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Effect of Selection Response on F_2 and F_3 Generation for Plant Height Character in Tomato MAGIC Population

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ABSTRACT: MAGIC (Multi parent advanced generation inter cross) breeding programme is the key to improve the traits like plant height in self pollinated crops like tomato (*Solanum lycopersicum* L.). Present investigation was planned to find the variability for plant height traits in MAGIC F_2 and F_3 populations. Using the observed variability present in the tomato MAGIC F_2 population, the selection was done for the plant height trait. The mean value observed for plant height was 117.60 cm with a range of 38.00 cm to 181.00 cm in MAGIC F_2 population. The trait followed normal distribution indicating the variability of a segregating population. And in MAGIC F_3 population wide range of variation was observed for plant height as the mean values for each accession ranged from 37.40 cm to 181.60 cm with grand mean 110.09 cm. The effectiveness of selection for these characters was estimated in F_3 generation and then compared with F_2 generation thus found the expected response to the selection. This indicates the effectiveness of selecting plant height characters in early segregating generations.

Keywords: MAGIC, Variability, Tomato, Plant height, F_2 and F_3 generation.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is commonly consumed vegetable crop of Solanaceae family. Tomato is grown across the world as it has wide adaptability to a variety of environments. It has a haploid chromosome number of 12 (2n=2x=24) with a genome size of 900 MB (Bordiya and Kang 2017). The cultivated tomato originates from wild relatives found in the Andean regions of Chile and Peru (Pailles *et al.,* 2017). Tomato was first domesticated in Mexico. It is believed that the Spanish explorer Cortez might have been the first to transfer to Europe in the mid 16th century (Rick and Fobes 1975). It remains in the focus of the horticultural industry, as an increase in its cultivation ever since the mid-nineteenth century all over the world (Morales, 2001).

MAGIC strategy has been used to intercross multiple alleles which provide more abundant genetic diversity and high mapping resolution as the number of recombination is more (Bandilo *et al*., 2013). The term MAGIC was first coined by Mackay and Powell (2007) and was advocated by them and Cavanagh *et al.* (2008) for crops. A very large set of recombinant inbred strains from a set of genetically diverse inbred mouse strains was constructed by Complex Trait Consortium and a strategy called a collaborative cross (Churchill *et al*., 2004). This strategy has been successfully used for fine mapping of the QTL in mice (Mott *et al*., 2000). The first MAGIC population in the plant is developed for *Arabidopsis thaliana* (L.) Heynh using this population, several known QTL for different traits were mapped with high precision, and a few novel QTLs were identified (Kover *et al*., 2009).

The MAGIC population is developed mainly to promote intercrossing and to shuffle the genes. The benefits of using MAGIC population are; each of the parents can be analysed for more targeted triats based on its selection which are used to make the multi parent crosses (Marriage *et al*., 2014). Multiparent populations are now attractive for variability present in the population for the selection of particular character.

The availability of variation for selection and the selection methodology were helped to achieve crop improvement in any breeding method (Malieshappa *et al*., 1988). The genetic variability can be achieved by crossing appropriately chosen parents. The rate and progress achieved through selection depends on the various factors like availability of genetic variability, selection intensity, breeding methodology and its genetic association with other related characters. A complex character like plant height exists in different tomato MAGIC populations with association of different genes which results in different relationships and also largely influenced by environment. Further, the effectiveness of early generation selection is reduced by genotype and the environmental interaction reduces (Rahman *et al*., 1986). Large environmental differences may lead to failure of parental plant height to be indicative of the plant height of progeny. So, direct selection for improvement of plant height attribute in segregating population may not be effective. This approach also results in the development of inbred lines (ILs) that would carry a various allelic combination that can be prospected for identification of agronomically superior ILs. Keeping these points in view the present study was aimed at studying the response of selection for plant height characters through mean between F_2 and F_3 generations in tomato MAGIC population.

MATERIALS AND METHODS

Eight parental lines (INDAM-2013-4, INDAM-2013-6-1, D-3-2, EC-625651, F-6059, H-24, EC-529080 and EC-538380) were pairwise crossed to produce two-way hybrids. The two-way hybrids were further intercrossed in a diallel fashion to generate four-way crosses. The eight-way crosses were made by intercrossing F_1 plants of the four-way crosses. SSD method was used to advance Eight-way cross plants to develop the eight-way MAGIC F_3 population. The F_1 plants were selfed to generate 600 F_2 plants. Further these individual F_2 plants were advanced to F_3 population, by selfing each MAGIC F_2 plants. The MAGIC F_2 population was evaluated at College of Horticulture, Bengaluru. Further, twenty plants from every 600 MAGIC F_3 individual plant was evaluated in the field during 2018-19 at Kolar for plant attributes. Plant height was measured from the ground level to the top of the primary branch just before the last harvesting in centimeters from all the 20 plants of MAGIC F_2 and F_3 population and averaged.

