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# PHENOTYPIC VARIABILITY OF THE F2 POPULATIONS DERIVED FROM CROSSES BETWEEN LOCAL AND INTRODUCED OKRA CULTIVARS

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***Abstract***. *Okra (Abelmoschus esculenthus) is a vegetable plant consumed in immature and tender texture fruits. Crosses of local okra with introduced varieties are carried out to improve the character of the local cultivars. This study aimed to assess the variability of agronomic characters, both quantitative and qualitative characters of various families of the F2 populations and select superior families that can be used to produce new cultivars. The F2 population was derived from inbreeding and selection of the crosses between local okra cultivars with B291 and Ve022 as introduced cultivars. The study used an experimental method with an individual observation. Qualitative characters were described based on the descriptor by IBPGR, while quantitative characters were analyzed using descriptive statistics. Results showed variation in each F2 family in plant height, the number of flowers per plant and the number of fruits per plant, except for SOMB291-16. FOHVE022-8, FOHB291-15, FOHVE022-17, SOMB291-23 and SOMB291-24 families could be selected due to the extended picking time were in line with the increase of fruit quality. A broad variability of quantitative characters was found for all characters, indicating a high opportunity to obtain valuable traits and desirable segregants in F2 populations. Variations in qualitative characters were found in stem color, leaf shape, fruit color and fruit shape. The selection of plants with specific characters could be maintained with inbreeding or self-pollinated desirable segregants.*
***Keywords:*** family; inbreeding; introduced cultivar; local cultivar; segregation

## 1. Introduction

Okra (*Abelmoschus esculentus* (L). Moench) is a vegetable plant consumed in immature and tender texture fruits or pods. Okra fruit has many benefits for human health because it contains many nutritional substances. It contains protein, lipid, carbohydrate, fibre, and numerous minerals such as phosphorus, sulphur, potassium, calcium, magnesium, and various vitamins such as vitamin A and C, thiamine, pyridoxine, riboflavin and unsaturated fatty acid such as linoleic acids (Gemede et al., 2014; Gopalan et al., 2007; Roy et al., 2014; Kumar et al., 2010; Kumar et al., 2013). The tender fruit contains high antioxidants and bioactive compounds, including folic acid, vitamin C and E, carotenoids, xanthin and lutein (Gemede et al., 2014; Roy et al., 2014). Mucus from the fruit can stabilize blood sugar (Gamede et al., 2014), while the seeds contain anti-fatigue substances (Xia et al., 2015). Fruit extracts have high polyphenols and flavonoids so that they function as hypoglycemia for the treatment of diabetes (Kumar et al., 2013; Xia et al., 2015). Due to its benefit to human health, okra is a functional vegetable food

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(Hayati et al., 2020).

Despite its enormous benefits, okra rarely reaches its maximum yield potential due to several constraints. Okra is being neglected because of the non-availability of high yielding, improved and locally adapted cultivars, the incident attack of yellow vein mosaic virus, and shoot and fruit borer (Arora et al., 2008; Reddy et al., 2012; Seth et al., 2016). Local okra cultivars that are well known and cultivated for years are okra Hijau and okra Merah (Hayati et al., 2020).

Both cultivars are unimproved open-pollinated cultivars. Okra Hijau cultivar has short internodes; hence flower buds look to appear in clusters. The number of fruits produced is around 12 per plant (Anggraini et al., 2018). Okra Merah cultivar has an attractive fruit appearance due to the color of fruits. Red coloration of fruit indicates anthocyanins as natural antioxidants, but the fruit production is much less than the okra Hijau cultivar, six fruits per plant (Pratiwi et al., 2018). Both okra cultivars have a short picking period of 6-7 days after anthesis (DAA), producing small fruit size and low fruit weight.

