Fruit picking time and fruit characteristics of the F2 population of local okra [Abelmoschus esculentus [L.] Moench] crosses with introduced variety

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Abstract. Okra attains its best fruit quality when the pods are still tender. The previous research reported that the crosses of the local okra, i.e. okra Merah and okra Hijau with introduced variety VE022 and B291 success to obtain plants with extended picking time. This research aimed to evaluate the fruit picking time and fruit characteristics of the F2 population and obtain the F2 genotypes that have a more extended fruit picking time. The research was conducted at the Research Station of the Faculty of Agriculture, Andalas University. The materials used are seeds collected from selfed-pollination of ten crosses [F2 populations] and okra Merah and okra Hijau cultivar as a control. Data collected based on an individual observation, and then the data were analyzed using descriptive statistics and unpaired t-test at a 5% significance level. Results showed that a particular plant from the F2 population has a more extended picking time of up to nine days after anthesis, indicating improved fruit quality characters, i.e. fruit length, fruit diameter, and fruit weight. Plants obtained with a longer fruit picking time of nine and eight days after anthesis are 14.4% and 67.0%, respectively. Selected plants, i.e. FOHVE022-8-13, SOMVE022-10-1, and FOHVE022-8-13 that consistently reveal a high number of fruits per plant, larger fruit size, and heavier fruit weight, need to be self-pollinated and evaluated in further research before releasing as a variety.

Keywords: functional vegetable, harvest, firmness, selfing

1. Introduction

Okra [Abelmoschus esculentus [L.] Moench] is a type of vegetable plant that is commonly consumed in its youthful fruit condition. Okra fruit has a high nutrient content and high nutrient variation [1][2]. The okra fruit extract has hypoglycemic effects for diabetic treatment [2][3]. Besides, okra seeds are reported as anti-fatigue due to the content of polyphenols and flavonoids [4]. Its ability to contribute essential nutrients and an immunity function make okra into functional food.

Okra is now widespread in tropical and sub-tropical regions worldwide [5], but not many reports when okra began to spread in Indonesia. One of the okra cultivars cultivated in Indonesia is okra Merah and okra Hijau [6]. The locals have a short picking time, less than 6-7 days after anthesis [DAA], so it has a small weight and size. Consumers prefer the tender texture of the fruit. Okra harvested on the seventh day after anthesis or so will reveal a tough and fibrous texture. Therefore, the improvement in a picking time character is necessary to obtain a genotype with good eating quality and high production.
The local okra's character improvements have been conducted by crosses the cultivars with introduced variety, namely VE022 and B291, which have a more extended harvest period. The crosses' evaluation successfully obtained a plant with a more extended harvest period, i.e., eight days after anthesis [7][8]. Thus, the genetic of selected plants need to homogenize. The research objective is to evaluate the fruit picking time and fruit characteristics of the F2 population and obtain the F2 genotypes with more extended fruit picking time.

2. Materials and Method

The research was conducted in the Research Station, Agriculture Faculty, Andalas University from July to October 2020. The material used is the seed from self-pollinated genotypes that have long fruit picking time, i.e., eight days after anthesis [Table 1]. Four F2 populations from the crosses of okra Hijau with introduced variety are compared with okra Hijau. Simultaneously, six F2 populations from the crosses of okra Merah with introduced variety are compared with the okra Merah cultivar. Okra Merah and okra Hijau cultivars are used as control varieties.

| Table 1. The selected population of okra evaluated and their pedigree |
|---------------------------------------------------------------|
| F1 Genotype | Selected plant [population] | Pedigree |
|------------|-----------------------------|---------|
| FOHVE022   | 8, 17                       | ♀OH x ♂VE022 |
| FOHB291    | 15, 41                      | ♀OH x ♂B291 |
| SOMVE022   | 10, 20                      | ♀OM x ♂VE022 |
| SOMB291    | 14, 16, 23, 24              | ♀OM x ♂B291 |

Note: OH = green okra, OM = red okra, VE022 and B291 = introduced variety used as male parent.

The plot consists of two rows with an inter-row spacing of 60 cm and intra-row spacing of 40 cm. Other agronomic practices followed as per standard recommendation to raise a healthy and good crop stand. The observed variables were fruit characteristics, i.e., fruit weight, fruit diameter, and fruit length. To determine the okra’s firmness texture, we used a force gauge to verify results from a hand or manual texture identification. Data collection was conducted based on an individual observation, and then data were analyzed using descriptive statistics and unpaired t-test at a 5% significance level.

3. Results and Discussion

As a fruit-vegetable plant, okra fruit is consumed when the fruit is still young and tender. Okra Hijau is regularly harvested at six days after anthesis [DAA] [7], while okra Merah is harvested at 6-7 DAA [8]. All populations evaluated showed variation in the number of plants harvested on 6, 7, 8, and 10 days after anthesis [Table 2]. Some F2 populations revealed plants that can be harvested up to 8 DAA [67.0%] and 9 DAA [14.4%]. No population has a tender fruit texture at 10 DAA.

The increased period in the picking time in the F2 population up to 8-9 days after anthesis compared to the okra Merah dan okra Hijau cultivar which harvested at 6 or 7 DAA showed that there had been an improvement in fruit quality characters [Figure 1]. All the F2 population from FOHB291 and FOHVE022 revealed a non-significant increase in length and weight of fruit at 7 DAA, while significantly reduce in fruit diameter. At 8 DAA, the F2 population performed a significant increase in fruit length and fruit weight; however, it revealed a similar size with the okra Hijau in fruit diameter. While at 9 DAA, all the F2 population showed significantly higher fruit length, fruit diameter, and fruit weight compared to those of the okra Hijau cultivar as the control.

