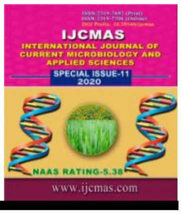
Int.J.Curr.Microbiol.App.Sci (2020) Special Issue-11: 2416-2422

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-11 pp. 2416-2422**
Journal homepage: http://www.ijcmas.com



Review Article

Breeding for Bread Reliability

Kondru Swetha, A. H. Madakemohekar*, M. Shanmukha Reddy, Pragada Venkata Yaswanth and Yalagandhula Abhilash

Department of Genetics and Plant Breeding, School of Agriculture, Lovely professional University, Phagwara- 144411(Punjab), India
**Corresponding author*

ABSTRACT

As predicted, the human population may reach upto 9 billion by the year 2050 and the mean annual income of people along with meeting their food and nourishment demands will pose a serious challenge to this evolving world. Also, natural calamities, urban sprawling for a better lifestyle intensifies the problem of food security. Starvation free world is conceivable however just if food creation is reasonably expanded and appropriated and extraordinary neediness is disposed of. All around the world, the destitutes and undernourished individuals live in country territories of creating nations, where they rely upon farming as a wellspring of food, salary, and business. Before, crop improvement through rearing has been the significant device to lift individuals out of neediness and increment worldwide food gracefully. To sufficiently address these food security challenges, new improved varieties should be created and arrive at ranchers sooner as a fractional arrangement. Recent breeding technologies have adopted an alternative strategy, which has guaranteed that worldwide food creation could stay up with caloric requirement like biofortification of crops. Genomic procedures can quicken our reaction to food security difficulties of crops, quality and strength and furthermore address ecological security challenges. Plant breeding in the course of recent years has conveyed high-yielding crops that have continued human populace development. The improvement of cutting edge crop assortments utilizing a set-up of current breeding advancements will satisfy the needs of populace development in a long time to come.

Keywords

Starvation, Food security, Destitute, Biofortification, Plant breeding

Introduction

The growing human population not only need more quantity of food but is also in severe need of the quality of food. Also, due to tremendous utilization of nitrogenous fertilizers the environment is being degraded. Furthermore, it is quite challenging to enhance the crop yield in spite of the climatic change globally and increasing biotic and abiotic stresses (OECD, 2009).

Crop enhancement through traditional breeding practices has been a progressing mission for quality and profitability upgrades. In its least difficult structure, crop improvement by reproducing has been cultivated by choice of previous, common wild structures, for example, those yielding more, giving better flavor or all the more effectively reaped. Numerous ages of choice among wild structures went into the creation of essentially every "conventional" crop. Numerous traditional crops are far taken out from their ancestor species in aggregate, and some are almost unequipped for autonomous propagation considering maize as an example (Ray, 2017).

Plant breeders concur that advancement of the developed genetic stock will be important to address the difficulties that lie ahead. Notwithstanding, to completely exploit the broad supply of good alleles inside wild germplasm, numerous advances are as yet required. These incorporate expanding our comprehension of the molecular basis for key qualities, growing the phenotyping and genotyping of germplasm assortments, improving our molecular comprehension of recombination so as to upgrade paces of introgression of alien chromosome districts, and growing new breeding methodologies that grant introgression of various characteristics (Feuillet, 2008).

Genetically modified crops

Genetically modified (GM) crops are now being cultivated for about more than two decades successfully holding the record of most acclimatized technology in this era of agriculture. By the adoption of this technology majority of the farmers in developing countries are getting benefitted by reducing the chemicals in the field by 37%, yield increasing upto 22% and revenue by 68% (Kouser, 2013).

The most widely accepted GM crops which are cultivated throughout the world are soybean, cotton, maize and canola. Apart from these crops there are several other crops also which are being cultivated with less eminence like brinjal, potato, papaya, rice, sunflower, sugarcane, tomato, and sugar beet. (Ray, 2017). This genetically modifying technology has the capability to increase the yield and more tolerant to biotic and abiotic stresses. (Fedoroff NV, 2010) (C, 2012). An outstanding and successful example of Golden Rice incorporated with provitamin A in the grain stands as an example to breed food crops with higher nutrient content. (Paine, 2005).

