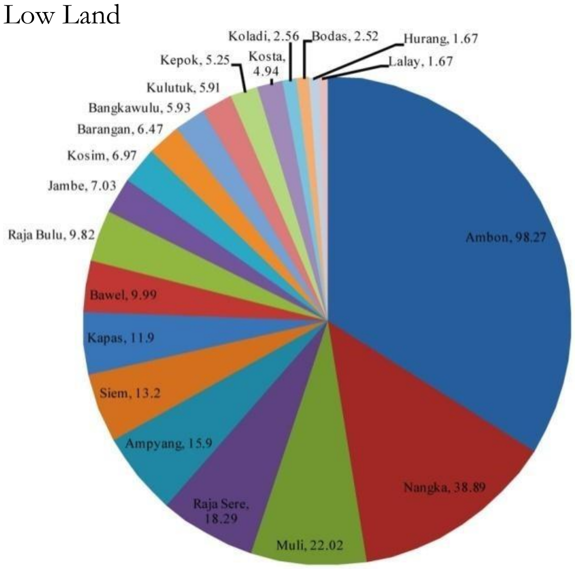
Nangka has IVI value 38.89% and Muli 22.02%. Bananas that have the lowest IVI value in are Hurang and Lalay with an IVI value of 1.67%. The result of vegetation analysis showed that Nangka, Ambon Kuning, Muli, Raja Sere Banana, Siem, Kapas are banana type which can be found in all plains. However, some have a tendency to spread in certain land seen from each of the IVI values.



(a). Low Land



(b). Medium Land



(c) High Land

Figure1. Banana Vegetation Analysis on Three Environments

Principal component analysis (PCA) was used to find out which characters gave high contribution values and influenced variations in the types of muli bananas observed. This analysis is based on 47 morphological characters. Table 3 shows that the main component (PC1) includes 16,265% of a variation of 72 banana "muli" accessions, i.e. number of fruits, number of bunch, fruit length (cm), peduncle colour, male bud size (cm), bract

ISSN: 3065-0380

Columbia Journal of Agricultural and Environmental Sciences

Research Article

apex shape, dan fruit shape (longitudinal curvature) (Table 4). In the second component (PC2) there are dwarfism characters, rachis type, position of suckers, and appearance of leaf upper surface, rachis type, and male bud shape. In the third komopnen (PC3), or fourth (PC4) there is no particular character that contributes to the variation of Muli's banana. It is possible for the magnitude of environmental influences, so it can not be explained statistically.

Table3. Eigenvalues and Percent of Total Variation in Banana Muli Population (*Musa acuminata* Colla)

PCi	Eigenvalue	Percent	Cumulative
1	7.645	16.265	16.265
2	3.991	8.492	24.757
3	3.321	7.067	31.824
4	3.162	6.728	38.552

Table 4. Table 4. Eigenvectors 15 Characters in Muli Population (*Musa acuminata* Colla) in All Locations in West Java

Characters	PC1	PC2	PC3	PC4
Leaf habit	0.225	0.135	0.356	0.087
Leaf blade: shape of base	0.049	-0.160	-0.351	- 0.321
Leaf blade length [cm]	-0.005	-0.079	-0.499	0.005
Leaf blade width [cm]	-0.071	0.161	-0.216	0.167
Pseudostem colour	-0.029	0.088	0.122	- 0.347
Petiole length [cm]	0.063	0.124	-0.318	- 0.121
Petiole widht [cm]	0.216	0.079	-0.208	0.048
Petiole margin color	-0.187	0.270	0.189	- 0.368
Pseudostem height [m]	0.012	0.263	-0.299	- 0.120
Male inflorescence: shape	-0.130	-0.328	-0.401	0.140
Diameter Male inflorescence	-0.083	-0.370	-0.479	0.148
Number of suckers	-0.014	-0.165	-0.131	0.213
Number of fruits	-0.750	-0.029	-0.465	- 0.501

