

DEVELOPING CUCUMBER CANDIDATE LINES BASED ON FRUIT SKIN COLOR

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ABSTRACT

This study aims to assemble cucumber strain candidates based on the diversity of fruit skin color. This research was conducted at Celeban Teaching Factory of Agricultural Development Polytechnic Yogyakarta-Magelang campus, Yogyakarta, Indonesia from February to June 2023. The research object consisted of two cucumber varieties as parental and two first derivatives or First Offspring lines from reciprocal crosses of two parental lines. The research method used a single-plant experiment by planting and observing each plant of the cross. The crossing was carried out by the double-cross method reciprocally to obtain two numbers of derivative plants, for each number planted as many as 80 plants so that there was a population of 160 derived plants and eight parental plants for each parental strain as a comparison. The parameters in this study included the intensity of green leaf color, the basic color of the fruit skin, the intensity degree of the basic color of the fruit skin, the tip shape of the fruit, the base form of the fruit and the cut of the crosscut fruit. The research's results from the observed population obtained a diversity of fruit skin colors classified into 4 clusters of the candidate lines, namely bright yellow, bright green, medium green, and dark green fruit skin clusters.

Keywords: Double cross, diversity, cluster, crosses, cucumber

INTRODUCTION

Cucumber (cucurbitaceae) fruit has commercial value in Indonesia, and a broad market share ranging from traditional markets to modern markets.

Cucumbers can be consumed fresh as daily food consumption or used as raw materials for the cosmetics and medicine industries. Cucumber is a potential commercial commodity but has not been developed massively. The purpose of the Hybrid and inbred varieties development is to support the cucumber varieties diversification. This shows that cucumber commodities are widely accepted by the public and have commercial value competitiveness. (Wijoyo, 2012) Nationally, the need for cucumber seeds from 2017-2019 continues to increase, the need for cucumber seeds is up to 74,154 kg per year in 2019 (Directorate of Horticultural Seeds, 2021). Cucumber production in 2018-2022 has increased, which is 433,922.5 tons in 2018 and 444,056.7 tons in 2022 (BPS, 2022).

Cucumber fruits vary in size and shape, generally long or short round, cucumber fruit skin varies in color from whitish green to light green to dark green (Lista, 2016). Consumers in each region have specific tastes for cucumber types with consideration of shape, color, and size. West Java and Central Java regions like cucumbers that are light green and not too long in size, while East Java and most parts of Eastern Indonesia like cucumbers with dark green fruit skin color, and large fruit size (Ibnu, 2014). Furthermore, Listari, (2021) reported the preference for cucumbers in the West Nusa Tenggara region was the small and long sizes of cucumber.

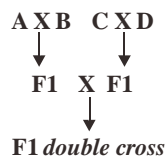
To fulfill the preferences and increase the productivity of cucumber can be done by assembling varieties using available genetic resources. Genetic Resources are a source of trait carriers so that they can be utilized to improve plant genetics and developed through the assembly of new varieties. Plant breeding is a link between germplasm and seeds for the assembly of varieties and then the seeds are propagated as a means of spreading the use of varietal technology (Sulaiman et al., 2018).

The cucumber KE 4723 variety is a hybrid variety of Indonesian origin in the company of the pedigree of this variety formed from CU 7778 x CU 7432. KE 4723 variety has a characteristic leaf color of this variety is dark green (RHS 137A) and notched fingers with a leaf length of 14.84-18.56 cm and leaf width of 22.11-25.76 cm. The fruit is cylindrical and yellow-green (RHS 149D), with faint white stripes and a non-bitter taste. This variety's main characteristics are the flat base of the fruit and the slight green color at the bottom of the fruit (Kepmentan, 2016).

Cucumber AGB KE 0316, is a hybrid variety of Indonesian origin and has a green leaf color (RHS NN137B), finger-notched. The fruit is elongated and round, rounded form fruit tip, green fruit base color (RHS 137 A), and green fruit tip color (RHS 144B). The color of the fruit line is greenish yellow (RHS 150D) and has a non-bitter taste at the base of the fruit. This variety's main characteristics are dark green fruit color that is evenly distributed (RHS 137A), cylindrical fruit shape, and rounded fruit tips (Kepmentan, 2017).

Plant breeding programs are intended to improve agronomic and other traits and to assemble/develop new varieties. This is expected to provide the criteria desired by breeders, seed manufacturers, and consumers (Ardian et al., 2016). Existing superior varieties are not used for a long time by farmers due to rapid changes in trends (Sulaiman et al., 2018). This is caused by very dynamic environmental conditions, one of which is the changing market preferences for preferred fruit types.