Genetically modified crops have made huge commitments to address the United Nations Sustainable Development Goals, specifically goals 1 (reducing poverty) and 2 (reducing hunger). Cultivating the genetically modified crops has reduced the poverty in the households therefore increasing the food security. There is even much better option to enhance the micro nutrient content in our diet by adopting the biofortified crops (Hefferon, 2014). In numerous occurrences, enhancing macronutrient values like proteins, sugars, lipids, fibres and micronutrients like nutrients, minerals, practical metabolites has great childhood wellbeing upgrades, for example, diminishing visual deficiency because of the absence of nutrient accessibility. Upgrading intake add-ons content, particularly the increase in mineral accessibility, adds to improved resistance frameworks and decreases hindering. In many creating nations, plant- based supplement consumption represents 100% of a person's supplement diet, further featuring the significance of healthfully improved crop- derived nourishments (Smyth, 2019).

Speed breeding

The editing of genes is the quickest ever method of breeding which can be applicable to all kinds of races including the wild and neglected species with an added advantage of phenomenal change in the environment. Environmental changes not only results in the weather extremities but also come up with the new races of pests and diseases, so there is an immediate need to acclimatize the crops and agricultural production in this scenario making sure of future bread reliability (Bailey- Serres, 2019; Hickey, 2019). A healthy competition could be created by the adoption of this speed breeding because it is costs less and much easy to use which makes even small laboratories and companies to make use of it (Qaim, 2020).

The whole cycle of breeding can be maximized and the total reproduction cycles can be minimized to a very great extent by speed breeding. Recently this method is being used to attain nearly six reproduction cycles each year for spring wheat (*Triticum aestivum*), durum wheat (*T. durum*), barley (*Hordeum vulgare*), chickpea (*Cicer arietinum*) and pea (*Pisum sativum*) and four reproduction cycles for canola (*Brassica napus*), instead of 2–3 under regular greenhouse environment (Ghosh S, 2018) (Watson A, 2018). Research on plants and their development can be enhanced by the process of speed breeding in completely closed and having benchmark environment in growth chambers. The phenotyping of traits, study of mutants and their transformation can be studied with the aid of speed breeding. The optimum usage of light in a greenhouse enables quick generation cycle by single seed descent(SSD) enabling the potential to expand crop improvement programmes on a larger scale. Additional lighting can be supplied through light emitting diodes (LED) which save handful of money to the growers or researchers. Speed breeding strategies can be reached out to different crops related to other current crop breeding advances, including high-throughput genotyping, genome altering and genomic choice to quicken the pace of yield improvement. Speed breeding conventions could be applied to abbreviate breeding cycles and quicken research work additionally in orphan crops (Chiurugwi, 2019).

Speed breeding now had showed to minimize reproduction cycles by increasing photoperiods while certain crop species, such as radish (*Raphanus sativus*), pepper (*Capsicum annum*), and leafy vegetables such as Amaranth (*Amaranthus* spp.) and sunflower (*Helianthus annuus*) answered favourably to the extended day lengths (Stetter *et al.*, 2016) (Ghosh *et al.*, 2018) (Chiurugwi, 2019; Sysoeva *et al.*, 2010). To start the reproductive phase, crops rice (*Oryza sativa*) and maize (*Zea mays*) require short day lengths while this procedure can speed up the breeding process for growth of vegetative stage (Collard *et al.*, 2017). Utilizing speed breeding, it is conceivable to create progressive ages of improved crops for field assessment through SSD, which is less expensive contrasted with the creation of DHs. Speed breeding is likewise ideal for insertion of genes (basic haplotypes) of particular phenotypes followed by MAS of elite hybrid lines. (Hickey, 2019; Wolter *et al.*, 2019).