Number of bunch	0.534	-0.028	-0.589	-0.356
Fruit length [cm]	0.639	-0.411	-0.517	0.324
Dwarfism	-0.164	-0.682	0.034	0.135
Pseudostem appearance	0.021	0.329	-0.308	0.001
Wax on leaf sheaths	-0.101	-0.004	-0.004	-0.300
Development of suckers	-0.092	0.059	-0.019	0.005
Position of suckers	0.217	0.624	-0.392	0.334
Blotches at the petiole base	0.251	-0.070	0.036	-0.031
Blotches colour	0.204	-0.033	-0.391	-0.595
Colour of leaf upper surface	0.027	-0.495	-0.317	0.483
Appearance of leaf upper surface	-0.220	-0.750	0.048	0.176
Colour of leaf lower surface	-0.057	-0.003	-0.410	-0.593
Wax on leaves	-0.224	-0.425	0.368	-0.380
Peduncle length [cm]	0.237	-0.145	0.118	0.003
Peduncle width [cm]	-0.130	0.090	0.179	0.077
Peduncle colour	0.985	-0.113	0.045	-0.045
Peduncle hairiness	-0.168	-0.034	-0.073	-0.153
Bunch position	0.158	0.314	0.065	-0.036
Bunch shape	-0.078	0.167	-0.136	-0.178
Bunch appearance	0.151	-0.087	-0.084	-0.053
Rachis type	0.119	0.690	-0.288	0.312
Rachis position	0.160	0.227	0.169	0.056

Male bud shape	-0.271	-0.626	0.248	-0.499
Male bud size [cm]	0.985	-0.113	0.045	-0.045
Bract base shape	-0.035	0.366	0.362	-0.376
Bract apex shape	0.985	-0.113	0.045	-0.045
Male inflorescence: persistence	0.227	0.036	-0.135	-0.144
Fruit: persistence of floral organs	-0.118	0.170	0.068	-0.066
Fruit shape (longitudinal curvature)	0.985	-0.113	0.045	-0.045
Fruit apex	-0.016	0.012	-0.106	-0.484
Fruit pedicel length [mm]	0.985	-0.113	0.045	-0.045
Fruit pedicel width [mm]	0.985	-0.113	0.045	-0.045
Pedicel surface	-0.225	-0.077	0.093	-0.050
Male inflorescence: opening of bracts	0.985	-0.113	0.045	-0.045

The results from the analysis of the main components of local banana accession in each plain were obtained characters that contributed to the variation. The value of PCi has positive and negative values, positive value (+) indicates that the relationship between the characters is closer, while the negative (-) indicates that the relationship between the characters is farther, making it profitable for the next breeding program. Based on this will facilitate the selection of characters that want to be developed in the next breeding program.

Cluster analysis is an analysis to group similar elements as research objects to be distinct and mutually exclusive clusters. Cluster analysis is included in multivariate statistical analysis of interdependent methods. Therefore the purpose of cluster analysis is not to relate or differentiate with other samples / variables. Cluster analysis is useful for summarizing data by way of grouping objects based on the similarity of certain characteristics among the objects to be studied (Sitepu, 2011). The euclidean coeffiecient on cluster analysis states the distance of the incapacity.

Euclidean spacing in more than one ranges represents a large non-incidental coefficient. The small inclination coefficient represents each genotype one with the other having variations that are not broad, in contrast large coefficient of non-perception states that the variation in each genotype is broad (Jamie et al., 2010). The euclidean distance of 72 muli banana accessions is in the range of 0.00 to 5.07 (Fig. 1). The range represents the euclidean distances coefficient on 46 accessions of the muli banana is large. A large inequality suggests that the variations contained in the 72 accessions are broad. Figure 1 shows that the muli banana population is divided into two large clusters. Each group has a different level of kinship with each other.

The presence of various types of muli bananas found in the same sub cluster is caused by the similarity of morphological characters in some other types of accessions. Similarly, the location of similar accessions that are not adjacent to similar accession due to the morphological morphological disparity in accession. The accuracy of the cluster analysis is determined by the number of characters observed. The more characters observed, the more obvious the differences and similarities between the accessions of banana muli (Rohlf, 2001). The pattern of close relationship between the accession of muli banana from various regions in West Java shown in the dendogram image can be used for the benefit of the next breeding.

It can be seen that the results of observation and kinship analysis using the distance of incompatibility in each variety of bananas in various places in West Java showed the existence of variation. Variations that occur in each type are seen from the appearance of phenotype in each variety even there are several varieties of bananas that vary in each location. Various environmental factors greatly affect the appearance of the existing banana phenotype. There are several different varieties of the location background and the height of the place is not in one group.

Differences in the geographic background of the origin of genotypes of the existing bananas allow for variations in phenotypic appearance. Associated with this, adaptation is a long process that plays an important role in phenotypic shifts (Suzuki et al., 1989). High levels of adaptation in banana plants may cause variations in the phenotypic appearance of the plants, so that there are similar varieties but different locations have different phenotypic features. Several different varieties clustered in the same cluster / sub cluster, it is assumed that the varieties have similarities in some morphological characters.