Previous research showed that various introduced okra cultivars evaluated showed high variability in many characters such as plant height, first flowering time, fruit weight, fruit diameter, fruit length and yield/plant. The introduced okra cultivars also varied in the maximum fruit picking time in the harvest. Two cultivars, *i.e.* Ve-022 and B-291, exhibited the longest in harvest (Hayati et al., 2020). The local okra cultivars, *i.e.,* okra Hijau and okra Merah have been crossed with both introduced okra varieties to improve the picking-time character. Evaluation of the crosses showed variation in the maximum picking day among plants within similar crosses. The fruit was still tender and not fibrous with an increase in picking-time of up to 8 DAA in the F1 population, namely SOMVE022 and SOMB291 as much 25% and 50%, respectively (Pratiwi et al., 2018) and FOHVE022 and FOHB291, as much 30% and 30%, respectively (Anggraini et al., 2018). The populations also revealed great variations, primarily in quantitative characters.

Inbreeding with selection was sufficient in recovering desirable families from okra (Ibrahim et al., 2013). Therefore, this study aimed to evaluate quantitative and qualitative characters of the F2 population and select superior families that can be used to produce new cultivars.

## 2. Methods

### 2.1. Evaluation of F2 Okra Population in the Field

This research was carried out at the Research Station of the Faculty of Agriculture, Andalas University, at an altitude of 173 meters above sea level. The materials used in this study were 12 populations of the F2 generation, the local cultivars, *i.e.*, okra Merah and okra Hijau, as control cultivars. The population or families used in the F2 generation derived from self-pollinated or

inbreeding of selected F1 population. The families were FOHB291-15, FOHB291-41, FOHVE022-8, FOHVE022-17, SOMB291-14, SOMB291-16, SOMVE022-10, SOMVE022- 20, SOMB291-23, SOMB291-24, which derived from crosses of okra Merah or okra Hijau cultivar with introduced variety B291 or Ve022. The main criteria for selecting families were its picking-time that attained 8 DAA (days after anthesis).

The evaluation used plots that consists of two rows with spacing of 60 x 40 cm for inter-row and intra-row, respectively. Fertilizer consisted of 100 kg Urea and 100 kg of KCl per hectare was applied at 15, 30 and 45 days after planting, while 200 kg SP-36 was applied at 15 days. Other agronomic practised are followed as per standard recommendations to raise a healthy and good crop stand.

### 2.2. Data Collected and Analyses

The study used an experimental method with an individual observation. Qualitative data were described based on the okra description guide from the International Board Plant for Plant Genetic Resources (IBPGR, 1991). The quantitative data collected were first flowering time (DAP=days after planting), plant height (cm), the number of flowers per plant, the number of fruits per plant and the maximum picking time (DAA=days after anthesis). Determining the fruit's firmness was done by fragmenting the fruit into two parts. The greater the pressing force against the tested fruit, the harder the fruit's texture. To verify a manual texture identification, we use a force gauge. The tender texture values ranged from 3.20 – 8.08 Newton [N] and will be higher with a fibrous and woody fruit texture (Hayati et al., 2021).

The data were analyzed using descriptive statistics by calculating mean, variance and standard deviation. Phenotypic variability is wide if the value of phenotypic variability is more significant than two times its standard deviation (Hayati, 2018). The unpaired *t*-test is used to compare the F2 population and the control.

## 3. Results and Discussion

Quantitative characters, including first flowering time, plant height, the number of flowers per plant, and the number of fruits per plant in all families of the F2 generation, have various appearances shown by the standard deviation values of the characters within each family (Table 1) .The variability indicates that the composition of the genotype that controls the character in the F2 population differed. Many genes that control quantitative character is also responsible for the magnitude of variability in the F2 population. An exception is in the SOMB291-16 family, which showed uniformity for the number of flowers and fruits per plant.

The crosses of the divergent population did not increase the variance in the first filial

generation (F1); however, the segregation variation was observed in the second filial generation (F2) due to the recombination (Lande, 1981; Benowicz et al., 2020). The magnitude of that variance depends on the extent of divergence of the population and the genetic base for such differentiation, including probability distributions of alleles and the number and effect size of alleles that contribute to a character (Slatkin & Lande, 1994; Koshy et al., 1998). A small number of large-effect alleles will likely cause a substantial increase in segregation variance (Lynch & Walsh, 1998).

