Genetically Modified Tomatoes

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Abstract--- *Tomato, also called as Lycopersiconesculentum Mill belongs to family Solanaceae. Tomato is a diploid plant with 24 chromosomes. Tomato varieties have been improved to a great extent by practicing mating, hybridization, self-pollination and by understanding shortage of gene duplication, by easily identifying the chromosome no.12. New methodology has been adopted like genome mapping of "agronomic characters" and implementation of backcross with advanced technique to enhance tomato crop along with understanding domestication process. Breeding in tomato plant is done to improve production & quality of fruit and make the same, pests & disease resistant. Conventional breeding methods adopted, didn't found to enhance tomato productivity; therefore, "molecular genetics and molecular markers techniques" are adopted and work is carried out on these. Thus, combination of conventional breeding & "plant biotechnology" methodology along with the genetic markers, "marker assisted selection" may be recognised as an important ornament for breeding tomato.*

Index Terms--- *Chromosomes, tomato, genome.*

I. INTRODUCTION

Most widely grown vegetable crop worldwide is tomato with annual production of approx. 142 million tons. It is considered as a valuable profitable crop in reference to land, yield, industrial application as well the human nutrition[1]. Lycopersiconesculentum Mill is a member of family Solanaceae that involves 3000 species and many more. Wild varieties of tomato sp. showed potent reservoir of valuable genes thereby providing a way to use them for breeding programs e.g. 'S.chilense" & "S.peruvianum"[2]. Origin of tomatoes was South America (Peru & Ecuador) but was first domesticated in Mexico. In present scenario, tomatoes are cultivated worldwide in areas which are free from frost for every three months, yearly[3].

Tomato is unique in terms of both as vegetable of economic importance and used as model plant for various experimental studies. Tomato is used as model plant because of its unique properties such as diploid nature, sequenced genome, genetic properties and genomic resources[4]. It is most widely grown crop in tropical areas and subtropical areas as it is rich in both vitamin A & C. Cultivation of tomato also provides a source of income to small holder, thereby providing a switch from subsistence to profitable farming and subsequently providing an increase in income.

Tomato is most widely cultivated crop worldwide. After China, India comes at second position to cultivate vegetables. More specifically, tomatoes and potatoes at universal level. As tomatoes are rich in vitamin A & C, they are widely attracted for their nutritional value[5]. Apart from that, they are also considered for their medicinal value as they

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are much used for purifying blood and curing problems related to digestive system. Mainly fresh tomatoes are grown over land or in greenhouse under proper cultivation parameters as greenhouse increases the crop availability[6]. Tomatoes also posses “anti-oxidative & anti –cancerous properties” and various nutrients such as beta carotene, flavonoids, lycopene etc. Number of products made of tomatoes are available in the market such as soups, juices, sauces etc[7].

Since tomato possess large amount of nutritional qualities, its demand is increasing day by day. However, despite of increased production, it also gets affected by ascertain environmental calamities like biotic & abiotic stresses. The stresses include diseases like fungal disease, bacterial disease, viral disease and diseases caused by nematodes. They also affect the growth of vegetable crops and ultimately their yield gets drowned. Major factors behind this include, increased temperature, problem of drought along with salinity& attacks from insects & various pests.

Major objective of breeding tomatoes via molecular & genetic techniques is to improve and enhance the quality of vegetable crop by making them tolerant to stresses, resistant to diseases. Diseases are mainly restricted by the aid of chemicals, which may sometimes leads to increase in toxic levels. Therefore, it is important to note that improvement of tomato is a very tough job to overcome the problems related to tomato yield.\

II. GENETICS OF LYCOPERSICON ESCULENTUM MILL:

Among all species cultivated, tomato is considered as rich in genetic resources. New methodology has been adopted like genome mapping of “agronomic characters” and implementation of backcross with advanced technique to enhance tomato crop along with understanding domestication process. Breeding in tomato plant is done to improve production & quality of fruit and make the same, pests & disease resistant. Genome size of tomato is 1C which is approximately 96picogram of Deoxyribonucleic acid. Cultivated tomatoes have also been chosen for sequencing in international labs because of its genome size which is very small in contrast to other Solanaceae species.

Genetic characteristics of tomato are simply advanced in many ways. Quality genes & “quantitative trait loci (QTLs)” are analyzed for the growing traits of fruits. The most important changes observed in tomato is the size of fruits. The difference between wild and modern tomatoes are the presence of tiny berries in wild tomato and succulent nature of modern tomatoes along with large size[8]. The locus present on the gene codes for cell division negative repressor sudden changes i.e. mutations at the promoter site. Similarly, several loci were also identified regarding shape of the fruit. The transformation of shape to elongate from round form is due to the presence of ovate gene. “Fs 8-1 loci” genes are found in fruits with square shape or elongated shape. Also, loci are responsible for controlling phenotypic divergence.

