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Speed Breeding

New technologies on multiple scales are re-engineering to increase the number of crop cycles to achieve multiple generations of crops per year. The integration of speed breeding to existing crop breeding methods will expedite the research studies through rapid generation of crops. The time period for the crop varieties development could be reduced significantly. Also, it accelerates the progress of plant research in the activities *viz.*, crossing, development of mapping population and adult plant phenotyping. Furthermore, this technique accelerate the introgression breeding for the pyramiding of traits.

INTRODUCTION

Indian agriculture is a climate dependent agriculture. The climate changes are expected to significantly decrease the crop growth around 5-10 per cent with every increase of 1°C and overall crop production could decrease up to 30 per cent in India in future. Increasing crop productivity will be therefore the key for ensuring food security especially when farming systems will be disturbed by extreme temperature, water stress, salinity and emerging pests and diseases. The role of improved crop varieties is very large to overcome the ill effects of the climate change. Hence, improved crop varieties for biotic and abiotic stresses should continuously be available as per the situation demands.

Presently used breeding methods take 8 to 10 years to develop a variety which is too longer that could not match with the current demand of climate smart varieties. The generation time of most plant species represents a bottleneck in crop breeding and applied research programs, creating the need for technologies that can accelerate plant development and generation turnover.

The term "speed breeding" was coined by researchers at the University of Queensland for the development of wheat lines. To shorten the generation time for getting seed yield in the crops, in this technology uses optimal light quality, light intensity, day length and temperature control to accelerate photosynthesis and flowering. In this technique, large number of plants can be grown densely and the

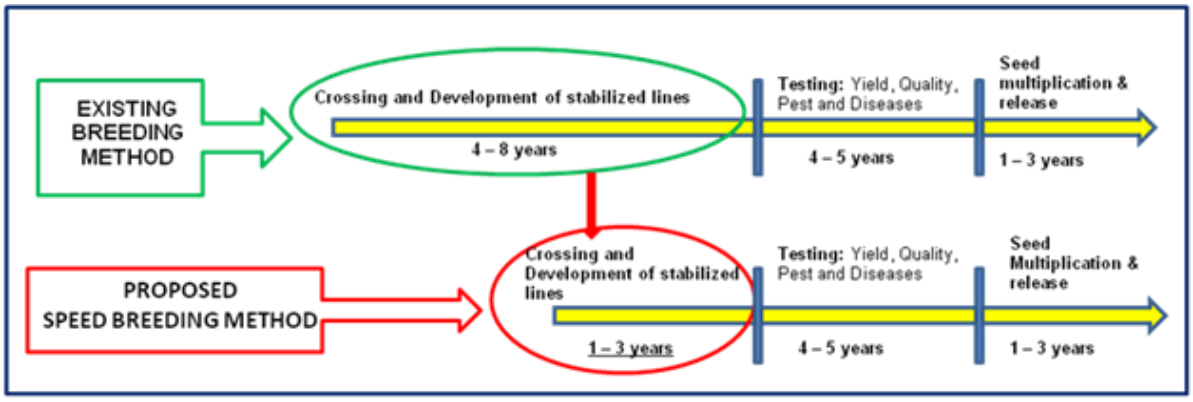

Figure 1. Existing Breeding Vs. Proposed Speed Breeding

cost of the inbred lines production could be reduced. The combination of 'seed chipping' technology and bar coding for single plant tracking can facilitate high-throughput marker-assisted selection.

Speed breeding facility will maintain all environmental parameters to induce early flowering. The facility will be installed with data acquisition system which saves all the parameters of each crop cycle and this information will be used as stored template to repeat the crop life cycle. The intelligent computer automation system controls all the parameters like temperature, humidity, light spectrum, photoperiodism, moisture level, irrigation, and fertigation.

The Speed breeding facility is designed to control parameters for biotic and abiotic stress experiments. The sensors will measure moisture level across different root zones in the soil. Specific spectrum lights will be used to induce early flowering and expedite vegetative growth of the plant. To promote reproductive phase, different spectral light with specific wavelength will be used inside the facility. The light vehicle system will maintain same light intensity on plant canopy till seed harvesting and it will minimize plant shading. Internal horizontal multi-screen will control photoperiodic and circadian cycle and will be able to regulate light based on short-day and long-day crop. Cooling module will maintain temperature from 10°C to 45°C and which will create ambient condition for plant to grow.

Humidification unit with water particle of fine micron will be used to maintain humidity and avoid condensation. Fertigation unit will be used to add nutrients, and maintain pH-level of water and soil.

In recent years, rapid generation-advance technology called "speed-breeding" has been adopted for multiple crops (Watson *et al.,* 2018). This technique has been for development of recombinant inbred lines, backcrossed inbred lines, and isogenic cultivars in rice (Collard *et al.,* 2017). Rana *et al.*(2019) adopted the biotron speed-breeding for the development of salt tolerance rice within 17 months with SNP marker-assisted selection. Samineni *et al.* (2019) has altered the photoperiod and induced the early flowering in the *Cicer arietinum* L.. Alahmad *et al* .(2018) used the speed breeding techniques for the bread wheat improvement. Hickey *et al.* (2017) used rapid generation advance technique to develop barley with multiple resistant traits.

CONCLUSION

The speed breeding techniques helps the breeder to reduce the crop duration to get seeds from breeding lines with short time spam. Consequently the development of any breeding lines will have short time duration while compare to the normal techniques. Also this technique requires very less space to raise many numbers of plants. Therefore, the environment controlled speed breeding facility will act as tool to accelerate research programs for the next-generation molecular breeder's.

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