Int. J. Agricult. Stat. Sci. Vol. 17, Supplement 1, pp. 2059-2064, 2021 www.connectjournals.com/ijass
DocID: https://connectjournals.com/03899.2021.17.2059 ISSN : 0973-1903, e-ISSN : 0976-3392

ORIGINAL ARTICLE

GENETIC RELATIONSHIP ANALYSIS ON 5 SPECIES OF BANANA (*MUSA PARADISIACA*) BASED ON MORPHOLOGICAL CHARACTERISTICS IN MAJALENGKA REGENCY, INDONESIA

Agus Yadi Ismail[1,*], Dadan Ramdani Nugraha[2], Sukron Aminudin[2] and Mai Fernando Nainggolan[3]

[1]Faculty of Forestry, University of Kuningan, Jalan Tjut Nyak Dhien Cijoho Kuningan, Indonesia.
[2]Faculty of Agriculture, University Majalengka, West Java, Indonesia.
[3]Faculty of Agriculture, Universitas Padjadjaran, Jatinangor, Jawa Barat, Indonesia.
E-mail: ismailagusy@gmail.com

Abstract: Banana (*Musa paradisiacal*) is a type fruit that has benefits and strategic role to improve the community's economy. This study aims to determine the relationship between 5 local genotypes of banana in Majalengka Regency, Indonesia. Such as Apuy, Roid, Latundan, Raja Bulu and Raja Dengkel bananas. The research methodology used was direct method in the form of field survey method that was descriptive and morphological characterization. The characters observed were all characters included in the banana descriptor. Observational data analysis was tested based on kinship test. The kinship test was carried out to determine the closeness of the kinship relationship between Apuy, Roid, Latundan, Raja Bulu and Raja Dengkel bananas. Data analysis using Mega6 software. The findings show that Apuy, Latundan and Raja Dengkel bananas has a closer relationship than other bananas.

***Key words*:** *Musa paradisiacal*, Banana, Genetic relationship test, Morphological Characteristics.

Cite this article

Agus Yadi Ismail, Dadan Ramdani Nugraha, Sukron Aminudin and Mai Fernando Nainggolan (2021). Genetic relationship analysis on 5 species of banana (*Musa paradisiaca*) based on morphological characteristics in Majalengka Regency, Indonesia. *International Journal of Agricultural and Statistical Sciences.* DocID: https://connectjournals.com/03899.2021.17.2059

1. Introduction

Banana (*Musa* sp) is the most popular Indonesia's quality fruit commodities it has many benefits [Semuel and Ernst (2019)]. Apart from being rich in nutritional content, bananas are also useful for the traditional medical processes. Imam and Akter (2011) stated that bananas can be used as a traditional medicinal for different diseases including dysentery, diabetes, hypertension, heart disease, diarrhea and for treating wounds.

Apuy banana is a local cultivar from Majalengka which existence is decreasing nowadays [Wijaya *et al*. (2019)]. The germplasm of Apuy banana is a valuable cultivar since, it has advantages in taste and fragrant aroma as well as its sweet and crunchy taste [Retnoningsih (2009)]. The research findings showed that there were 7 genotype of banana plants spread across three districts, such as janten banana, lady finger, kapok, cavendish, plantain, latundan banana and cooking banana [Venkatachalam *et al*. (2007)]. The diversity of banana varieties in general and specifically in Majalengka Regency has not been identified either morphologically or genetically.

Morphological characterization of banana plants is needed as a support for the assembly of superior varieties through characterization, which can see the particularity of a banana [Udoro *et al*. (2020)]. Morphological identification can be used to analyze the kinship among accessions. In this regard, the number of morphological characters that have high heritability or high repeatability will determine the accuracy of grouping accessions [Visscher *et al*. (2008)]. Morphological information for plant breeders is not

***Author for correspondence** **Received** July 22, 2021 **Revised** October 24, 2021 **Accepted** November 27, 2022

merely used to see the similarities among cultivars, but also obtain genetic information about how the genetic relationships between the plant's genetics are [Retnoningsih (2009)].