One of the crossing methods that can be done in variety development is the double cross method. According to Syukur et al. (2018), the double cross method is a cross between two hybrid parents (F1). This cross will produce F1 as a double cross hybrid variety. It is recommended that the number of characters collected in a double cross does not exceed 10 characters. The double cross method model is:



Genotype contribution: 25 percent A, 25 percent B, 25percent C, and 25percent D. Double cross purpose is to collect superior traits that exist in both F1 varieties. In addition, the F1 double cross will generate higher genetic diversity than the F1 single cross.

The reciprocal cross is a cross made between one plant as a male parent and one other plant as a female parent and then crossed simultaneously in the opposite role, namely the male parent in the first cross becomes the female parent while the female parent in the first cross

becomes the male parent. Alternating crosses aimed to determine the effect of the sex of the elders on the inheritance pattern of a trait. In plant breeding activities, alternating crosses become one of the methods in the assembly of a plant cultivar.

New variety assembly that has superior traits that meet commercial criteria can be done through plant breeding programs. Efforts that can be made are by carrying out the process of assembling candidate lines with the double-cross cross method. Crossing is done to collect or bring up characters (Syukur et al., 2018). Double-crossing activities of KE 4723 and AGB KE 0316 varieties are expected to combine several superior characters to generate cucumber candidate lines with diverse fruit skin colors for the assembly of new cucumber varieties.

METHODOLOGY

Time Frame and Location

The research was carried out from February 1 to June 30, 2023 at Celeban Teaching Factory, Agricultural Development Polytechnic of Yogyakarta Magelang.

Tools, materials, and Research objects

The tools used in the research were a cultivator, roller meter, hoe/dig, sprayer, and scales. The object used in this study were cucumber seeds of KE 4723 and AGB KE 0316 varieties as parents, seeds of KE 4723 x AGB KE 0316 cross (Line 01), seeds of AGB KE 0316 x KE 4723 cross (Line 02), as well as the material used in this research were opaque paper, woolen thread, straws, plastic clips, label paper, ropes, manure, compound fertilizer, cocopeat

and pesticides made from Imidakloprid, Fipronil, Emamectin benzoate, Abamectin, Propineb and Azoxistrobin.

Research Methodology

Single plant experiment was used in this study that is by planting and observing each cucumber plant variety KE 4723 and AGB KE 0316 as parents and lines generated from a double-cross of reciprocal crossing system between the parents to obtain the crossing combination of KE 4723 x AGB KE 0316 (Lines 01) and AGB KE 0316 x KE 4723 (Lines 02).

Implementation/Execution

This study was conducted with two plantings, the first phase planting procedure was to plant KE 4723 and AGB KE 0316 which were used as parents, and then double cross with a reciprocal crossing system to obtain two lines that would be planted in the second phase. Pollinators affect the success of the cross because the male flowers of cucumber come out a few days earlier than female flowers and pollination of cucumber plants is cross-pollinated type (Misluna, 2016). Pollination is carried out in the morning because female flowers bloom and the condition of pistils and stamens is still good (Limbongan, 2019) but also low pollen production, pollen viability, pollinator skills, air temperature and pollination time are factors that affect the success of pollination (Alfiyah et al., 2017). The second phase planting procedure was to grow the parents with 8 plants each and plant 80 seeds of each crossed strain. Observations were made on each plant of the parents and the derivatives of the double cross.

Observation

Scoring observations were made based on the Guideline for the Conduct of Tests for Distinctness, Uniformity, and Stability of *Cucumis sativus* L. from the International Union for the Protection of New Varieties of Plants (UPOV, 2019). Observations were made on the characteristics of leaf green color intensity, fruit skin base color, fruit skin base color intensity, fruit tip shape, fruit base shape, and crosscut fruit shape.

Analysis

Observation data were analyzed by phenotypic diversity analysis using the cluster analysis method. The diversity analysis data was processed with OriginPro 2023b software and displayed in the form of a dendrogram so that the similarity of cucumber plants from the double cross can be seen.

RESULTS AND DISCUSSION

Plant breeding programs are intended to obtain new superior varieties obtained from a series of goal-directed activities. This research aims to produce hopeful lines of cucumber plants with dark green fruit characters and small fruits. The first step of this research is to provide a basic population by double-crossing two commercial F1 varieties and alternating crosses of the two commercial varieties. Candidate lines are groups of living things resulting from breeding activities that have superior traits that are utilized and developed into superior varieties (Kepmentan, 2019). The initial stage of breeding is the availability of a base population. The creation of a basic population aims to maintain the homogeneity of other characters and increase diversity that has economic value (Lubis, 2020).