Table 1. First flowering, plant height, the number of flowers per plant, the number of fruits per plant and the maximum picking-time for various families of the F2

| Families | First flowering (DAP) | Plant height (cm) | Number of flowers per plant | Number of fruits per plant | Maximum picking time (DAA) |
|---|---|---|---|---|---|
| FOHB291-15 | 60.2±15.0 | 88.5±4.3 | 22.2±12.4 | 19.3±11.8 | 9 |
| FOHB291-41 | 67.0±7.5 | 103.7±30.0 | 36.7±22.9 | 32.0±22.0 | 9 |
| FOHVE022-8 | 58.4±12.5 | 123.1±40.0 | 33.0±17.2 | 29.1±15.7 | 9 |
| FOHVE022-17 | 72.3±11.3 | 96.0±12.7 | 15.5±4.3 | 10.5±3.4 | 9 |
| Okra Hijau | 55.1±8.8 | 141.2±21.1 | 25.8±14.5 | 23.1±14.1 | 7 |
| SOMB291-14 | 64.4±11.8 | 97.0±8.9 | 32.1±3.9 | 28.1±2.9 | 8 |
| SOMB291-16 | 65.3±4.7 | 80.7±11.9 | 8.3±0.5 | 5.7±0.5 | 9 |
| SOMB291-23 | 49.4±3.2 | 142.9±19.9 | 39.6±9.7 | 36.2±9.6 | 8 |
| SOMB291-24 | 54.7±6.6 | 133.8±19.9 | 19.6±6.1 | 15.1±5.4 | 9 |
| SOMVE022-10# | 44.00 | 207.00 | 95.00 | 89.00 | 8 |
| SOMVE022-20# | 44.00 | 181.00 | 64.00 | 58.00 | 7 |
| Okra Merah | 58.1±8.6 | 154.4±35.5 | 20.8±7.9 | 17.9±6.4 | 7 |

# = only one plant in population, means±standard deviation

Each family in the F2 generation is a population of plants with different genotypes due to the segregation of alleles that make up the genotype composition. High variability within families in each character in the F2 generation indicates a broad spectrum of genetic variability from which desirable or valuable characters and segregants can be selected.

The increased period in the fruit picking time in the F2 population up to 8-9 days after anthesis compared to the okra Merah and okra Hijau cultivars harvested at 6 or 7 DAA indicates that there has been an improvement in fruit quality characters (Table 2).

More extended picking time indicates an increase in fruit or pod length, diameter, and weight. All families, except FOHB291-41, have significantly longer fruit picked of 8 DAA than the okra Hijau cultivar (12.85 cm). There was no increase in fruit diameter at 8 DAA in FOHVE022-8, FOHB291-15, FOHVE022-17, and FOHB291-41 families. However, picking time at 8 DAA tends to increase fruit weight, except for FOHB291-41. The fruit length of

SOMB291-23 and SOMB291-24 families are significantly longer than a control (okra Merah) at 8 DAA. Family SOMB291-23 consistently reveals significantly larger in diameter and heavier in weight at 8 DAA than a control. Based on the increase of fruit quality with the extended picking time, the selected families are FOHVE022-8, FOHB291-15, FOHVE022-17, SOMB291-23 and SOMB291-24.

Table 2. Length, diameter and weight of fruit in various populations with different picking time