Morphological studies in banana have been widely studied by various scientists in the world. Bello-Perez *et al*. (2005) studied molecular and morphological characteristics of banana starch using different spectroscopic techniques. They found that the banana starch has a high crystallinity level, which might be important in several food applications. Carmona-Garcia *et al*. (2009) presented effect of the reagent used in the chemical modification of banana starch and its impact on some morphological, physicochemical and functional characteristics. The results showed that starch with certain characteristics was obtained with the type of reagent for crosslinking. Li *et al*. (2010) analyzed the chemical composition and anatomical structure of banana pseudo-stem. Analysis was carried out with three methods such as Light Microscopy (LM), Scanning Electron Microscopy (SEM), and Confocal Laser Scanning Microscopy (CLSM). They show that the banana pseudo-stem has potential value for pulping and banana stems possess a structure involving helicoidal fibers. Sunandar and Kahar (2017) proposed morphology and anatomy characteristic of pisang awak (*Musa paradisiaca* cv. Awak) in West Kalimantan, Indonesia. They show that the Pisang Awak has both sides rounded for shape of leaf base with two layers of hypodermal cells, two layers of palisade cells and laticiferin association with vascular bundles. Petiole of Pisang Awak has straight with erect margins forpetiol canal leaf type with a single layer of epidermis, compact cell, and rectangular shape. The parenchyma cells were found in the middle part of the petiole. The root of Pisang Awak has two epidermis layers, many layers of the cortex, endodermis, vessels scattered at the center of root and phloem cells were formed alternately with vessel cells.

Identification is an activity to characterize all the traits owned or contained in the source of genetic variation as a data base before starting to plan plant breeding [Witcombe *et al*. (2005)]. Many studies have been carried out in connection with identification, exploration and morphological characterization activities such as the research from Lankoandé *et al*. (2015). The purpose was to find out information on banana species in Majalengka Regency and to find out the kinship among these species. The main contribution of this study is observed the genetic relationship of 5 banana species in Majalengka Regency. The expected result is the discovery of superior local banana varieties other than Apuy bananas.

2. Research Methodology

The research was conducted in Majalengka Regency from July to November 2020. The materials used in this study were the populations of Apuy, Roid, Latundan, Raja Bulu and Raja Dengkel bananas. This research was conducted by using direct method in the form of field survey because this research is descriptive and morphological characterization. The characters observed in the five types of bananas were all included in the banana descriptor published by the International Plant Genetic Resources Institute, namely (1) growth type, (2) pseudo stem color, (3) anthocyanin color, (4) blotches color, (5) petiole type, (6) wing type, (7) edge of petiole margin color, (8) blade position on the stem, (9) color of midrib upper surface, (10) color of midrib lower surface, (11) shape of leaf base, (12) edge of peduncle margin color, (13) fine hairs on peduncle, (14) arches of peduncle, (15) bunch shape, (16) bunch density, (17) patterns of male flowers, (18) presence of hermaphrodite flowers, (19) bract scars, (20) fruit curvature, (21) dorsal surface, (22) shape of fruit apex, (23) peel color before maturity, (24) mature peel color, (25) presence of flower organs, (26) pulp color, (27) presence of flowers, (28) shape of flowers, (29) the outer color of the bractea, (30) the inner color of the bractea, (31) shape of bractea base and (32) heart tip shape. Observational data analysis was tested based on kinship test. The kinship test was carried out to determine the closeness of the kinship relationship between Apuy, Roid, Latundan, Raja Bulu, and Raja Dengkel bananas. The data is analyzed using PGMA from Mega 6 software.

3. Results and Discussion

Plant characterization is carried out to determine the morphological character of a plant which can then be used as a basis for determining diversity in these individuals. Characterization can be performed on qualitative or quantitative characters; characterization will be easier to perform on qualitative characters since they are only slightly influenced by environmental factors.

The results of the observations show that the

Table 1: Morphological descriptions of the observed banana plants.

