Annals of
Reviews and Research

Mini Review
Volume 7 Issue 4 - August 2022
DOI: 10.19080/ARR.2022.07.555720

Ann Rev Resear

Juvenile Period in Plants: A Necessary Tool in Plant Breeding

Florence Mfon Umoh[1]*, Ebenezer Lanre Fashoranti[2] and Emmanuel Imoren[1]

[1]*Rubber Research Institute of Nigeria, Edo State, Nigeria*

[2]*Raedial Farm Limited, Benin City, EdoState, Nigeria*

Submission: July 16, 2022; **Published:** August 02, 2022

***Corresponding author:** Florence Mfon Umoh, Rubber Research Institute of Nigeria, Edo State, Nigeria

Abstract

Plant juvenile period is the period between seed germination and its ability to achieve and maintain flower Hackett [1]. The duration of this period is determined by genetic and environmental factors Kazakov & Kichina [2], and their interaction can produce different plant behaviours Inmaculada et al. [3]. The benefits of traditional breeding practices however, are difficult to achieve in most crops, due to their long juvenile periods thus necessitating long breeding cycles. Two main strategies have been used in fruit breeding programs to overcome these difficulties which include the development of early selection criteria to eliminate genotypes with a long juvenile period and the shortening of this period by means of forced growth of seedlings. However, the length of the juvenile period has agronomic importance due to its relationship with the length of the unproductive period of the new cultivars subsequently reproduced by vegetative cuttings, an important character for fruit trees Inmaculada et al. [3], Experiments have being done on different crops to reduce the juvenile period by manipulating different growth factors and parameters as rapid flowering would hasten conventional breeding and help realize the benefits from genomic selection methods. The objective of this review is to briefly discuss on the juvenile phase of some crops and its effects on the breeding time thus delaying the improvements of those crops.

Keywords: Juvenile phase; Plant breeding; Crop improvement

Background Introduction

Plant juvenile period is the period between seed germination and its ability to achieve and maintain flower Hackett [1]. The duration of this period is determined by genetic and environmental factors Kazakov & Kichina [2] and their interaction can produce different plant behaviours Inmaculada et al. [3]. Plant breeding is an alteration in plants as a result of their use by man, ranging from unintentional changes resulting from the advent of agriculture to the application of molecular tools for precision breeding. It aims at selecting a better type among variants, in relation to yield and quality of edible parts; ease of cultivation, harvest, and processing; tolerance to environmental stresses; and resistance against pests Flavio & Alexandre [4]. The benefits of traditional breeding practices, however, are difficult to achieve in most crops, due to their long juvenile periods thus necessitating long breeding cycles; desired genotypes for a hybridization do not have synchronized flowering due to photoperiod or vernalization requirements, or preferred lines are grown asexually and have limited flowering potential. With the knowledge that plant breeding requires the production of fertile flowers to produce the necessary gametes obtaining such flowers in a synchronized manner and in a practical period can be challenging. Amasino [5]. Thus, seedlings with long juvenile period are not desired by breeder because the first stages of the breeding process are delayed by their assessment De la Rosa et al. [6]. Two main strategies have been used in fruit breeding programs to overcome these difficulties which include the development of early selection criteria to eliminate genotypes with a long juvenile period and the shortening of this period by means of forced growth of seedlings.

Lin et al. [7] emphasized the need to increase he current rate of genetic gain of critical food crops to protect global food security. As the human population presently is around 7.8 billion and is estimated to reach 9.9 billion by 2050 IISD, [8]. Climatic fluctuations (rising temperatures, frequent floods) and drought have been forecasted to lead to novel diseases and frequent pest outbreaks, requiring an agile plant breeding response Hussain et al. [9] Therefore, enhancing the rate of genetic gain depends on accelerated crop breeding pipelines to allow rapid delivery of improved crop varieties. As educed by the breeder's equation Moose et al. [10]. Plant breeding can be hastened by enhancing factors that influence the genetic gain per unit time Bohra et al;

Sinha et al; Varshney et al. [11-13] and importantly, the breeding cycle time Cobb et al. [14]. Since the early 21st century, this suite of Speed Breeding techniques has been applied across economically and scientifically important model, crop and pasture families, including Poaceae, Fabaceae, and Brassicaceae, to achieve up to threefold improvement in annual generation turnover compared to conventional generation advancement systems.