| Families | Picking time (DAA) | Fruit length (cm) | Fruit diameter (mm) | Fruit weight (g) |
|---|---|---|---|---|
| FOHVE022-8 | 9## | 21.25 | 21.05 | 44.50 |
| | 8 | 18.68±2.29* | 19.95±4.28ns | 35.95±12.51* |
| | 7 | 13.90±2.64ns | 19.63±3.85ns | 31.63±9.86ns |
| FOHB291-15 | 9 | 20.03±1.31* | 20.63±1.35* | 36.35±5.25* |
| | 8 | 18.04±2.86* | 19.26±2.17ns | 35.92±9.30* |
| | 7 | 13.96±2.10ns | 14.69±2.92* | 17.40±1.50* |
| FOHVE022-17 | 9# | 21.00 | 19.90 | 37.30 |
| | 8 | 20.33±0.41* | 17.07±3.09ns | 34.60±0.96* |
| | 7 | 15.35±0.32* | 12.23±0.24* | 23.33±1.78ns |
| FOHB291-41 | 9# | 19.90 | 29.10 | 29.10 |
| | 8 | 14.50±1.00ns | 15.10±1.40ns | 22.15±0.05ns |
| | 7 | 14.03±0.41ns | 14.33±0.58ns | 21.97±0.26ns |
| Okra Hijau | 7 | 12.85±1.96 | 17.61±2.83 | 22.69±7.60 |
| SOMVE022-10 | 8# | 17.90 | 26.80 | 66.10 |
| | 7# | 14.40 | 20.70 | 38.90 |
| SOMB291-14 | 8# | 17.30 | 16.10 | 39.90 |
| | 7 | 15.63±2.10ns | 14.37±1.51* | 30.20±4.66ns |
| SOMB291-16 | 9# | 18.00 | 18.70 | 33.80 |
| | 8 | 16.80±1.90ns | 18.10±2.00ns | 30.70±1.70ns |
| | 7 | 12.03±1.19ns | 12.37±0.74* | 21.40±0.71* |
| SOMB291-23 | 8 | 18.41±1.57* | 22.94±3.25* | 49.54±12.22* |
| | 7 | 17.80±1.31* | 21.06±1.66ns | 35.67±6.41ns |
| SOMB291-24 | 9 | 19.33±1.11* | 22.77±3.58ns | 41.40±5.67* |
| | 8 | 16.40±2.00* | 18.79±2.09ns | 32.33±7.64ns |
| | 7 | 14.45±1.28ns | 15.83±3.73ns | 25.50±3.62ns |
| Okra Merah | 7 | 14.19±1.83 | 19.19±2.34 | 29.69±8.15 |

means±standard deviation
*= significant at 5 % level, ns = not significant
# and ## = number of plants is 1 and 2, respectively

Okra is harvested when its length reaches 5 to 7.6 cm to obtain the tender texture depends on the variety (Tanner & Ballew, 2020). Okra fruit is commonly consumed at 5-10 DAA (Roy et al., 2014). The prolonged picking time will increase the length, diameter, and weight of okra fruit. All families of the F2 populations have more than 7.6 cm in length when fruits are picked at a maximum period of picked.

Phenotypic variability of the quantitative characters of the F2 populations showed a broad variability for all characters (Table 3). A broad spectrum variability indicates a high probability to obtain valuable characters and desirable plants or segregants from the population. The crop improvement program will be rewarding due to the selection process is more effective and efficient. Eshiet & Brisibe (2015) stated that it is crucial to assemble, characterize and evaluate many useful cultivars and utilize desirable characters in okra improvement programs which is highly dependent on genetic variability.

Table 3. Phenotypic variability of quantitative characters of F2 populations

| Character | Variance | 2 x SD | Variability criteria |
|---|---|---|---|
| First flowering (DAP) | 160.19 | 25.32 | Broad |
| Plant height (cm) | 1436.57 | 75.80 | Broad |
| The number of flowers per plant | 263.70 | 32.48 | Broad |
| The number of fruits per plant | 243.08 | 31.18 | Broad |
| Picking time (DAA) | 67.59 | 16.44 | Broad |

SD = Standard deviation

A broad variability in first flowering designates that opportunity to obtain plants with early production. Variability in plant height specifies a high opportunity to obtain an ideal height performance. High variability in the number of flowers and fruits per plant indicates the opportunity to obtain plants with high yields. The fruit picked at a tender stage of maturity is essential to consider the production and quality of okra fruit (Piloo & Kabir, 2011; Barnwal et al., 2017). A broad variability in picking time shows an opportunity to get plants whose fruit is still tender and not fibrous when the picking time is prolonged. Hayati et al. (2021) reported that only a few plants had a picking time of 9 DAA (14.4%) and 67% at 8 DAA. All families had thick and fibrous fruit texture at harvested at 10 DAA. Therefore, the maximum picking time obtained from plants evaluated in this study was 9 DAA, while 8 DAA dominated the ideal time for picking fruit.