Wild tomatoes and their relatives are self incompatible in nature. Hereditary male sterility has also been recorded often in the genera and several loci were identified and mentioned that produce male sterility[9]. Tomatoes have proven to become an ideal crop for genetic analysis due to their simple basic biology, their ease of cultivation and the abundance of genetic variations in cultivated and native types. Natural genetic variation is the evolutionary energy.

Without it, there can be no evaluative powers or adaptation to environmental changes (figure 1).

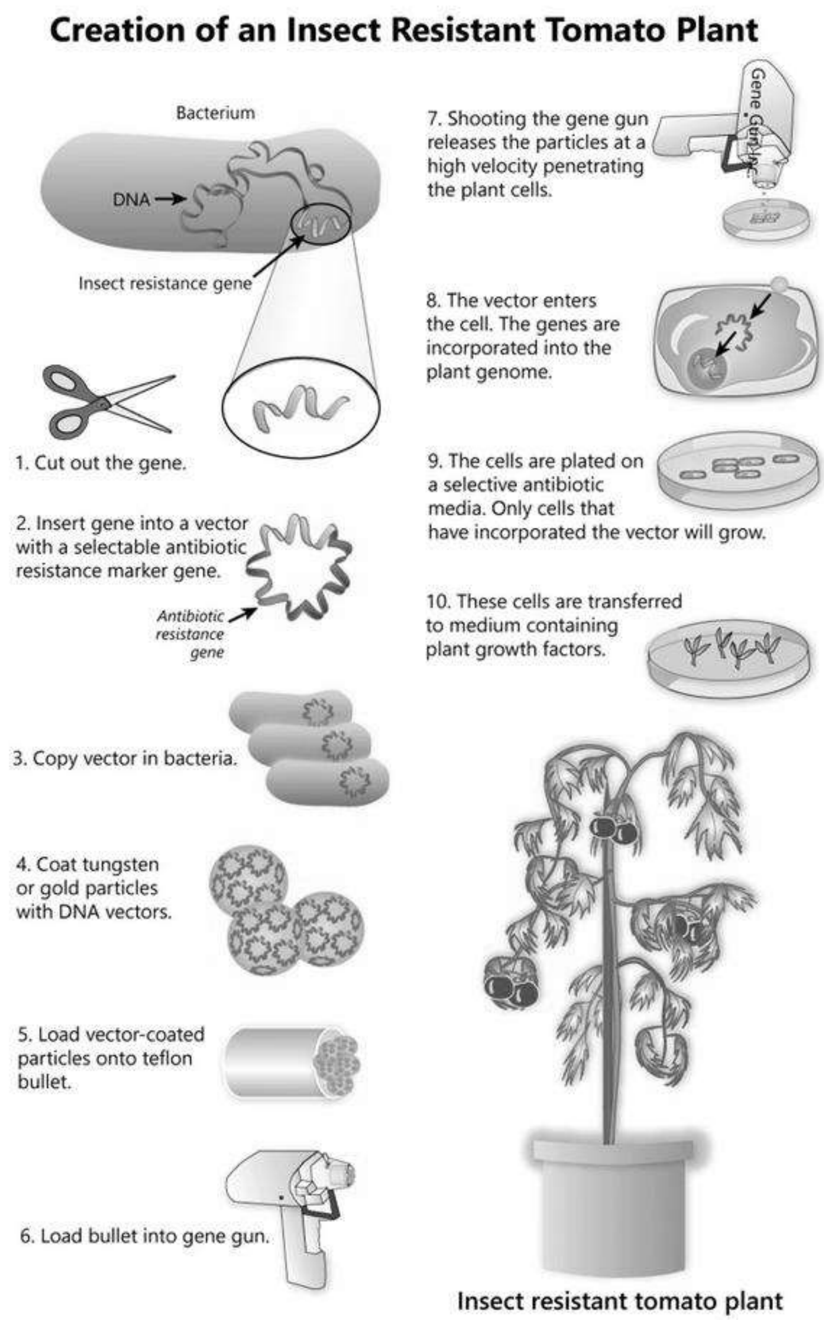

Fig. 1: Methodology of transgenic tomato production

III. BREEDING OF *LYCOPERSICONESCULENTUM* MILL.:

With increase in population and ever growing demand of food, breeding technologies have gained importance for the enhancement of crops. The conventional crop breeding initiative has been enhanced by implementation of molecular biology, "omics" sciences followed by bioinformatics. Integration of molecular biology and bioinformatics techniques in conventional breeding programs has led to the identification of new characters or crosses so as to modify the plant in a more proper way that would enhance the yield of crop and prevent its loss due to certainties[11]. Tomato is selected as a model plant for studying the process of fruit development due to its small size and diploid nature. Also, advancement in genetics and studying the genomic traits, has led to the understanding of structural as well as functional parameters (figure 2).

IV. OBJECTIVES:

Yield of the fruit is the major objective for breeding tomatoes. As it is known that the increase in yield of tomato depends largely on the size of the fruit, fruit efficiency and cell number. So by breeding initiative, an objective is taken to enhance the yield of tomato plants. The yield is enhanced by the mutations done in reference to fruit size. Also, the study of genetic traits of tomatoes has led to the identification of genes that affects the cell cycle, number of carpels and sets of fruits. Hybridization techniques have also led to enhance the yield of the tomato plants.