All the F2 population from SOMB291 and SOMVE022 exhibited a non-significant increase in fruit length at 7 DAA, while they exhibited a significant increase at 8 and 9 DAA. For fruit diameter, all the F2 population of SOMB291 and SOMVE022 harvested at 7, 8, and 9 DAA revealed similar size with...
okra Merah at 7 DAA. All the F2 populations performed significantly heavier fruit weight at different picking times than the okra Merah’s fruit weight at 7 DAA.

Table 2. Number of plants with tender fruit texture in various genotypes with a picking day of 6 to 10 days after anthesis [DAA]

| Genotype         | Plants (%) harvested on |          |          |          | Total of plant |
|------------------|-------------------------|----------|----------|----------|----------------|
|                  | 6 DAA | 7 DAA | 8 DAA | 9 DAA | 10 DAA | plant |
| FOHVE022-8       | 100   | 100   | 57.1   | 14.3   | 0.0    | 14    |
| FOHB291-15       | 100   | 100   | 50.0   | 18.8   | 0.0    | 32    |
| FOHB291-17       | 100   | 100   | 100    | 25.0   | 0.0    | 4     |
| FOHB291-41       | 100   | 100   | 100    | 33.3   | 0.0    | 3     |
| Green Okra       | 100   | 94.4  | 0.0    | 0.0    | 0.0    | 18    |
| SOMVE022-10      | 100   | 100   | 100    | 0.0    | 0.0    | 1     |
| SOMVE022-20      | 100   | 100   | 0.0    | 0.0    | 0.0    | 1     |
| SOMB291-14       | 100   | 100   | 14.3   | 0.0    | 0.0    | 7     |
| SOMB291-16       | 100   | 100   | 100    | 33.3   | 0.0    | 3     |
| SOMB291-23       | 100   | 100   | 50.0   | 0.0    | 0.0    | 14    |
| SOMB291-24       | 100   | 100   | 61.1   | 16.7   | 0.0    | 18    |
| Red Okra         | 100   | 88.0  | 0.0    | 0.0    | 0.0    | 17    |

ns, * = non-significant and significant at 5 % level based on t-test

Figure 1. Fruit characteristics of the F2 population at different picking time compared to the Okra Hijau and Okra Merah picked at 7 DAA

An interesting phenomenon is from SOMVE022-10 and SOMVE022-20 genotypes which consist of one plant in each. SOMVE022-20 had a long fruit size [19.1 cm], big diameter [25.6 mm], and heavy weight [45.9 g], even though picked at 7 DAA. SOMVE022-10 revealed 17.9 cm in fruit length, 26.8 mm in fruit diameter, and 66.1 g in fruit weight at 8 DAA. A high value in fruit length of this genotype contributes to a heavier fruit weight of the F2 population at 8 DAA compared to a fruit weight at 9 DAA.
Okra is harvested when its length reaches 5 to 7.6 cm to obtain the tender texture; however, the fruit length depends on the variety [9]. Okra fruit is commonly consumed at the picking time of 5-10 DAA [10]. The picking time's extent will increase length, diameter, and okra fruit weight [6]. All F2 populations have more than 8 cm in length when picked at maximum picking time. The increase in the fruit length is 3.7-25.0% and 36.8-52.9%, 1.6-23.0% and 1.6-23.8% for fruit diameter and 0.8-49.7% and 32.5-108.9% for fruit weight, respectively when picked at 8 and 9 DAA in F2 populations using okra Hijau as a parent of crosses. The increase in fruit length is 3.2-18.3%, and 33.8-49.6%, 8.3-25.0% and 43.8-51.2% for fruit diameter, while ranged from 18.8-59.3% and 57.9-62.4% for fruit length, respectively picked at 8 and 9 DAA in the F2 population. The fruit quality improvement indicates the importance of improving the picking time character of okra fruit to obtain the most out of it.

An individual selection is performed on each F2 population which is picked at 8 and 9 DAA. FOHVE022-8-13 has a maximum harvest of up to 9 DAA, and SOMVE022-10-1 and FOHVE022-8-13 that have a maximum harvest of up to 8 DAA are selected plants that consistently reveal a high number of fruits per plant, larger fruit size, and heavier fruit weight [data were not shown]. These selected plants need to homogenize through selfed-pollinated and evaluated in the next generation. Determining the fruit's texture by fragmenting the fruit into two parts is the most straightforward procedure to test the fruit’s firmness. The greater the pressing force against the tested fruit, the harder the fruit's texture [7]. The hardness measurement values of some F2 and control at various picking times ranged from 3.20 – 8.08 Newton [N], and 12.11 – 12.78 N for fibrous and woody fruit texture, respectively. The fruit's hardness value using the force gauge is in line with determining the fruit firmness using a manual method. The suitable fruit picking time is similar to the low hardness using a force gauge.

4. Conclusion
Plants obtained from the F2 population with a longer picking time of nine and eight days after anthesis are 14.4% and 67.0%. A longer picking time indicates that the plants showed improved fruit quality characters. Selected plants, i.e. FOHVE022-8-13, SOMVE022-10-1, and FOHVE022-8-13 that consistently reveal a high number of fruits per plant, larger fruit size, and heavier fruit weight, need to be self-pollinated and evaluated in further research before releasing as a variety.

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