EC AGRICULTURE EDITOR'S CHOICE - 2020

Speed Breeding: An Effective Breeding Technique for Rapid Generation Advance in Crop

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Biography

*Prof. Dr. A. K. M. Aminul Islam received both of his bachelor and Master's degree from Bangladesh Agricultural University. After that he joined as Lecturer of Genetics and Plant Breeding at Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh and became Professor in the same department of the university. He is currently serving as Director (Research) of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh. Dr. Islam has obtained his Ph D degree in Chemical and Process Engineering from Universiti Kebangsaan Malaysia. The dissertation title of Dr. Islam was "**Improvement of Biodiesel Production through Genetic Studies of Jatropha (Jatropha curcas L.)**". Dr. Islam is the author of 85 articles published in nationally and internationally reputed journals, 9 book chapters and 3 books. He is a member of editorial board and referee of several national and international journals. He is also serving as the General Secretary of Plant Breeding and Genetics Society of Bangladesh, Seminar and research Secretary of JICA Alumni Association of Bangladesh and member of several professional societies. Prof. Islam acted as Principal Breeder in the releasing system of BU Hybrid Lau 1, BU Lau 1, BU Capsicum 1, BU Lalshak 1, BU Baromashi Seem 1, BU Sheem 1, BU Sheem 2, BU Sheem 3 and BU Sheem 4. Supervising the research of MS and Ph D students' in areas Plant Breeding & Seed Technologies. Conducting research on development of hybrid vegetables, hybrid Brassica napus using CMS system, renewable energy research with Jatropha curcas.*

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Received: February 09, 2020; **Pubished:** February 29, 2020

Crop production around the world is recently being experienced significant losses due to unpredictable climate change. As a result, producing higher amount of quality food for the over growing global population under the changing climate has become a major concern for all the sectors of agriculture. The rate of genetic gain has to be raised further than the levels presently attained in current breeding programs to ensure global food security [1]. Therefore, new and innovative methods are required to hasten the crop breeding program. Conventional breeding have undoubtedly provided many substantial varieties throughout the past century, but now a days, such technique is required that can accelerate the breeding program so that we can get an improved and substantial crop variety within a short time as desire. Beside this, the duration of research also needed to be curtailed. Speed breeding is such a tool or technique for rapid generation advance that significantly reduces the harvest time of crops in order to speed up the agricultural research and increase the production of food to meet the demand of growing population.

Citation: S Sarkar and AKM Aminul Islam. "Speed Breeding: An Effective Breeding Technique for Rapid Generation Advance in Crop". EC Agriculture (2020): 09-11.

Speed breeding is a highly flexible process and can easily be practiced within a low cost growth room. It can be done in some long day to day neutral crops by extending the light exposure duration to plants for reducing the generation times. This breeding practice was first promoted by NASA targeting to raise wheat in space using extended photoperiods or constant light and precise temperature in order to overdrive photosynthesis and hasten plant growth (https://www.thehindubusinessline.com). In case of developing a crop variety through traditional breeding program, it requires about three to seven years for crossing and inbreeding with only one generation per year, around four to five years to test the quality and yield and around one to three years for increasing seed and releasing variety. That means a total of around 10 - 15 years are spent in releasing an elite variety using traditional breeding method. Whereas in speed breeding program, growing up to six generations is possible per year for wheat, barley, chickpea and four generations per year for canola [2]. Speed breeding is also being applied on pea, peanuts, grass pea, amaranth, quinoa, *Brachypodium*, *Medicago* and many more crops. This process has shorten the harvest time two to three times quicker than the conventional breeding. Although it is a low cost program because the program can be run within a minimum place and even operated with low cost LED bulbs for providing extended photoperiod. As it is done inside a glasshouse, a larger breeding population of around 900 plants can be grown per meter square area. Adequate seeds can be achieved from this large population for efficient application of SSD (Single Seed Descent) method for selection. That means a large breeding population can be handled by speed breeding by reducing their maintenance cost for developing inbreed lines.

Beside this, the growth rate of plants are also better in the glasshouse set for speed breeding comparing to normal glasshouse condition. Comparing to conventional breeding, speed breeding has a high aptitude to double the genetic gain of crop [3]. Many novel traits can be introduced within very short time in speed breeding program. Selection can be performed rapidly to generate even up to F_4 generations of BC_1 lines for crop like wheat only within one and half year [4]. It is an efficient tool that hustles up the pre breeding exertions and enables the validation, characterization and deselection of different important traits. Screening methodologies for resistance to disease can also be applied through speed breeding. Another advantage of this tool is saving the gene banks to insert new allelic diversity in crop. In gene cloning, speed breeding can be operated not only to develop the population we needed but also for back crossing to introduce any desired trait to the materials.

Speed breeding can also be utilized to boost up the transgenic approaches of crop improvement. In this case the embryo is rescued from the plant grown through speed breeding system and callus is grown. Plants developed from the callus are transformed for speed breeding and it saves around three months as the plants under speed breeding grow faster than the normal glasshouse due to supplemented photoperiod. Scientists are also applying speed breeding system to speed up the double haploid program. To achieve an inbreeding line through traditional breeding, we needed to cycle several generations and this extensive procedure had to introduce and test multiple traits of interest. World need to feed around nine to ten billion people by 2050, so scientist must search for more effective crop improvement methods that can response quicker to the continuous changes in climate and evolving pathogens. In such condition, speed breeding can easily be used to transfer target genes of multiple traits into a cultivar or accumulate desirable traits into elite breeding materials. This technique speeds up the process of genomic selection reducing the need of field testing that requires in conventional breeding. That's why this breeding method is being practiced across the globe. Many breeding companies are also using speed breeding commercially. Scientists are thinking of combining speed breeding genomic selection with CRISPR technique in future to reverse the alleles in the crossing cycle. Beside this, they are extrapolating boundless possibilities of combining speed breeding with other contemporary crop breeding tools, as well as genome editing, high-throughput genotyping and genomic selection that will hasten the speed of crop improvement. So, speed breeding technique is undoubtedly going to be one of the most significant methods or tools in the modern world of breeding.

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