Juvenile phase and the importance of plant breeding in its improvement

The life cycle of higher plants is characterized by two development stages, the vegetative and the reproductive. The former consists of the juvenile and adult vegetative stages. During the juvenile phase, the plants are unable to flower, even under inductive conditions. In certain perennial plants, this period can persist for several decades Amasino Yamagishi et al. [15]. In many fruit crops, this phase before flowering can take more than 20 years Van Nocker & Gardine [16]. However, the length of the juvenile period has agronomic importance due to its relationship with the length of the unproductive period of the new cultivars subsequently reproduced by vegetative cuttings, an important character for fruit trees. Many plants experience an extended juvenile phase before being capable of transitioning to reproductive growth, and this can severely delay the development of new lineages with preferred traits. The switch from vegetative to reproductive development in flowering plant is one of the most important developmental transitions Benedicte Catherine [17] which requires the coordination of developmental and environmental signals.

Photoperiod manipulation in grain amaranth, was reported to be useful in flowering synchronization in several germplasm lines, which, when used with DNA marker technology have led to the development and identification of true hybrids, thus, advancing the breeding program Stetter [18]. Other methodologies to improve generation turnover by promoting early flowering in vegetables involve higher expression of flowering genes. Borovsky et al. [19]; increasing the photoperiod and a foliar mineral supplement have also shown to reduce time to anthesis for a higher generation turnover in oats Tanaka et al. [20]. For the winter pea crop, the manipulation of flowering regulatory genes is a promising way to control key developmental stages, like the dates of floral initiation and flowering as an ideal winter pea should initiate its flower primordia late to avoid frosts, but early to escape drought and heat stresses in late spring. Its correct timing is important in maximizing reproductive success and thus has a major impact on crop performance.

Experiments have been done on different crops to reduce the juvenile period by manipulating different growth factors and parameters as rapid flowering would hasten conventional breeding and help realize the benefits from genomic selection methods. In addition, clonally propagated crops, like banana, roots, and tubers (not fruit crops), are now employing speed breeding to reduce flowering time, increase flowering rate, and the predictability of flowering, for the introduction of disease resistance traits Vira, Souza et al. [21,22] A study was done by De la Rosa et al. [7] on olive seedling to establish useful negative pre selection criteria on the basis of the influence of seedling vigour (measured as plant height or stem diameter) on the characteristics at the adult stage. The results revealed that early evaluation and selection for juvenile period can be performed at the seedling stage in olive progenies on the basis of vigour measurements. Therefore, selection for short juvenile period was valid irrespective of parentage and thus could be efficient in a general context. No correlation existed between juvenile period and yield or fruit traits so this preselection criterion would have no negative effects on these characters.

Pritsa et al. [23] performed an experiment on olive seedling to assess growth traits during the initial developmental stages which could be correlated to time of first flowering, thus, facilitating fast selection in olive breeding programs. It was revealed that pre-selection in olive seedlings for earliness of first flowering is possible, based on vegetative characteristics assessed very early in their development. In the same vain, Rallo et al. [24] studied the relationship between the length of the juvenile period and nine olive seedling parameters (plant height, diameter, number of nodes, lateral shoots, internode length, leaf length, width, area, and shape index) with the aim of selecting the best traits to be used as pre-selection criteria for short juvenile period. It was observed that strong positive correlations existed between the parameters studied. Furthermore, Bagnara [25] performed an experiment on pear seedlings to estimate the relationship between vegetative aspects and early bearing. It was concluded that a short juvenile period in pear is associated with a good efficiency in reserves and dry matter accumulation in woody parts of plant. Leo´n et al. [26] demonstrated that olive seedlings with a short juvenile period will also produce plants with a short unproductive period once vegetatively propagated.

References

1. Hackett WP (1985) Juvenility, maturation, and rejuvenation in woody plants. Hort Rev Amer Soc Hort Sci 7: 109-155.
2. Kazakov IV, Kichina V (1988) Methods of accelerating the cropping of apple trees by reducing the juvenile phase. Acta Hort 224: 141-144.
3. Inmaculada Moreno-Alıas, Hava F Rapoport, Rafael Lopez, Lorenzo Leo´n, Rau´l de la Rosa (2010) Optimizing Early Flowering and Pre-selection for Short Juvenile Period in Olive Seedlings, hortscience 45(4): 519-522.
4. Breseghello F, Guedes Coelho AS (2013) Traditional and Modern Plant Breeding Methods with Examples in Rice (Oryza sativa L.); J. Agric. Food Chem 61 (35): 8277-8288.
5. Amasino R (2010) Seasonal and developmental timing of flowering. Plant J 61: 1001-1013.
6. De la Rosa R, Kiran AI, Barranco D, Leon L (2006) Seedling vigour as a preselection criterion for short juvenile period in olive breeding, Australian journal of agricultural research 57(4): 477-481.