ISSN: 3065-0380
Columbia Journal of Agricultural and Environmental Sciences
Research Article

This research is an initial procedure in banana plant breeding program, so further research is required to characterize each type of banana and for higher level of kinship accuracy, it is better to analyze the kinship using molecular marker. To get the more varied types of bananas, it is necessary to scan the observation sites related to the civilization of the community, enabling the discovery of the local endemic banana species.

Based on Figure 2, the accessions from Cianjur 6, Tasikmalaya 4, West Bandung 3, Purwakarta 4, Sumedang 5, and West Bandung 2, are separate groups from other groups. The accession group has a different appearance compared to other accessions. Variations in the appearance of fruit morphology are shown in Figure 3. Each banana muli accession originating from each location has a diverse fruit appearance. Each location shows variations of fruit on the number of bunch character, number fruits of bunch, and size of bunch.

ISSN: 3065-0380

Columbia Journal of Agricultural and Environmental Sciences

Research Article

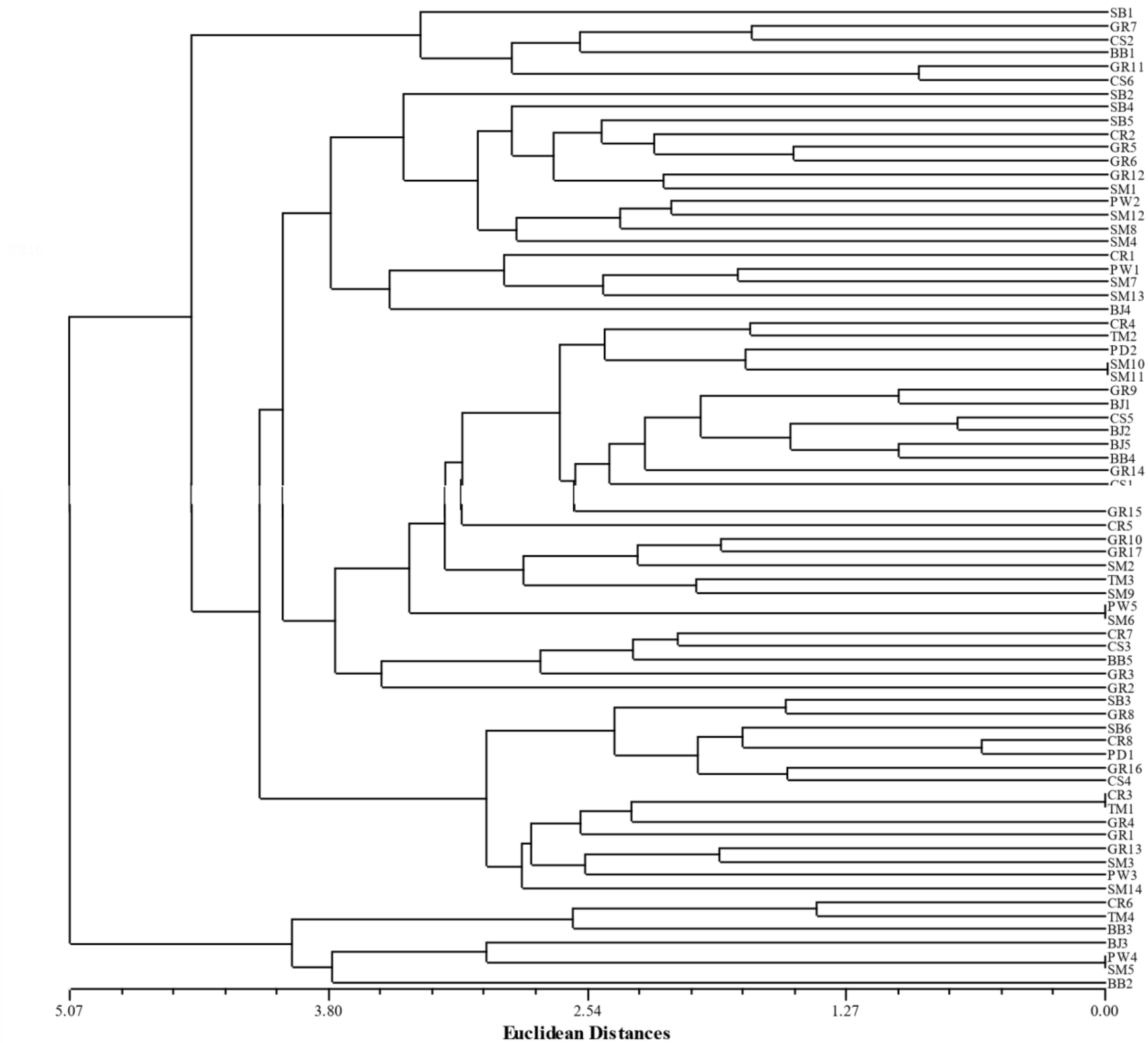


Figure 2. Custer Analysis of Muli Varieties (*Musa acuminata* colla) at All Locations in West Java Based on Morphological and Agronomic Traits