Variety	General Description
Apuy	Plant height ranges from 2.25 m with a small tree size, slightly curved petioles, short banana bunches between 4-5 combs, completely ripe banana peel, sweet and soft white pulp color with a fragrant aroma.
Roid	Plant is large and tall, long petioles, wide leaf shape, long banana bunches about 8-9 combs, slightly thick banana peel, white pulp and sweet taste has no aroma.
Plaintains	Plant height ≥3 m, pseudostem color; yellowish green outside and light green inside, slightly blackish brown blotches, straight shape slightly curved, mature peel color yellow orange and slightly ripe.
Raja Bulu	Plant height ranges 2.6 - 3 m, green stem color with blackish brown blotches, banana bunches 40-60 cm with fruit combs totaling 6-8 combs, cylindrical fruit shape, slightly thick peel with round or rectangular pointed ends, pulp yellowish white, no seeds and the taste is slightly sweet to sweet.
Raja Dengkel	Plant height ranges from 2.25 m, pseudostem color; green outside and light green inside, slightly brown blotches, medium bunches slightly curved, shape of leaf base; all sides are rounded, short banana bunches between 4-5 combs, shape of the canal is straight with erect margins, shape of fruit is straight and slightly curved, mature yellow pulp color, soft taste, watery and has no aroma.

observed plants have different appearance or morphological characteristics, the observed banana plant morphology can be seen in Table 1. Morphological differences in the observed banana varieties such as pseudo stem characters, color, height, diameter and different peel color of bananas. The difference in the morphological characteristics of the banana can be seen in Fig. 1. The different morphological characters in banana varieties were observed such as pseudo stem, color, height, diameter, and peel color of bananas. The different morphological characters in banana can be seen in Fig. 1. Based on the research conducted [Vallad and Goodman (2004)], it is shown that the diversity of banana plants in a certain area is caused by whether or not the area is suitable as a place to grow banana plants, this is what causes different morphological of banana plants.

Fruit is the most important part of the banana plant; the character of the fruit can also be one of the distinguishing factors. Based on Fig. 1, the curvature shape of the fruit shows that Apuy, Latundan and Raja dengkel bananas have curved shapes, while Roid and Raja Bulu bananas have an erect shape. The color of the fruit peel is one of the characteristics that can be seen easily to distinguish one variety from another. The color of banana peel before maturity is generally green, then the color of the peel after maturity varies, such as yellow, bright yellow, and orange. Apuy, Latundan and Raja Dengkel fruits have almost the same peel color, namely yellow - orange, for Apuy bananas the banana peel is completely ripel. Meanwhile, Roid Banana and Raja Bulu have bright yellow peel color.

The various differences in each character possessed by each type of banana are influenced by many factors, such as environmental, genetic and biased factors during field observations. Leiwakabessy (2018) explained that if environmental factors have a stronger influence than genetic factors, then plants in different places with different environmental conditions will have varying morphologies [Weiher *et al*. (1998)]. Conversely, if environmental factors are weaker than genetic factors, then even though the plants are planted in different places, there will be no morphological variations. Other factors that also affect, for example, color variations. The color of a plant species can change according to the conditions in which it is grown and is closely related to food supply and radiation.

Based on a literature study on banana plant species originating from Majalengka Regency, they have various types. From 5 species, an analysis of the relationship between the five banana species is carried out. The closest degree of kinship banana relationships in Majalengka Regency were Apuy Banana, Latundan and Raja Dengkel, while the farthest degree of kinship was Roid and Raja Bulu.

Based on Fig. 2, the level of similarity with a coefficient of 0-0.8, if a vertical line is drawn from point 0.6, there are three groups of bananas, namely, I; Apuy and Latundan, II; Raja Dengkel and III; Roid and Raja Bulu. Group I bananas have characteristics and a very close relationship between Apuy bananas and P Latundan, but far from group II bananas and group III