How to cite this article: Florence Mfon U, Ebenezer Lanre F, Emmanuel I. Juvenile Period in Plants: A Necessary Tool in Plant Breeding. Ann Rev Resear. 2022; 7(4): 555720. DOI:10.19080/ARR.2022.07.555720

7. Zibei Lin, Noel O I Cogan, Luke W Pembleton, German C Spangenberg, John W Forster, et al. (2016) Genetic Gain and Inbreeding from Genomic Selection in a Simulated Commercial Breeding Program for Perennial Ryegrass. Plant Genome 9 (1).
8. IISD. World Population to Reach 9.9 Billion by 2050.
9. Hussain B (2015) Modernization in plant breeding approaches for improving biotic stress resistance in crop plants. Turk J Agric for 39: 515-530.
10. Moose SP, Mumm RH (2008) Molecular plant breeding as the foundation for 21st century crop improvement. Plant Physiol 147: 969–977.
11. Bohra A, Jha UC, Godwin ID, Varshney RK (2020) Genomic interventions for sustainable agriculture. Plant Biotechnol J18: 2388-2405.
12. Sinha P, Singh VK, Bohra A, Kumar A, Reif JC, et al. (2021) Genomics and breeding innovations for enhancing genetic gain for climate resilience and nutrition traits. Theor Appl Genet 134: 1829-1843.
13. Varshney RK, Bohra A, Yu J, Graner A, Zhang Q, et al. (2021) Designing Future Crops: Genomics-Assisted Breeding Comes of Age Trends Plant Sci 26: 631-649.
14. Cobb J, Juma RU, Biswas PS, Arbelaez JD, Rutkoski J, et al. (2019) Enhancing the rate of genetic gain in public-sector plant breeding programs: Lessons from the breeder's equation Theor Appl Genet 132: 627-645.
15. Yamagishi N, Kishigami R, Yoshikawa N (2014) Reduced generation time of apple seedlings to within a year by means of a plant virus vector: a new plant-breeding technique with transmission of genetic modification to the next generation; Plant Biotechnol J 12: 60-68.
16. VanNocker S, Gardiner SE (2014) Breeding better cultivars, faster: Applications of new technologies for the rapid deployment of superior horticultural tree crops; Hortic Res 1: 14022.
17. Benedicte W, Catherine R (2009) Systems biology for plant breeding: the example of flowering time in pea, Biology Reports, 332(11): 998-1006.
18. Stetter MG, Zeitler L, Steinhaus A, Kroener K, Biljecki M, et al. (2016); Crossing Methods and Cultivation Conditions for Rapid Production of Segregating Populations in Three Grain Amaranth Species. Front Plant Sci 7: 816.
19. Borovsky Y, Mohan V, Shabtai S, Paran I, (2020) CaFT-LIKE is a flowering promoter in pepper and functions as florigen in tomato. Plant Sci. 301: 110678.
20. Tanaka J, Hayashi T, Iwata H (2016); A practical, rapid generation-advancement system for rice breeding using simplified biotron breeding system. Breed Sci 66: 542-551.
21. Vira B Wildburger C, Mansourian S (2015) International Union of Forestry Research Organizations (Eds.) Forests, Trees and Landscapes for Food Security and Nutrition: A Global Assessment Report; IUFRO World Series; IUFRO: Vienna, Austria.
22. Souza LS, Diniz RP, Neves R, Alves AAC, de Oliveira EJ(2018) Grafting as a strategy to increase flowering of cassava. Sci Hortic 240: 544-551.
23. Pritsa TS, Voyiatzis DG, Voyiatzi CJ, Sotiriou MS (2003) Evaluation of vegetative growth traits and their relation to time to first flowering of olive seedlings. Aust J Agric Res 54(4): 371-376.
24. Rallo P, Jiménez R, Ordovás J, Paz Suárez M, (2008) Possible early selection of short juvenile period olive plants based on seedling traits; Australian journal of agricultural research 59(10): 933-940.
25. Bagnara GL, Maltoni ML, Laghi M, Rivalta L (1993) Relationship between vegetative structure and early bearing in pear seedlings; VI International Symposium on Pear Growing 367: 101-108.
26. Leon L, R De la Rosa D, Barranco and Rallo L (2007) Breeding for early bearing in olive. Hort Science 42: 499-502.

DOI:10.19080/ARR.2022.07.555720

 How to cite this article: Florence Mfon U, Ebenezer Lanre F, Emmanuel I. Juvenile Period in Plants: A Necessary Tool in Plant Breeding. Ann Rev Resear. 2022; 7(4): 555720. DOI:10.19080/ARR.2022.07.555720