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# Speed breeding: an advance breeding approach to enhance crop generation

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## Introduction

We are all aware that the world's population is increasing at an alarming rate, on track to exceed 9 billion people by 2050. Global food availability and quality are dwindling as a result of the global warming trend and new plant diseases caused by insects, pests, and microbes. These problems need a long-term solution that minimizes agricultural products' detrimental influence on global food production and food quality while simultaneously minimizing their negative impact on the environment. The future demand for agricultural products will be influenced by grain varieties' capacity to adapt to environmental changes. It is essential to develop new varieties that suit our requirements, either via plant breeding or genetic improvement. As a consequence, plant breeders are increasingly focusing their efforts on creating genetic resistance to diseases as well as tolerance for abiotic stresses such as drought, heat, and cold. However, traditional plant breeding is restricted in its ability to meet these requirements due to the annual breeding cycle and other biological and genetic constraints. The creation of new, better cultivars of the majority of agricultural plants often takes many years. It is very uncommon for 4–6 generations of inbreeding to be required after the crossing of selected parent lines in order to generate genetically stable lines for agronomic features and yield evaluation. This is particularly time intensive for field crops, which usually have just one or two generations each year.

Agricultural speed breeding is a critical technique for rapid generation development because it enables significant reductions in crop harvest times, quicker agricultural research, and increased food supply to meet the needs of an ever-growing population (Sarkar, S. and Aminul Islam AKM, 2020). Speed breeding in controlled environment growth chambers may be used to accelerate plant development for a number of scientific purposes, including phenotyping mature plant traits, mutant research, and plant transformation. A glasshouse environment enhanced with LED lighting allows rapid generation cycling through single seed descent (SSD), with plant density scaled up for large-scale crop development efforts. The speed breeding technique is gaining popularity since it shortens the breeding cycle and accelerates agricultural research by allowing for rapid generation development. Speed breeding may be achieved in a number of methods, one of which is by prolonging the life of plants via daily light exposure and early seed harvest, enabling them to cycle rapidly from seed to seed, thus reducing generation times for certain crops that need long days or are day neutral. It is possible to produce up to six generations per year of spring wheat (Triticum aestivum), durum wheat (*Triticum durum*), barley (*Hordeum vulgare*), chickpea (*Cicer arietinum*), and pea (*Pisum sativum*) using speed breeding, and four generations per year of canola (*Brassica napus*) using speed breeding. Additionally, the technique has been successfully used to oat, several Brassica species, grass pea, quinoa, Medicago truncatula, and Brachypodiumdistachyon, to mention a few crops.

Spring bread wheat (*Triticum aestivum*), durum wheat (*Triticum durum*), barley (*Hordeum vulgare*), and the model grass *Brachypodiumdistachyon*were grown in a controlled environment room with an extended photoperiod (22 hours light/2 hours dark) to evaluate speed breeding as a method for accelerating applied and basic research on cereal species. The light/dark cycle was chosen over a continuous photoperiod to facilitate the functional expression of circadian clock genes. Researchers compared the development of plants in glasshouses with no extra light or heating to that of plants in the outdoors throughout the spring and early summer of 2016. (Norwich, UK). Flowers emerged in the leaves of plants bred in a hurry approximately half as long as flowers appeared in the leaves of plants grown in a glasshouse. With the exception of Chinese Spring, wheat plants reached anthesis in 35–39 days, barley plants in 37–38 days, and *B. distachyon* plants in 26 days, depending on the cultivar or accession utilized. Similarly, when the photos were taken, similar glasshouse plants were in the early stem elongation or three-leaf growth phases, respectively. When comparing the speed breeding chamber to a glasshouse without additional light, wheat seed counts per spike decreased, albeit not always significantly, and both wheat and barley plants produced a sufficient number of spikes per plant despite the rapid growth. Speed breeding had no impact on the viability of harvested seeds, with similar seed germination rates observed across all species studied. Apart from that, crosses between wheat cultivars breed rapidly generate viable seeds, including crosses between wheat cultivars of various tetraploid and hexaploid kinds. Additionally, they were used to significantly reduce the generation time of the model legume *Medicago truncatula* and the rapid-cycling pea (*Pisum sativum*) variety JI 2822, both of which were cultivated under identical conditions (Domoney, C. et al).

**Conclusion**

The latest advances in genetic tools, breeding techniques, and the development of next-generation sequencing (NGS) technologies have created a versatile forum for sequencing, labeling, mapping, and introgression of a gene for the required phenotype at a low cost, but this procedure is time-consuming. Coupled with other methods, including faster breeding speeds, longer generation cycles, and quicker production of cultivars, breeders will significantly shorten the breeding period, progress generations more rapidly, and advance cultivars at a more rapid pace. Speeding up genetic benefit may be achieved by utilizing scientific advances in breeding methods and their integration with each other. Speed breeding can increase the rate of backcrossing and pyramiding of traits, as well as transgenic pipelines. Speed breeding happens in an enclosed chamber of artificially provided LED light (such as halogen lamps) that is provided with PAR of 400-700 nm and photoperiod of 22 hours, with 2 hours of darkness per day in a day with the majority of the time spent under diurnal light and at room temperature. Whereas relative humidity should be 60-70%. Because rapid breeding reduces the period to maturity, it can cut down on crop generations, including tomatoes, potatoes, and Amaranthus (which can be grown to maturity in eight generations rather than two in the field) (early flowering and fruiting under continuous light).

**References**

Domoney, C. et al. Exploiting a fast neutron mutant genetic resource in *Pisum sativum* (pea) for functional genomics. *Funct. Plant Biol.* 40,1261–1270 (2013).

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