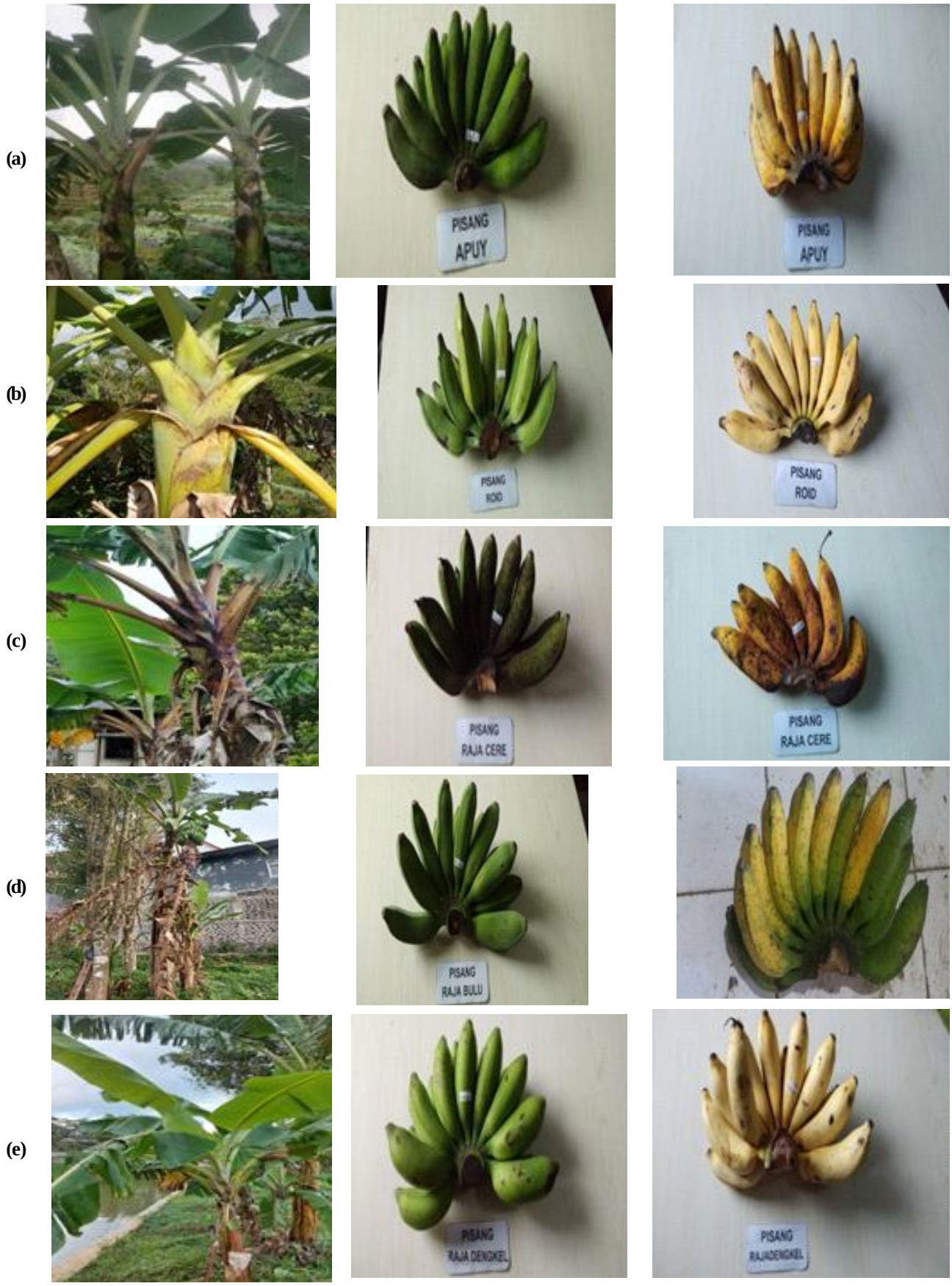

Fig. 1: Morphological appearance of the observed banana plant variety information: (a) Apuy banana, (b) Roid banana, (c) Latundan, (d) Raja Bulu banana, (e) Raja Dengkel banana

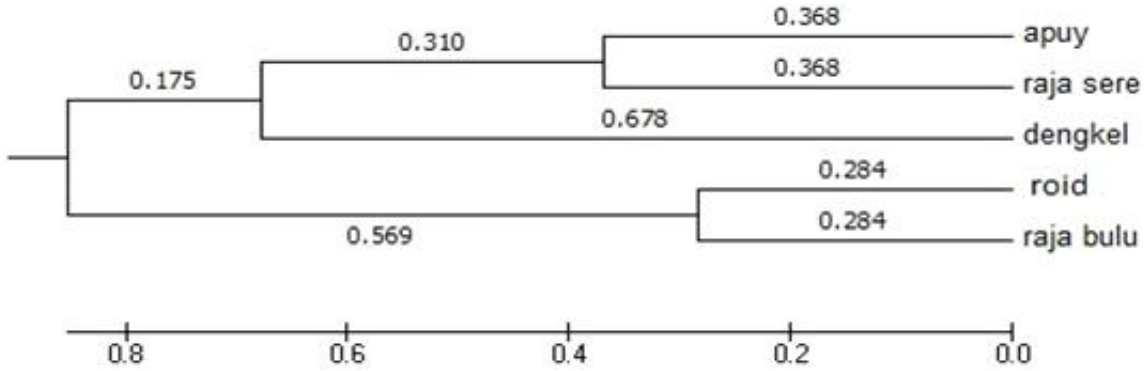

Fig. 2: Similarities between several banana cultivars using the PGMA method [Sneath and Sokal (1973)]