Variations in qualitative characters were found in stem color, leaf shape, fruit color and fruit shape, while there was no variation in leaf color characters (Figure 1).

In the F2 generation, the family FOHB291-15 with green stems found was 28 plants (87.5%), while plants with green stems and red spots were four plants (12.5%). All plants in the FOHVE022-8 population had green leaves and variation in leaf shape, type 3 and type 4, respectively 28.6% and 71.4%. Plants within the family FOHVE022-8 had green fruit and various fruit shapes, *viz*. type 3 as many as two plants (14.3%) and type 8 as many as 12 plants (85.7%).

The color of fruit in the family SOMB291-14 was green with red spots and red/purple. Four plants (57.14%) had green fruit color with red spots, and three plants (42.86%) had red/purple

fruit. The family SOMB291-23 had green fruit colors as many as three plants (21.4 %), greenish-red fruit color was seven plants (50.0%), and red/purple fruit color was four plants (28.6%).

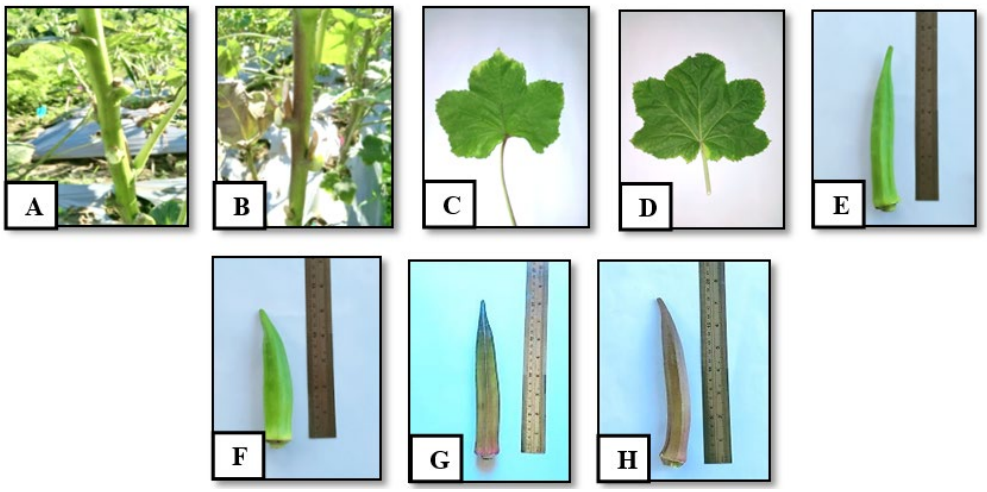


Figure 1. Variation on qualitative characters within F2 population
A. Green stem color, B. Green stem color with red spots, C. Leaf shape type 3, D. Leaf shape type 4, E. Fruit shape type 3, F. Fruit shape type 8, G. Fruit color green with spots, H. Fruit color red/purple.

The shape of the fruit in the family SOMB291-23 also differed, type 3, type 7 and type 8. The fruit shape of type 3 contained three plants (21.4 %), type 7 is two plants (14.3%) and type 8 is nine plants (64.3 %). In SOMB291-24, different stem colors were green, green with red, and red/purple spots. There were three plants (16.7%) with green stems only, three plants (16.7%) with green stems with red spots, and 12 plants (66.6%) with red/purple stems. The family SOMB291-24 had various fruit colors; green, dark-green, green with red, and red/purple spots. There were seven plants (38.9%) that had green fruit color, one plant (5.5%) which had dark green fruit color, five plants (27.8%) which had green fruit color with red spots, and five plants (27.8%) which had a red/purple color. The variation found in fruit, stem, and leaves within similar families and among families indicated that segregation existed in the F2 population. The selection of plants with valuable characters could be maintained with inbreeding or self-pollinated of particular segregants.