CRISPR

In the course of recent years, through advances in the field of bacterial and plant research, novel strategies have risen which currently permit sequence specific transformations to be made productively and with high exactness via CRISPR/Cas9 innovation (Bortesi, 2015; Puchta, 2014). Several past techniques for sequence specific mutations, for example, zinc finger nucleases and the transcription activator-like effector nuclease framework (TALENS) and the utilization of oligonucleotides (Abdallah, 2015) seem to have been cleared aside for this method (CRISPR/Cas9), which vows to be less complex, more adaptable and more precise. Research in genomics and genome altering has changed the field of precision breeding. The accessibility of high-throughput sequencing procedures and computational investigation has included significant data in genomic information. This data dependent on genomic information can be misused to recognize attractive qualities/characteristics that can be fused in wild family members of the crops. Joining this with the genome altering innovations, for example, CRISPR and the related Cas9 nuclease (CRISPR-Cas9), it is currently conceivable to alter the plant genome with outrageous exactness and precision. CRISPR-Cas9 permits the editing of DNA from various perspectives; for instance, by essentially adding random mutation(addition or deletion) through nonhomologous end joining to derange genes, by creating focus on point mutations in genes utilizing exact base editors, and by entire gene inclusion employing the cell's homology-coordinated repair pathway. Multiple characters can be inserted at once by editing various loci utilizing the multiplex approaches (Cermak, 2017). The potential of CRISPR-Cas9 shows that crops like rice, maize and wheat characters can be improved in terms of yield and harvest quality (Zhang, 2017).

A significant benefit of CRISPR mediated plant rearing is the accessibility of conventions to deliver conceivably 'without transgene' varieties. This gives scientists a chance to make hereditarily changed GM crops indistinguishable from ordinarily reproduced crop varieties. Despite the fact that the acknowledgment of CRISPR crops is disputable, and (quickly changing) GMO guidelines fluctuate from nation to nation, these crops actually hold incredible potential for fast variety advancement and prompt effect on farmers' lives. (Muhammad Zuhaib Khan, 2019).

CRISPR innovation can quicken crop adaptation. Domesticating plants is a period and work intensive cycle including adjusting a plant from its wild state to another structure that can suffice a man needs and deeds. A huge number of years prior, old ranchers started the training of every single significant crops like rice, wheat and maize. Nonetheless, our predecessors utilized just a predetermined number of progenitor species in transition in the domestication cycle, and essentially chose plants with improved attributes, for example, high return and simplicity of reproducing, culture, gather and capacity, bringing about the loss of genetic diversity and diminished health benefit and taste of our present food crops. Expanding present crop variety is one of the most impressive methodologies for advancing sustainable agriculture system, and the domestication of ignored, semi-trained or wild yields would increment such variety (Yi Zhang, 2020).

Sustainable agriculture can be achieved by growing perennial crops having deep root systems that can get acclimatized to weather change and storage of carbon. Although, even after several trials converting wheat into a perennial crop by the process of hybridization has showed negative results (Cui, 2018). While looking for a substitute, researches have found converting a wild grass *Thinopyrum intermedium* would be a better solution to create perennial wheat (DeHaan, 2018). This procedure can be quickened by utilizing CRISPR innovation to straightforwardly target genes that are homologous to genes of domesticated wheat, which are now all around portrayed (Venske, 2019).

Biofortification

Globally, it is considered that greater than one billion people starve daily and around three billion people in the world are suffering from micronutrient deficiencies (FAO, 2009). The deaths due to deficiency of iron, zinc, vitamin-A are prominent in South Asia and

Sub-Saharan Africa noting down the number to 1.5 million deaths (Caulfield L, 2005). The lack of healthy sustenance issue is additionally misrepresented by the expanding total populace which is probably going to arrive at 8 billion by 2030, and a large portion of this expansion will happen in the developing world. Consequently, human nourishment body, for example, the World Health Organization (WHO) and the Consultative Group on International Agricultural Research (CGIAR) have made battling this concealed starvation (micronutrient deficiency) one of their difficulties (WHO, 1992; Bouis, 2000).

Biofortification is presently one of the most savvy procedures to address worldwide hunger (Go´mez-Galera S, 2010). This system for providing micronutrients to the poor in creating nations includes causing the staple nourishments they to eat more nutritious by utilizing conventional plant breeding and biotechnology.

