The Pharma Innovation Journal 2022; 11(5): 1138-1139

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(5): 1138-1139

www.thepharmajournal.com
Received: 08-03-2022
Accepted: 23-04-2022

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Challenges in plant breeding: A review

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Abstract
Plant breeders must improve the yield levels of crop plants at least by double than what is being produced now in order to achieve zero hunger by 2030 as per Sustainable Development goals. This is not easy as we have only few years left with to achieve the goal. Further the improved plant varieties should face the various Biotic and Abiotic stress factors that are increasing with the current climate changes. In this review we shall discuss the situation of hunger in the world, remaining available land to increase food production and the effects of Biotic and Abiotic factors on the food production.

Keywords: Biotic factors, Abiotic factors, Sustainable development

Introduction

Recently, plant breeders have been warned that agricultural production needs to increase significantly to meet the growing global demand for crops from an increasing population [1]. This will require increased crop production to improve food security and reduce the risk of future hunger. However, the decline in available arable land, current climate change, and the environmental conditions under which crops are grown make increasing agricultural production even more difficult. To date, about 70% of the world's land area has been used [2].
The projections of Tillman *et al.* [3] pointed out an increase of crop demand between 100 and 110% until 2050 considering the per capita consumption, and according to the projections of Ray, et al. [4] the annual increase in food production shows that it will be insufficient to attend the food demand in 2025 and in 2050 (Table 1). Therefore, extra available land will be necessary that yet doesn't exist, to cultivate the major crops and feed the world. All this is happening because the population in the world is increasing faster than crop production/area is achieved in the same time.

Table 1: Mean of food production (ton/ha/year) according to Ray, *et al.* [4].

Crop production	Yeld in 2008	Increase per year	Yeld in 2025	Required extra land	Yeld in 2050	Required extra land
Maize	5,2 tons/ha/year	84 kg/ha/year	6,5 tons/ha/year	15 millions ha	8,6 tons/ha/year	29 millions ha
Rice	4,4 tons/ha/year	40kg/ha/year	4,9 tons/ha/year	33 millions ha	5,9 tons/ha/year	67 millions ha
Wheat	3,1 tons/ha/year	27kg/ha/year	3,4 tons/ha/year	46 millions ha	4,1 tons/ha/year	95 millions ha
Soybean	2,4 tons/ha/year	31kg/h/year	3,0 tons/ha/year	14 millions ha	3,8 tons/ha/year	28 millions ha

Impact of abiotic and biological stress on food production

Extreme temperatures, droughts and salt are the main abiotic factors that reduce crop productivity [5]. Changes in environmental and climatic conditions are expected to promote the emergence of new pests and diseases that reduce plant resistance. Another problem recently discovered by De Storme and Geellen [6] is that high temperatures can induce meiotic restitution of the chromosome set during the male gamete formation. The result of this reported problem is an increase in polyploid plants, and as a result, these individuals exhibit reduced fertility. This is another important issue for the future that has not been considered before.
Meanwhile, according to Lucas [7], the losses caused by weeds, pests, pathogens and viruses worldwide between 2001 and 2003 were about 26.3% for soybeans, 28% for wheat, 28.8% for cotton and 31.2% for corn. In rice it is 37.4% and 40.3% in potatoes. These values are noteworthy considering that about one-third of all crop production is lost. This continued loss of crop production due to pests and diseases is one of the major obstacles to achieving global food security.

Fortunately, significant advances have been made in the knowledge of genetic regulation of the development of biological diseases and the strategies that can be used to control it.

Nowadays, several R genes are identified, cloned, modified and transferred to different crop species by using conventional breeding techniques, molecular Marker Assisted Selection and biotechnological tools, like OMICS in order to fight against pest and diseases and achieve durable resistance or tolerance by combining them with quantitative genes [8]. Therefore, in smart agriculture, the use of traditional crop breeding techniques is considered insufficient to increase food production and provide an increasing population through a sustainable environment. Therefore, tools of tissue culture techniques such as micro propagation, gametic embryogenesis, somatic embryogenesis, cell suspension and protoplast fusion enable rapid and large-scale cloning of high quality plants and are pure lines to produce abiotic resistant plants [9]. Not all abiotic factors can be reversed by plant breeding techniques. Some abiotic factors can be reduced by applying state-of-the-art cultivation techniques such as environmental management practices and binding microorganisms to plants to promote biocontrol resistance against pathogens [10].

Among the 17 goals of the Agenda for Sustainable Development adopted by the UN States members, the aim of the goal 2 is to achieve zero hunger, finish all malnutrition and double the crop productivity until 2030 [11]. To achieve this goal in the few years that remain to increase crop productivity, plant breeders need to deal with producing improved genotypes for enhancing food production and also producing resistant genotypes for the current and foreseen biotic and abiotic factors that the climate change will bring in.

So what can we do to achieve Sustainable Development Goal 2?

One of the biggest challenges to plant breeders is to achieve novel solutions to increase food production in the current climate change. So to reach the goal 2, plant breeders need to reduce the impact of climate change on crop production by developing improved varieties tolerant to biotic and abiotic factors, like drought and high temperature which will exert strong effect over the developmental time of plant life-cycle and affect the plant- pathogen interactions [12].

Introgression can also be done by mating wild relatives with elite plants and using repetitive selection to increase the elite genome of resistant plants. If the resistance gene is found in the cytoplasm of a wild species, it should be used as a mother plant in mating and repeat selection to obtain the resistance gene. This process can be accelerated by using assistive selection with molecular markers. On the other hand, the resistance gene can be transferred to a genetically desired crop.

Conclusion

So, now the onus lies on the plant breeders to mitigate the Biotic and Abiotic stress factors by contemplating various combinations of breeding and biotechnological tools. Already a lot of advancement has been achieved by the plant breeders and hope they will accomplish their targets in the comimg years and achieve Sustainable Development goal 2 of eliminating hunger and malnutrition.

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