## 4. Conclusions

Based on the evaluation, all families of the F2 showed variability in all characters, except for SOMB291-16. FOHVE022-8, FOHB291-15, FOHVE022-17, SOMB291-23 and SOMB291-24 families could be selected due to the extended picking time were in line with the increase of fruit quality. A broad variability of quantitative characters was found for all characters, *i.e.* first flowering, plant height, the number of flowers per plant, the number of fruits per plant and picking time. Variations in qualitative characters were found in stem color, leaf shape, fruit color and fruit shape.

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## References

Anggraini, F. L., Sutoyo, Gustian, & Hayati, P. K. D. (2018). Evaluasi F1 Hasil Persilangan Kultivar Okra (*Abelmoschus esculentus* (L.) Moench) Hijau dengan Beberapa Varietas Okra Introduksi. Prosiding Seminar Nasional Perhimpunan Ilmu Pemuliaan Indonesia. Hal. 225-229. Padang. 4-5 Oktober 2018. http://carano.pustaka.unand.ac.id/index.php/car/catalog/ category/proc

Arora, D., Jindal, S. K., & Singh, K. (2008). Genetics of Resistance to Yellow Vein Mosaic Virus in Inter-Varietal Crosses of Okra (*Abelmoschus esculentus* L. Moench). *SABRAO Journal Breeding and Genetics*, 40(2), 93-103.

Barnwal, A. K., Pal, A. K., Tiwari, A., Pal, S., & Singh, A. K. (2017). Effect of Picking Stages on Fruit and Seed Development in Okra (Abelmoschus esculentus L. Moench) Cultivars Kashi Pragati and Kashi Kranti. *International Journal of Agriculture, Environment and Biotechnology*, 10(6), 695-701. https://doi.org/10.5958/2230-732X.2017.00086.9

Benowicz, A., Stoehr, M., Hamann, A., & Yanchuk, A. D. (2020). Estimation of The F2 Generation Segregation Variance and Relationships among Growth, Frost Damage and Bud Break in Coastal Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) Wide-Crosses. *Annals of Forest Science, 77*(28), 1-13. https://doi.org/10.1007/s13595-020-0925-9

Eshiet, A. J., & Brisibe, E. A. (2015). Morphological Characterization and Yield Traits Analysis in Some Selected Varieties of Okra (*Abelmoschus esculentus* L. Moench). *Advances in Crop Science and Technology*, 3(5), 1-5. https://doi.org/10.4172/2329-8863.1000197

Gemede, H. F., Ratta, N., Haki, G. D., Woldegiorgis, A. Z., & Beyene, F. (2014). Nutritional Quality and Health Benefits of Okra (*Abelmoschus esculentus*): A Review. *Food Science and Quality Management,* 33, 87-96.

Gopalan. C., Sastri, B. V. S., & Balasubramanian, S. (2007). Nutritive Value of Indian Foods. National Institute of Nutrition (NIN), ICMR.

Hayati, P. K. D. (2018). *Analisis Rancangan dalam Pemuliaan Tanaman: Penerapan Statistika dalam Penelitian Pemuliaan Tanaman*. Padang, Indonesia: Andalas University Press.

Hayati, P. K. D., Putri, Y. H., Gultom, R. F., Siddik, I. M. Sutoyo, & Ardi. (2020). Evaluation of Agro-Morphological Traits of Some Introduced Okra (*Abelmoschus esculentus* (L.) Moench) Varieties: Correlation, Variability and Heritability Studies. *International Journal of Crop Science* 3(1), 5-11. https://doi.org/10.25077/jijcs.3.1.5-11.2020

Hayati, P. K. D., Yld, M. M., Martinsyah, R. H., & Sutoyo. (2021). Fruit Picking Time and Fruit Characteristics of The F2 Populations of Local Okra (*Abelmoschus esculentus* (L.) Moench) Crosses with Introduced Variety. *Journal IOP Conference Series: Earth and Enviromental Sciences,* 741, 2-4. https://doi.org/10.1088/1755-1315/741/1/012008

IBPGR. (1991). *Report of an International Workshop on Okra Genetic Resources, Held at The National Bureau for Plant Genetic Resources (NBPGR)*. New Delhi, India: 8-12 October 1990 International Crop Network Series 5:133p.