The field trials were conducted at College of Horticulture, Bengaluru for F_2 generation during 2018 and at Kolar for F_3 generation during 2019 summer season. Ploughing and harrowing was done for the main field to bring the soil to the fine tilth and the FYM @ 25 t/ha was incorporated into the soil. Seeds were sown in seedling nursery and three-week-old seedlings were transplanted in the main field. Each line was transplanted in a ridge of three-meter length spaced 45 cm apart with intra row spacing of 60 cm. The evaluation of MAGIC F_3 population with eight founder lines was done in an Augmented Block Design. A set of twenty blocks were raised wherein each block 30 MAGIC F_3 population. In each MAGIC F_3 population 20 plants were maintained and eight founder lines were repeated in all blocks. All agronomic practices were performed as per the package of practices of UHS, Bagalkot. The mean of MAGIC F_3 generation and their corresponding mean of individual plant selections in MAGIC F_2 generation were used for selection process.

RESULTS AND DISCUSSION

A wide range of variability for plant height trait was observed in tomato MAGIC F_2 population (Table 1). The mean value recorded for the plant height was 117.60 cm with a range of 38.00 cm to 181.00 cm. Spectral variability observed in the MAGIC F_2 population for the plant growth habit was depicted in Plate 1. The trait under study followed normal distribution (Fig. 1) indicating the variability of a segregating population. And in the MAGIC F_3 population wide variation was observed for plant height as the mean values for each accession ranged from 37.40 cm to 181.60 cm with grand mean 110.09 cm (Table 1). This indicates that early segregating populations have the different heights due to each genotype having a different capacity of growth. Similar results were also reported by Bharathkumar (2014); Renuka *et al.* (2017) in tomato.

The contribution for the trait *viz*., indeterminate plant growth habit was found to be higher from the parent, EC-538380. Most of the MAGIC F_2 individuals expressed the phenotype of indeterminate growth habit. Kulkarni (2003); Kaushik *et al*. (2011); Mohamed *et al*. (2012) were also in accordance with the genetics of tomato growth habit.

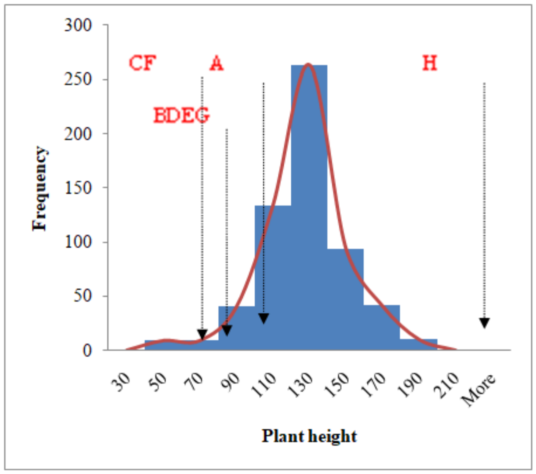
The plant height performance of F_3 families raised from the F_2 populations on the basis of the crosses showed much encouraging results (Table 1). All the 600 families could be isolated as promising families for later generation. Thus there was practically a great relation between the plant height of individual F_2 selection and the mean plant height of corresponding F_3 families. Similar type of finding was also reported by Islam *et al*. (2012). Thus selection for the trait like plant height based on phenotypic performance in early generation is effective. In respect of plant height MAGIC F_3 generation showed high mean performance and percentage of population mean than in MAGIC F_2 generation.

Table 1: Estimates of variability for plant height trait among founder lines, MAGIC F_2 and F_3 population.

	Parental lines								MAGIC population			
	A	B	C	D	E	F	G	H	F_2		F_3	
	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean	Mean±SE	Range	Mean±SE	Range
PH	94.36	89.50	57.54	83.22	82.34	50.88	82.74	109.88	117.60±0.96	38.00-181.00	110.09±0.98	37.40-181.60

PH: Plant height (cm)

A:	INDAM-2013-4	B:	INDAM-2013-6-1	C:	D-3-2
D:	EC-625651	E:	F-6059	F:	H-24
G:	EC-529080	H:	EC-538380		



A:INDAM-2013-4; B: INDAM-2013-6-1; C: D-3-2; D: EC-625651; E: F-6059; F: H-24; G: EC-529080; H: EC-538380

Fig. 1. Frequency distribution of the mean values of plant height trait among 600 tomato F_2 MAGIC lines field evaluated during 2018 at COH, Bengaluru**.**

Plate 1a. Spectral variability observed in the MAGIC F_2 population for the plant growth habit at COH, Bengaluru during 2018-19.

Plate 1b. Spectral variability observed in the 600 MAGIC F_2 population for the plant growth habit at COH, Bengaluru during 2018-19.

CONCLUSIONS

The parent, EC-538380 contributed to the indeterminate plant growth habit and the parent H-24 contributed to the determinate plant growth. Most of the MAGIC F_2 and F_3 individuals expressed the phenotype of indeterminate growth. A wide variability for the trait, plant height was observed in the both MAGIC F_2 and F_3 populations and followed a normal distribution. This investigation suggested that the selection for the plant height trait can be made in the early segregating generation, keeping aside the major quantitative characters as yield for selection in later generation.

FUTURE SCOPE

1. Advancement of the MAGIC F_2 population to MAGIC RILs to get a stable and homozygous population.
2. Large scale field evaluation of tomato MAGIC RILs to know the variability for plant height trait.

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Conflict of Interest. None.

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