The characters and traits of plants vary in each variety. There are two types of diversity, namely qualitative diversity and quantitative diversity. Qualitative diversity is characterized by discrete data distribution, easy to distinguish in observations usually controlled by a few genes, and often appears without or with little influence by the environment (Syukur et al., 2018). The results of the double-cross and reciprocal cross were then observed and scored based on qualitative fruit characters guided by the International Union for the Protection of New Varieties of Plants 2019 (UPOV).

Muhammad Adelin Nazhirin Leaf Green Color Intensity

According to Mu'arif, (2018), cucumber leaves are light green to dark green. Scoring observations of green leaf color characters have a score of 7 (dark) in all populations observed based on the International Union for the Protection of New Varieties of Plants 2019 (UPOV). This is because the two parents used have a characteristic of dark intensity in leaf green color and is also reinforced by the statement of Sirojuddin et al., (2015) in his research stating that F1 will display the same character as its parents.

Fruit Skin Color

The observation on fruit color consists of observations of the basic color of the fruit skin and the intensity of the basic color of the fruit skin, based on the International Union for the Protection of New Varieties of Plants 2019 (UPOV) Scoring results of observations can be inquired in Table 1. According to Table 1, the variable basic color of the fruit skin is yellow and green with variable intensity of the basic

color of the fruit skin being light, medium, and dark. Suryo, (2016) states that multiple genes (polygenes and multigenes) affect the emergence of various variations within a phenotype class.

Based on qualitative observations of fruit, population diversity occurs in the basic color of the fruit skin, the intensity of the base color of the fruit skin, and the shape of the tip and base of the fruit. Based on observation data, this research discovered four types of fruit skin color in the population specifically bright yellow, bright green, medium green, and dark green. For the variable observation of fruit tip shape, this study discovered two characters, *id est* obtuse and round. In the form of the base of the fruit variable also found two characters, namely pointed and blunt, these characters are inherited from both parents and represent the characters in the resulting derivatives.

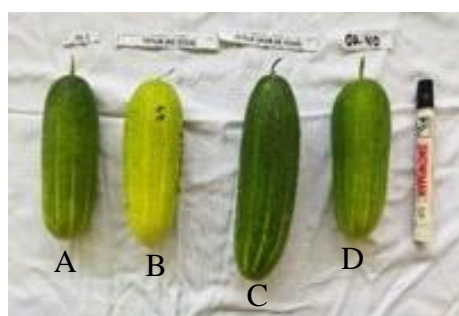
Fruit Shapes

Observation variables on Fruit shape consist of observations of fruit tip shape, fruit base shape, and cross-sectional fruit shape. The results of observations of fruit shape variables can be seen in Table 1. According to Table 1, the variable fruit shape found diversity in the parameters of fruit tip shape and fruit base shape. Amier, (2022) reported that the double cross method performed on tomato plants will make the seeds of double cross hybrids not uniform because it is two crosses of heterozygous parents. While the shape of the transversely cut fruit is not found diversity in the population. According to Arif et al. (2011), there is no effect of female parents on character inheritance if there are no phenotypic differences in the F1 and F1 reciprocal populations.

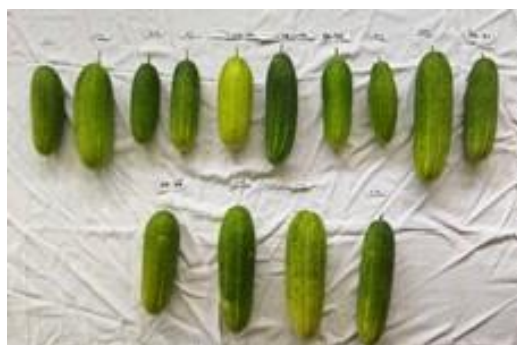
Table 1 Variety and Qualitative Character Scores in the Population