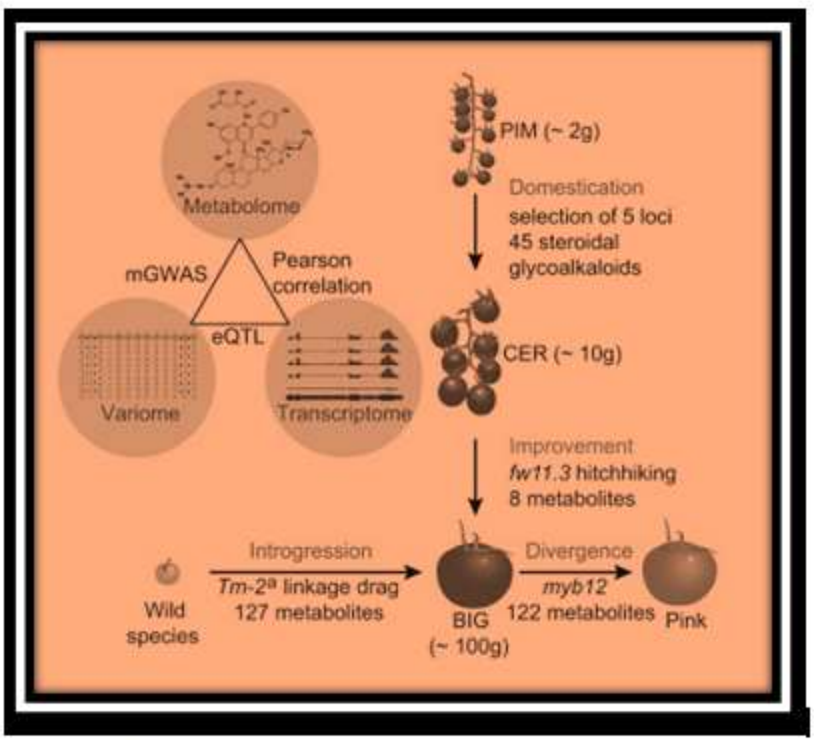

Fig.2: Omics technology for tomato breeding

Apart from the enhanced yield objective, tomato breeding also involves other objectives which are as follows:

IV.I *Insects& Disease resistant*:

To produce tomatoes resistant to insects& pathogens, causing disease is the one major objective of breeding program. Development of tomatoes resistant to diseases is an important endowment to modern crop breeding for improving tomatoes. Selection & sequencing of field, labs, and greenhouses, genetic markers used by "AVRDC-World vegetable centre" to separate population, thereby producing pure lines of tomatoes[12]. These pure lines of tomatoes were found to be resistant to Fusarium wilt, TMV, "yellow curl leaf disease", etc.

Insects & pathogens resistant tomatoes were developed by transferring traits from wild species to cultivated species. E.g. "*Cladosporiumfulvum"* was procured from "*S. pimpinellifolium",* wilting disease caused in tomatoes[13].

IV.I.I. Abiotic stress tolerant plants:

By integrating conventional breeding techniques with "marker-assisted breeding" has provided a tomato plant resistant to "heat & drought" thereby overcoming the negative impacts of "abiotic stresses" & ultimately improved the quality of tomato plants.

V. METHODOLOGY OF LYCOPERSICONESCULENTUM MILL BREEDING:

Method of breeding tomato plant involves hybridization technique and pedigree selection. Sometimes, while transferring desired traits from wild species to cultivated ones, back cross is also done. Some of the methods are as follows:

V.I Selection of plants:

This involves collection of plants with desirable phenotypic characters followed by harvesting so as to use them for carrying out experimental studies. For this purpose, mass selection is done in order to prevent & preserve traits of cultivated varieties.

V.II Pedigree methodology:

This method involves crossing between successive generations to isolate a new variety via single cross. This methodology is very durable & successful. Plants are selected from the new generations to as to develop plants with new genetic differences. This methodology is better than mass selection of plants.

V.III Hybridization technology:

Hybridisation technology has led to the development of new varieties in tomatoes which provides them resistance against diseases, insects, pests and several abiotic stresses, natural calamities like flood, rain, drought etc. Hybridisation technology has increased the chances of survival of tomato plants, thereby fulfilling the need of the ever growing population.

VI. RESULT &CONCLUSION

Tomato is "self-pollinated" with diploid number of chromosomes. It is rich in vitamin A& C, along with additional properties such as anti-oxidant and anti-cancerous. It is also used as model species for carrying out experiments in labs.

They are the best example for transferring genes from wild sp. to cultivated sp. for enhancing the quality and productivity of the food crop. Therefore, combination of conventional breeding steps with modern molecular tools such as “molecular marker-assisted selection” may serve as an important tool for breeding of tomato plants.

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