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The Effects of Climate Change on Plant Breeding

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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, and phenotyping.

Keywords: Population, Weather, Plant selection, Crop

INTRODUCTION

Global population growth, pandemics, and local conflicts all call for increased and reliable crop production. In order to feed the globe, breeding is a constant concern. With an estimated annual increase in crop productivity, modern plant breeding and agronomic advancement have contributed to massive and quick increases in yield in many crops. To achieve the target of doubling global production in 2050, current production gains must be increased in a world with declining arable land and rising ecosystem preservation. The threat to the world food system is exacerbated by climate change. Climate change has already had an impact on agricultural output. Stronger temperature-moisture coupling amplified the effects of climate warming in semi-arid places and intensified and increased the frequency of extreme events compromising production stability. Increasing temperature and its volatility decreased worldwide agricultural yields. Unpredictable pest and disease patterns linked to the changing environment pose a severe threat to food productivity. Additionally, other environmental aspects including soil ecology will be impacted by the temperature change. For instance, the adverse effects of climate change on soil processes and properties, as well as changes to nutrients and their bioavailability in soils, have the potential to endanger food security.

Increased yields in numerous crops and increased tolerance to a variety of biotic and abiotic stress are both results of traditional plant breeding techniques. Plant breeders are unable to quickly respond to the rising demand for food production due to the lengthier time involved in variety development and breeding cycles. Increasing crop production by hastening the breeding of climate-resilient crops is the challenge that the majority of plant breeding systems face in the twenty-first century. Plant breeders still encounter difficulties as a result of limited genetic diversity and unreliable climatic conditions worldwide, despite advances in our understanding of gene function and the creation of technologies like gene editing. New breeding technology has been used to explore how climate change would affect agriculture. The effects that climate change has already had on breeding are one factor that has mostly gone unnoticed. The effects that climate change has on the breeding process are outlined in this review. We also make some recommendations for potential approaches to these problems that take into account environmental data and a variety of trans-disciplinary techniques.

MATERIALS AND METHOD

A faster breeding cycle is necessary due to climate change: Commercial variety development is an ongoing and protracted process that involves repeatedly crossing germplasm and then choosing individuals with desirable traits. Four steps typically make up a self-pollinated crop breeding cycle: selecting parental lines, crossing them to obtain the necessary genetic diversity from the germplasm pool to create F1 progeny, top-crossing or back-crossing F1 progeny to expand access to new genetic diversity, or both.

Climate change drives the changes in breeding objectives

Breeding always has a variety of goals, and as a result of climate change, breeding goals are changing more regularly. For instance, breeding for resilience is now of the utmost importance due to climate change. But because the effects of climate change are unpredictable, growing crops that are ready for them is still challenging. Based on the most probable or anticipated worst-case weather scenarios in any given cropping system, we can forecast the types of adaptive responses that plants will require.

Effectiveness of selection and genetic gains are impacted by climate change

New molecular technologies have made breeding more efficient, yet the fundamental idea behind breeding has not altered. Plant breeding is still a difficult, expensive, and time-consuming process. This reflects the reality that breeders must test a variety of candidates over a number of years and locations in order to choose the best genotypes with a wide range of climatic resilience. This is because crop breeding significantly depends on grain yield expression and a few key agronomically significant.

Existing breeding practises do not sufficiently handle climate change

Because breeding trials are typically undertaken in many areas with constantly changing climates, plant breeders frequently believe breeding has already encountered and can endure the hazards of climate change despite the significant influence of this phenomenon. This reflects the fact that many breeding programmes, particularly in developing nations, lack comprehensive and reliable weather measures in their trials. In addition to weather, other factors can influence gene expression.

CONCLUSION

Developing crops that are climate change-ready is challenging and difficult, even if climate resilience has become the focal point of breeding initiatives. These difficulties result from the conflict between the urgent breeding needs brought on by climate change and our incomplete understanding of GEIs. The environmental factor, which includes information shortages and knowledge gaps regarding affecting mechanisms, appears to be the bottleneck to accelerated climate adaptation breeding.