Cluster	VARIABLE					
	Basic Color of Fruit Skin	The intensity of Fruit skin basic Color	Leaf Green Color Intensity	Fruit Tip Shape	Fruit Base Shape	Crosscut Fruit Shape
1	2 (Yellow)	3 (Bright)	7 (dark)	3 (Round)	3 (Obtuse)	1 (Round)
				3 (Round)	3 (Obtuse)	1 (Round)
2	3 (Green)	3 (Bright)	7 (Dark)	2 (Obtuse)	3 (Obtuse)	1 (Round)
				2 (Obtuse)	2 (Sharp)	1 (Round)
				3 (Round)	2 (Sharp)	1 (Round)
3	3 (Green)	5 (Medium/moderate)	7 (Dark)	2 (Obtuse)	3 (Obtuse)	1 (Round)
				3 (Round)	3 (Obtuse)	1 (Round)
				3 (Round)	2 (Sharp)	1 (Round)
				3 (Round)	3 (Obtuse)	1 (Round)
				2 (Obtuse)	2 (Sharp)	1 (Round)
4	3 (Green)	7 (Dark)	7 (Dark)	2 (Obtuse)	3 (Obtuse)	1 (Round)
				3 (Round)	3 (Obtuse)	1 (Round)
				3 (Round)	3 (Obtuse)	1 (Round)
				2 (Obtuse)	2 (Sharp)	1 (Round)
				3 (Round)	2 (Sharp)	1 (Round)

Source: UPOV score, 2019

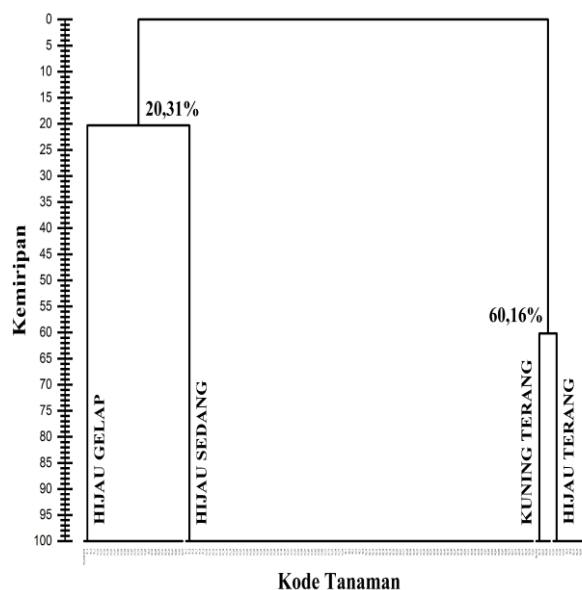


Picture 1. Photographs of fruit skin color diversity found during the observation process in the second planting phase of cucumber crops at Celeban Teaching Factory, Agricultural Development Polytechnic Yogyakarta-Magelang, Yogyakarta, Indonesia. A. Medium green fruit skin; B. Light yellow skin; C. Dark green skin; D. Light green skin. (Source: personal document).



Picture 2. Photograph of the diversity of fruit shapes found during the observation process in the second planting phase of cucumber crops at Celeban

Teaching Factory, Yogyakarta-Magelang Agricultural Development Polytechnic, Yogyakarta, Indonesia. (Source: personal document).



Picture 3. Dendrogram of similarity between fruit skin color clusters. The dark green cluster is 20.31% similar to the medium green cluster. While light yellow is 60.16% similar to the light green cluster.

Based on qualitative data, there are four types of character groups. This group was created because qualitative characters are easy to grouped and can be differentiated clearly in each

part of the plant when observed. According to Taufik et al., (2020), qualitative traits are phenotypes that are qualitatively significantly different from each other and can be clustered.

The use of cluster analysis is used to group observational data into several clusters with grouping criteria based on the level of similarity. Characteristics within a cluster have a high level of similarity, while between clusters have a low level of similarity (Taufik et al., 2020).

Consumers in each region have specific tastes for cucumber types with consideration of shape, color, and size. West Java and Central Java regions like cucumbers that are light green and not too long in size, while East Java and most parts of Eastern Indonesia like cucumbers with dark green fruit skin color, and large fruit size (Ibnu, 2014), but the interest on development is currently leaning towards small cucumbers. Furthermore, Listari, (2021) reported the preference for cucumber in the West Nusa Tenggara region with small and long sizes.

The results of this study are the initiation in the formation of cucumber genetic diversity, especially in fruit color, so that it has the potential as a candidate strain to become a new variety. Genetic purification with directed selection (pedigree) and selfing on selected plants in each generation can be done to ensure the desired pure lines can be achieved.

CONCLUSIONS AND SUGGESTIONS

Based on this study's result, the double-cross crossing in this research resulted in a collection of candidate lines of cucumber based on fruit skin color with bright yellow, bright green, medium green, and dark green fruit skin color

characters. The author suggests the purification of strain candidate, and characterization of candidate lines until the lines become pure lines.

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