Mini Review
Volume 10:9, 2022

Journal of Biodiversity & Endangered Species

ISSN: 2332-2543 Open Access

Plant Breeding is Challenged by Climate Change

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Abstract

In order to mitigate the effects of climate change and secure global food production, plant breeding is crucial in addition to crop management and policy changes. The goals, effectiveness, and genetic gains of the existing plant breeding system, however, are also impacted by changes in environmental conditions. In this study, we discuss the difficulties associated with breeding climate-resilient crops as well as the limitations of the next-generation breeding strategy. Crops that are prepared for climate change should be available sooner thanks to the integration of multiple disciplines and technology into the three schemes of genotyping, phenotyping and envirotyping.

Keywords: Plant breeding • Crop life cycles • Climate change

Introduction

The practise of genetically modifying plants for human benefit is known as plant breeding. It has a long history and is used by farmers and professional plant breeders all over the world. Plant breeding is a crucial component of the answer to the rapid climate change that has increased the frequency and severity of environmental challenges in recent decades. Through a variety of methods, including straightforward selection of plants in farmer's fields with desirable features for propagation and more sophisticated classical or molecular procedures, plant breeding can create varieties that adapt to climate change [1].

Description

The poorest farmers and the poorest nations are most at risk as a result of the current climatic changes, which are already having a negative impact on food production and quality. Due to the anticipated or likely increased frequency of various abiotic stresses, such as heat and drought, as well as the increased frequency of biotic stresses, a negative effect has resulted (pests and diseases). Additionally, it is anticipated that climate change would result in biodiversity losses, primarily in more marginal environments. Abiotic and biotic stressors have both been handled through plant breeding. Increased access to a variety of varieties with different durations to escape or avoid predictable occurrences of stress at critical points in crop life cycles, improved water use efficiency, and a reemphasis on population breeding in the form of evolutionary participatory plant breeding to provide a buffer against irradiation are some examples of strategies of adaptation to climate changes. Recently, evolutionary participatory programmes for barley and durum wheat were launched by ICARDA in partnership with scientists in Iran, Algeria, Jordan, Eritrea, and Morocco [2].

We consume only kinds of wheat, rice, corn, and potatoes that have been developed by plant breeders and farmed by farmers all over the world. Genetics was discovered, and plant breeding became a more dependable method of enhancing variations. Modern biotechnology, a method utilised in plant breeding, has made the process of creating new adapted varieties more precise and quick. With continued investment, plant breeding will contribute significantly more to feeding the globe and combating climate change because the science behind it is growing quickly. The poorest farmers and the poorest nations are most at risk as a result of the current climatic changes, which are already having a negative impact on food production and quality. Due to the anticipated or likely increased frequency of various abiotic stresses, such as heat and drought, as well as the increased frequency of biotic stresses, a negative effect has resulted (pests and diseases). Additionally, it is anticipated that climate change would result in biodiversity losses, primarily in more marginal environments [3].

Abiotic and biotic stressors have both been handled through plant breeding. Increased access to a variety of varieties with different durations to escape or avoid predictable occurrences of stress at critical points in crop life cycles, improved water use efficiency, and a reemphasis on population breeding in the form of evolutionary participatory plant breeding to provide a buffer against irradiation are some examples of strategies of adaptation to climate changes. Recently, evolutionary participatory programmes for barley and durum wheat were launched by ICARDA in partnership with scientists in Iran, Algeria, Jordan, Eritrea, and Morocco. In most geographical areas, it is quite likely that over the past 50 years, hot days and hot nights have increased in frequency while cold days, cold nights, and frosts have decreased. Over the majority of land areas, heat waves have grown in frequency, heavy precipitation events have increased in frequency over most regions, and since 1975, the occurrence of extremely high sea levels has increased globally. Additionally, since around 1970, there has been a rise in the number of powerful tropical cyclones in the North Atlantic, with less of an increase elsewhere. The yearly frequency of tropical cyclones shows no discernible trend; however there is evidence of rising severity [4].

Climate changes in history

Despite being one of the most pressing issues facing the world today, climate change is nothing new. Previous climate changes have had significant repercussions. One of these is the drop in CO2 concentration, which occurred 350 million years ago and is thought to be the cause of the appearance of leaves. The earliest plants were leafless, and it took between 40 and 50 million years for leaves to form. The second climate change was brought on by what is arguably the largest volcanic eruption in Earth's history, which occurred in Siberia near the end of the Permian period (approximately 250 million years ago). Up to 4 million km3 of lava burst onto the planet's surface. Currently, 5 million km2 is covered by the eruption's ruins. The ozone layer was depleted globally as a result of this huge eruption, either directly or indirectly through the production of organ halogens. The peak eruption phase's synchronisation with the mass extinction that wiped out 95% of all life is explained by the ensuing burst of UV light [5].

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Date of Submission: 02 September, 2022, Manuscript No. jbes-22-79389; **Editor Assigned:** 04 September, 2022, PreQC No. P-79389; **Reviewed:** 15 September, 2022, QC No. Q-79389; **Revised:** 20 September, 2022, Manuscript No. R-22-79389; **Published:** 26 September, 2022, DOI: 10.37421/2332-2543.2022.10.445

The end of the last ice age (between 15,000 and 13,500 years ago), which had the primary effect of making much of the globe prone to lengthy dry seasons, was the third major climate change. As a result, conditions were favourable for annual plants, which may endure dry spells as dormant seeds or tubers. The Fertile Crescent saw the beginning of agriculture as we know it today roughly 11,000 years ago, and other regions soon followed. The fourth climate shift is the so-called Holocene flooding, which is thought to have occurred around 9000 years ago and was responsible for a worldwide sea level rise of up to 1/4 m. Mass migration to the North West was caused by the land lost to rising sea levels, which may also account for how domesticated plants and animals, which by this time had already reached modern Greece, began to migrate across the Balkans and subsequently into Europe. According to estimates made with the help of formal economic models (Stern Reference Stern2005), the overall costs and hazards of climate change will amount to a 5% annual decline in the world's gross domestic product (GDP) in the absence of adequate counteraction. The estimates of damage could reach a 20% reduction in GDP or more if a wider range of hazards and effects are considered, with a disproportionate burden on and an increased danger of hunger in the world's poorest nations.

Conclusion

Approximately 370 million of the world's poorest people reside in rural areas that are resource-poor, extremely diverse, and risk-prone. The most extreme poverty is frequently found in dry or semi-arid regions, as well as in ecologically fragile highlands and hills More people are being compelled to live in marginal locations (such as floodplains, exposed hillsides, arid or semi-arid lands) in many nations, placing them at risk from the detrimental effects of climate variability and change. This is especially true for persons with lower income levels. In the absence of better use of early warning systems and development programmes, food insecurity will likely worsen due to climate change. Currently, what they generate feeds millions of needy people. There may be more hunger if population growth and climate change decrease output, over semi-arid regions, rising temperatures and decreasing precipitation are anticipated to result in lower yields of maize, wheat, rice, and other primary crops over the course of the next two decades. The security of the world's food supply may be significantly harmed by these changes.

Acknowledgement

None.

Conflict of Interest

None.

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How to cite this article: Williamson, Hugh F. “Plant Breeding is Challenged by Climate Change.” J Biodivers Endanger Species 10 (2022): 445.