bananas. In group II bananas, it is clear that they have beyond characteristics and kinship from group I and group III. Group III bananas have characteristics and a very close relationship between Roid and Raja Bulu, but far from group I and II bananas. Based on the research on reff [Wijaya (2020)], the degree of genetic similarity between Apuy bananas, Raja Dengkel and Latundan ranged 77 to 92.51. Whereas in the research on reff [Nedha *et al*. (2018)] that the degree of genetic banana kinship in Kediri Regency ranged 13-97.6 with the farthest kinship was kapok super banana and morosebo, then the closest kinship is green banana and green Madura.

This different type of diversity is caused by environmental conditions that vary within each region and the demand for banana plants for certain environmental conditions [Kikulwe *et al*. (2011)]. According to Nedha *et al*. (2018), high genetic diversity is one of the important factors in producing superior local banana varieties, and the morphological characterization of banana plants is needed as a basis for assembling these superior varieties as well as initial information in an effort to find superior characters and diversity [Santos *et al*. (2011)]. According to Lui *et al*. (2011), kinship between individuals shown by the dendrograms correlates with the genetic distance of the individual. Close kinship indicates low genetic distance and distant kinship indicates high genetic distance. Based on genetic distance, it shows that there are variations between individuals in the population which can be caused by the genetic mixing of one parent tree with the parent tree around it as a result of crossbreeding.

4. Conclusion

Based on the observations, it can be concluded that there are differences in morphological characters among 5 banana genetics in Majalangka Regency, namely Apuy, Roid, Latundan, Raja Bulu and Raja Dengkel bananas. Based on the results of the kinship test analysis, the closest degree of kinship banana relationships in Majalengka Regency were Apuy Banana, Latundan and Raja Dengkel, while the farthest degree of kinship was Roid and Raja Bulu. The benefit obtained from this study is to know the morphological characteristics in Majalengka for the classification process on banana plants.

Acknowledgement

The authors are grateful to referees for their careful reading, suggestion, and valuable comments which have improved the paper substantially.

References

Bello-Perez, L.A., A. De Francisco, E. Agama-Acevedo, F. Gutierrez-Meraz and F.J.L. Garcia-Suarez (2005). Morphological and molecular studies of banana starch. *Food Sci. Tech. Int.*, **11(5)**, 367-372. https://doi.org/10.1177%2F1082013205058409

Carmona-Garcia, R., M.M. Sanchez-Rivera, G. Méndez-Montealvo, B. Garza-Montoya and L.A. Bello-Pérez (2009). Effect of the cross-linked reagent type on some morphological, physicochemical and functional characteristics of banana starch (*Musa paradisiaca*). *Carbohydrate Polymers*, **76(1)**, 117-122. https://doi.org/10.1016/j.carbpol.2008.09. 029

Imam, M.Z. and S. Akter (2011). *Musa paradisiaca* L. and *Musa sapientum* L.: A phytochemical and pharmacological review. *J. Appl. Pharmaceut. Sci.*, **1(5)**, 14-20._https://japsonline.com/admin/php/uploads/78_pdf.pdf

Kikulwe, E.M., E. Birol, J. Wesseler and J. Falck Zepeda (2011). A latent class approach to investigating demand for genetically modified banana in Uganda. *Agricultural Economics*, **42(5)**, 547-560. https://doi.org/10.1111/j.1574-0862.2010.00529.x

Lankoandé, B., A. Ouédraogo, J.I. Boussim and A.M. Lykke

(2015). Phenotypic traits of Carapa procera fruits from riparian forests of Burkina Faso, West Africa. *J. Horticulture and Forestry*, **7(6)**, 160-167. https://doi.org/10.5897/JHF2015.0394

Leiwakabessy, F. (2018). The Effect of Method and Ripening Duration on the Content of β-Carotene of Fe'i Banana (*Musa troglodytarum* L.). *Int. J. Appl. Biol.*, **2(1)**, 29-38. https://doi.org/10.20956/ijab.v2i1.4020