			
Citatah	Mandalawangi	Cipatat	Cileleus Pamulihan
			
Ciptasari Pamulihan	Sukamaju Pamulihan	Pasawahan Purwakarta	Sawit Purwakarta

			
Lamping Rancakalong	Tegalbuleud Sukabumi	Jampang Tengah Sukabumi	Tanjungsari
			
Cikawung ading cipatujah	Cipicung Jatigede	Karyamukti Cibalong	Karyasari Cibalong

ISSN: 3065-0380
Columbia Journal of Agricultural and Environmental Sciences
Research Article

			
Cikelet	Caringin	Limbangan Tengah	Limbangan
			
Limbangan	Majasari Limbangan	Mekarsari Cibalong	Sindangkerta Cipatujah

			
Banjarsari	Langensari	Rancah	Argabinta Sukabumi

Figure 3. Fruits Character Phenotypic of Muli (Musa acuminata Colla) in West Java

Conclusions

Most characters contribute to variation with the value of the main component i.e. number of fruits, number of bunch, fruit length (cm), peduncle colour, male bud size (cm), bract apex shape, dan fruit shape (longitudinal curvature)The accessions from Cianjur 6, Tasikmalaya 4, West Bandung 3, Purwakarta 4, Sumedang 5, and West Bandung 2, are separate groups from other groups. The accession group has a different appearance compared to other accessions. Need to do the identification and characterization of *Musa acuminata* Colla var. Muli ex-situ to support plant breeding activities further.

Acknowledgement

The study was funded by the Ministry of Research Technology and Higher Education Republic of Indonesia, Directorate of Research and Community Service Padjadjaran University. We are sincerely grateful for the funding. We would like also convey our gratitude to technicians and banana farmers who provided the banana samples analyzed and characterize in the study. The authors are thankful to Shandy Nugraha, BSc., Septian Indrajati, BSc. and Fransisca Natalia Tarigan, BSc, Department Of Agronomy Faculty of Agriculture Padjadjaran University for helping to collect the sample and supporting research activity.

References

Badan Pusat Statistik. 2015. Produksi Buah Pisang di Jawa Barat. http://www.bps.go.id. Diakses tanggal 8 Juni 2015 pukul 13:00 WIB.

Cardenas, M.V., and K.J. Frey. 1972. *Optimum Environment For Maximizing Heritability And Genetic Dain From Selection*. Iowa State Journal of Science.

Damayanti, Fitri. 2007. Analisis Jumlah Kromosom dan Anatomi Stomata Pada Beberapa Plasma Nutfah Pisang (*Musa* sp.) Asal Kalimantan Timur. BIOSCIENTIAE Vol. 4(2):53-61, Juli 2007. Jurusan Biologi FMIPA Universitas Mulawarman.

International Plant Genetik Resources Institute (IPGRI)., 1984. Descriptor for Banana (*Musa* spp.). IPGRI.

Mustita, Nanti. 2009. *Kajian Kandungan Dan Karakterisik Pati Resisten Dari Berbagai Varietas Pisang*. Jurnal Teknologi Industri dan Hasil Pertanian Vol. 14(1), Maret 2009.

Rohlf, F.J. 2001. NT SYS-pc: Numerical Taxonomy and Multivariate Analysis System Version 2.1. User Guide. Departement of Ecology and Evolution State University of New York.

Simmonds NW. 1996. Bananas. New York: Longman Inc.

Sitepu R., Irmeiiyana, Gultom B. 2011. Analisis Cluster terhadap Tingkat Pencemaran Udara pada Sektor Industri di Sumatera Selatan. Jurnal Penelitian Sains. Volume 14 Nomer 3(A) 14303: 11-17

Sukartini, 2008. Analisis Jarak Genetik dan Kekerabatan Aksesi-aksesi Pisang berdasarkan Primer *Random Amplified Polymorphic DNA. J. Hort.* 18(3):261-266,2008. Balai Penelitian Tanaman Buah Tropika.

Suyanti, dan Supriyadi A., 2008. Pisang, Budidaya, Pengolahan dan Prospek Pasar. Penebar Swadaya. Jakarta.