Plants regularly show hereditary variation in basic micronutrient content, which permits the plant breeding projects to improve the degrees of minerals and nutrients in crops (KD, 2009). Conventional breeding is the principle procedure sought after by the Harvest Plus program, focusing on the staple yields, wheat, rice, maize, cassava, pearl millet, beans, and yam in Asia and Africa (Zhao, 2011).

Biofortification spotlights on upgrading the micronutrient substance of consumable piece of staple crops just as their bioavailability. Rearing systems depend on the restricted hereditary variation present in the germplasm that can be sourced from explicitly viable plants (KD, 2009). In situations where breeding methodologies can't accomplish critical improvement in micronutrient focus, transgenic strategies offer a valuable other option (Zhao, 2011). Genetic engineering has no toxic imperatives and even manufactured or artificial genes can be utilized. The fundamental added favor of these methodologies is that speculation is just required at the innovative work stage, and from there on the biofortified crops are altogether sustainable (Gurdev S. Khush, 2012).

Biofortification is likewise liable to be more valuable than different intercessions in the long haul since it eliminates obstacles, for example, the dependence on framework and consistence (Go´mez-Galera, 2010). Additionally, plants acclimatize minerals into natural structures that are normally bioavailable and add to the common taste and texture of the food (Gurdev S. Khush, 2012).

Scientists must concentrate on characters with immense interest to enhance the yield. New strategies can be improvised to fasten the breeding process by focusing on improvement of genotyping and phenotyping ways including the diversity of genes in the germplasm breeding. Most of the developing countries will be gained by adopting these technologies which are economically affordable and easily utilized.

Food security can be increased by improvement of crops through breeding which can satisfy the hunger needs of the people globally (Mark Tester, 2010). Considering plant breeding as one of the technique that can improve food production can fix the problem of food security prevailing in many countries.

Foreknowledge data on business sectors, climate and atmosphere, breeding research and especially effective dissemination systems are required also since low degrees of reception seriously limit improved varieties' capability to improve food security**.**

References

Abdallah NA, P. C. (2015). Genome editing for crop improvement: Challenges and opportunities. *GM Crops & Food*, 183-205.

Bailey- Serres, J. J. (2019). Genetic Strategies for Improving Crop Yields. *Nature*, 109-188.

Bortesi L, F. R. (2015). The CRISPR/Cas9 system for plant genome editing and beyond.. *Biotechnol Adv*, 41-52.

Bouis HE, R. G. (2000). The CGIAR micronutrient project: justification, history, objectives and summary of findings. In: Workshop on improving human nutrition through agriculture. *The role of International Agricultural Research Centres.*, 3374-381.

Global Status of Commercialized Biotech/GM Crops. *International Service for the Acquisition of Agri-biotech Applications, Ithaca, NY*. (2012).

Feuillet, P. L. (2008). *Trends Genet*.

Caulfield L, R. S. (2005). Stunting,wasting, and micronutrient deficiency disorders. In: Disease control priorities in developing countries,. *World Bank University Oxford Press*, 551-57.

Cermak, T. E. (2017). A multipurpose toolkit to enable advanced enome engineering in plants. *Plant Cell*, 1196-1217.

Chiurugwi T, K. S. (2019). Speed breeding orphan crops. *Theor Appl Genet*, 607-616.

Collard, B., Beredo, J., Lenaerts, B., Mendoza, R., Santelices, R., Lopena, V. *et al.*, (2017). Revisiting rice breeding methods–evaluating the use of rapid generation advance (RGA) for routine rice breeding. *Plant Prod. Sci.*, 337-32.

Cui, L. e. (2018). Development of perennial wheat through hybridization between wheat and wheatgrasses: a review. *Engineering*, 507-513.

DeHaan, L. C. (2018). Development and evolution. *Sustainabilit*.

CRISPR rops: plant genome editing towards disease resistance. 2018. *Annual. Rev. Phytopathol.*, Pp. 479-512.

FAO. (2009). The state of food insecurity in the world. *Food and*.

Fedoroff NV, B. D. (2010). Radically rethinking agriculture for the 21st century. *Science, 327*(597), 833-834.