Ibrahim, E. A. A., Abed, M. Y., Moghazy, A. M. (2013). Genetic Behavior of Families Selected from Some Local Okra *(Abelmoschus esculentus* L. Moench) Populations in Egypt. *Plant Breeding and Biotechnology,* 1(4), 396-405. https://doi.org/10.9787/PBB.2013.1.4.396

Koshy, M. P., Namkoong, G., & Roberds, J. H. (1998). Genetic Variance in the F2 Generation of Divergently Selected Parents. *Theoretical and Applied Genetics,* 97, 990-993. https://doi.org/10.1007/s001220050982

Kumar, D. S., Tony, D. E., Kumar, A. P., Kumar, K. A., Rao, D. B. S., & Nadendia, R. (2013). A Review on : *Abelmoschus esculentus* (Okra). *International Research Journal Pharmacy and Applied Science, 3*(4), 129-132.

Kumar, S., Dagnoko. S., Haougui, A., Ratnadass, A. Pasternak, D., & Kouame, C. (2010). Okra (*Abelmoschus* spp.) in West and Central Africa: Potential and Progress on its Improvement. *African Journal of Agricultural Research, 5*(25), 3590-3598.

Lande, R. (1981). The Minimum Number of Genes Contributing to Quantitative Variation Between and within Populations. *Genetics,* 99(3-4), 541-53.

Lynch, M., & Walsh, B. (1998). *Genetics and Analysis of Quantitative Traits* . Sunderland: Sinauer Associates.

Piloo, N., & Kabir, J. (2011). Effect of Age of Harvest on Fruit Quality of Okra (*Abelmoschus esculentus* (L.) Moench). *Journal Environmental Research and Development, 5*(3), 615-622.

Pratiwi, S. I., Rozen, N., Gustian, & Hayati, P. K. D. (2018). Evaluasi F1 Hasil Persilangan Beberapa Varietas Okra (*Abelmoschus esculentus* (L.) Moench) dengan Kultivar Okra Merah. Prosiding Seminar Nasional Perhimpunan Ilmu Pemuliaan Indonesia. hal. 281-285). Padang. 4-5 Oktober 2018. http://carano.pustaka.unand.ac.id/ index.php/car/ catalog/ category/proc

Reddy, M. T., Haribabu, K., Ganesh, M., Reddy, K. C., & Begum, H. (2012). Genetic Divergence Analysis of Indigenous and Exotic Collections of Okra (*Abelmoschus esculentus* (L.) Moench). *Journal of Agricultural Technology*, 8(2), 611-623

Roy, A., Shrivastava, S. L., & Mandal, S. M. (2014). Functional Properties of Okra *(Abelmoschus esculentus* (L.) Moench*).* Traditional Claims and Scientific Evidences. *Plant Science Today*, 1(3), 121-130. https://doi.org/10.14719/pst.2014.1.3.63

Seth, T., Chattopadhyay, A., Chatterjee, S., Dutta, S., & Singh, B. (2016). Selecting Parental Lines among Cultivated and Wild Species of Okra for Hybridization Aiming at YVMV Disease Resistance. *Journal of Agricultural Science and Technology 18*(3), 751-762. Retrieved from https://jast.modares.ac.ir/article-23-8435-en.html

Slatkin, M., & Lande, R. (1994). Segregation Variance after Hybridization of Isolated Populations. *Genetics Research,* 64(1), 51-56. https://doi.org/10.1017/s0016672300032547

Tanner, C. & Ballew, J. (2020). Harvesting Vegetable. Retrieved from https://hgic.clemson.edu/factsheet/ harvesting-vegetables/

Xia, F., Zhong, Y., Li, M., Chang, Q., Liao, Y., Liu, X., & Pan, R. (2015). Antioxidant and Anti-Fatigue Constituents of Okra. *Nutrients*, 7(10), 8846-8858. https://doi.org/ 10.3390/ nu7105435