Li, K., S. Fu, H. Zhan, Y. Zhan and L. Lucia (2010). Analysis of the chemical composition and morphological structure of banana pseudo-stem. *BioResources*, **5(2)**, 576-585. https://ojs.cnr.ncsu.edu/index.php/BioRes/article/view/BioRes_05_2_0576_Li_FZZL_Anal_Chem_Struc_Banana_Pseudostem

Lu, i. A., V. Isajev, L. Rakonjac, M. Mataruga, V. Babi, D. Risti and S. Mladenovi-Drini (2011). Application of various statistical methods to analyze genetic diversity of Austrian (Pinus nigra Arn.) and Scots pine (Pinus sylvestris L.) based on protein markers. *Genetika*, **43(3)**, 477-486.

Nedha, N., S.L. Purnamaningsih and D. Damanhuri (2018). Observasi dan karakterisasi morfologi tanaman pisang (*Musa* spp.) di kecamatan Ngancar kabupaten Kediri. *Jurnal Produksi Tanaman*, **5(5)**, 821-827. https://core.ac.uk/download/pdf/295409898.pdf

Retnoningsih, A. (2009). Moleculer based classification and phylogenic analysis of Indonesian banana cultivars. *Doctoral dissertation*, Bogor Agricultural Institute.

Santos, E.A., M.M. Souza, A.P. Viana, A.A.F. Almeida, J.C.O. Freitas and P.R. Lawinscky (2011). Multivariate analysis of morphological characteristics of two species of passion flower with ornamental potential and of hybrids between them. *Genetics and Molecular Res.*, **10(4)**, 2457-2471. http://dx.doi.org/10.4238/2011.October.13.3

Semuel, L. and W. Ernst (2019). Inventory on banana (*Musa* spp.) as trading commodities in Maluku islands. *Afr. J. Agricult. Res. Indonesia*, **14(33)**, 1693-1712. https://doi.org/ 10.5897/AJAR2018.13541

Sunandar, A. and A.P. Kahar (2017). Morphology and anatomy characteristic of Pisang Awak (*Musa paradisiaca* cv. Awak) in West Kalimantan. *Biosaintifika. J. Biology & Biology Education*, **9(3)**, 579-584. https://doi.org/10.15294/biosaintifika.v9i3.11258

Udoro, E.O., T.A. Anyasi and A.I.O. Jideani (2020). Characterization of the root and flour of South African Manihot esculenta Crantz landraces and their potential end-use properties. *Int. J. Food Properties*, **23(1)**, 820-838. https://doi.org/10.1080/10942912.2020.1759625.

Vallad, G.E. and R.M. Goodman (2004). Systemic acquired resistance and induced systemic resistance in conventional agriculture. *Crop Science*, **44(6)**, 1920-1934.

Venkatachalam, L., R.V. Sreedhar and N. Bhagyalakshmi (2007). Micropropagation in banana using high levels of cytokinins does not involve any genetic changes as revealed by RAPD and ISSR markers. *Plant Growth Regulation*, **51(3)**, 193-205. https://doi.org/10.1007/s10725-006-9154-y

Visscher, P.M., W.G. Hill and N.R. Wray (2008). Heritability in the genomics era-concepts and misconceptions. *Nature Reviews Genetics*, **9(4)**, 255-266. https://doi.org/10.1038/nrg2322

Weiher, E., G.P. Clarke and P.A. Keddy (1998). Community assembly rules, morphological dispersion and the coexistence of plant species. *Oikos*, **81(2)**, 309-322. https://doi.org/ 10.2307/3547051.

Wijaya, A.A. (2020). Identifikasi pisang apuy sebagai kultivar unggul lokal kabupaten Majalengka. *AGROMIX*, **11(1)**, 79-86. https://doi.org/10.35891/agx.v11i1.1907

Witcombe, J.R., K.D. Joshi, S. Gyawali, A.M. Musa, C. Johansen, D.S. Virk and B.R. Sthapit (2005). Participatory plant breeding is better described as highly client-oriented plant breeding. I. Four indicators of client-orientation in plant breeding. *Experimental Agriculture*, **41(3)**, 299-319.