Ghosh S, W. A. (2018). Speed breeding in growth chambers and glasshouses for crop breeding and model plant research. *Nat Protoc*.

Ghosh, S., Watson, A., Gonzalez-Navarro, O., Ramirez-Gonzalez, R., Yanes, L., Mendoza-Suárez, M. *et al.* (2018). Speed breeding in growth chambers and glasshouses for crop breeding and model plant research. *Nat. Protoc*, 2944-293.

Go´mez-Galera S, R. E. (2010). Critical evaluation of strategies for mineral fortification of staple food crops. *Transgenic Res*, Pp. 165-180.

Gurdev S. Khush, S. L.-I.-S. (2012). Biofortification of crops for reducing malnutrition. *Plant Biotechnol Rep*, 195-202.

Hefferon, K. (2014). Nutritionally enhanced food crops; progress and perspectives. *Int. J. Mol. Sci.*, 3895-3914.

Hickey, L. A.- B. (2019). Breeding Crops to Feed 10 Billion. *Nature Biotechnology*, Pp. 744-754.

Hickey, L., Germa, S., Diaz, J., Ziems, L., Fowler, R., Platz, G., Dieters, M. (2017). Speed breeding for multiple disease resistance in barley.

KD, H. (2009). Nutrient biofortification of food crops. *Annual Rev. Nutr*, 401-421.

Kouser, S. a. (2013). Valuing financial, health, and environmental benefits of Bt cotton in Pakistan. *Agric.Econ*, 21052113.

Mark Tester, P. L. (2010). Breeding Technologies to Increase Crop Production in a Changing World. *Science*, Pp. 818-822.

Muhammad Zuhaib Khan, S. S.-e.-A. (2019). A CRISPR Way for Fast Forward crop domestication. *Trends in Plant Science*, Pp. 293-29.

OECD. (2009). Organisation for Economic Cooperation and Development. *OECD-FAO Agricultural Outlook*.

Paine JA, S. C. (2005). Improving the nutritional value of Golden Rice through increased pro-vitamin A content. *Nature Biotechnology*, Pp. 482-487.

Puchta H, F. F. (2014). Synthetic nucleases for genome engineering in plants: prospects for a bright future. *The Plant Journal*, Pp. 727-741.

Qaim, M. (2020). Role of New Plant Breeding Technologies for Food Security and Sustainable Agricultural Development. *Applied Economic Perspectives and Policy published by Wiley Periodicals*, Pp. 129-150.

Ray, F. G. (2017). Genome ediing of crops: A renewed oppurtunity for food security. *Biotechnology in Agriculture and the Food Chain*, *8*(1), 1-12. Retrieved from https://www.tandfonline.com/doi/full/10.1080/21645698.2016.1270489.

Stetter, M., Zeitler, L., Steinhaus, A., Kroener, K., Biljecki, M., and Schmid, K. (2016). Crossing Methods and Cultivation Conditions for Rapid Production of Segregating Populations in Three Grain Amaranth Species. *Front. Plant Sci*, Pp. 816.

Sysoeva, M., Markovskaya, E., & Shibaeva, T. (2010). Plants under continuous light: A review. *Plant Stress*, Pp. 5-17.

Venske, E. e. (2019). Bread wheat: a role model for plant domestication and. *Hereditas*.

Watson A, G. S. (2018). Speed breeding is a powerful tool to accelerate crop research and breeding. *Nat Plants*, Pp. 23-29.

WHO. (1992). National strategies for overcoming micronutrient malnutrition. *World Health Organization*.

Wolter, F., Schindele, P., and Puchta, H. (2019). Plant breeding at the speed of light: The power of CRISPR/Cas to generate directed genetic diversity at multiple sites. *BMC Plant Biol*, Pp. 1-8.

Yi Zhang, M. P. (2020). A CRISPR way for accelerating improvement of food crops. *nature food*, Pp. 200-205.

Zhang, H. (2017). Genome editing-principles and applications for functional genomics researh and crop improvement. *Critical reviews in Plant science*, Pp. 291-309.

Zhao FJ, S. P. (2011). Recent developments in modifying crops and agronomic practice to improve human health. *Food Policy*, Pp. 94-101.