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Breeding in Tomato (*Solanum lycopersicum* L.)

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Abstract
Tomato (*Solanum lycopersicum* L) is one of the world's second most popular and widely grown vegetable. It belongs to the solanaceae family and is a good source of Vitamin C which adds variety of colours and flavours to the food. It is different forms are adapted to wide range of environment. Tomato is highly diversified vegetable beside facing many production issue including biotic & abiotic stresses caused severe losses both yield & quality.

Keywords: Tomato, self- pollinated Climate, Breeding, Stress, Diseases.

Introduction
Tomato (*Solanum lycopersicum* L.) is one of the important vegetable in the world ranking second in importance to potato in many countries.It has many other uses tomato seeds contain 24% of oil and it is used as salad oil and in the manufacture of margarine .Green tomatoes are also used for pickles and preserves. Rich source of mineral vitamin and organic acid tomato food provide 3- 4% total sugar, 4-7% total solids, 15-30 mg/100g ascorbic acid, 7.5-10 mg/100ml acidity and 20-50 mg/100g fruit weight of lycopene. In large quantities, tomato is used to produce soup, juice, ketchup, puree, paste and powder; supplies vitamin C and adds variety of colour and flavours to the food. Tomato plants are dicots and grow as a series of branching stems with a terminal bud at the tip that does the actual growing. It is characterized by two types -determinate and indeterminate type.

Flower biology- Tomato produces perfect, hermaphrodite, pentamerous flowers. Depending upon temperature, humidity and sunshine flower a thesis and anther dehiscence takes place at 6 a.m. and 7 a.m. to 10 a.m. respectively. The pollen grains remain viable for 2-4 days; the stigma becomes receptive 15-20 hours before a thesis. Pollination of Tomato is due to bees (entomophily). Self-pollination also takes place when the style is short and the stigma protrudes outside the level of anther.

Tomato Breeding
Breeding in tomato is done to improve crop yield and other traits related to crop quality. As market demand for tomato increases along with a burgeoning population, much effort has been directed toward the quality and production of the tomato crop using classical breeding alone or in association with the modern gene technologies and bioinformatics. Such breeding programs will help in improving tomato crop traits and producing new varieties with qualities associated with yield improvement, nutritional value, and biotic and abiotic stress tolerances.

Breeding Objectives
- Earliness-Increased fruit yield, Fruit quality, large fruit size, high fruit quality and continuous production for home garden tomatoes.
- Indeterminate cultivars for green house production

- Resistance to disease (Wilt, blight, anthracnose, mosaic and root knot nematode)
- Resistance to insects (Fruit borer, whitefly)
- Resistance to abiotic stresses-Cold set varieties, Hot set varieties, Drought tolerance, Salt tolerance, Low temperature germination and growth, Chilling injury tolerance, Herbicide tolerance

Breeding Methods

- **Mass Selection**- Mass selection, or phenotypic selection, is based on the appearance of each individual plant within a population. Phenotypically attractive plants are selected; seeds are harvested to obtain a stock of mixed seeds which are then used to produce the next generation. The procedure is repeated until the desirable character is obtained. Mass selection procedures are used to improve existing varieties of tomato, as well as other crops. It is considered to be the easiest and least expensive method of plant breeding.
- **Pedigree**- Pedigree breeding method of tomato generates progeny of selected plants from a single cross, starting in F2 generation and continuing through successive generations until F6. Main objective of this method is to finally obtain a new variety with the preferred traits and it is very fast in developing new cultivars.
- **Hybridizatio**n - The main goal of hybridization is to combine desirable traits from two or more different varieties in order to obtain pure-breeding progeny with more improved traits compared to that of the parent plants. This technique is applied for tomato using both intraspecific (between different tomato varieties) and interspecific (between cultivated tomato varieties and tomato wild relative lines).
- **Grafting**- Tomato grafting methods are based on selecting scion stock with biotic resistance to soil-borne pathogens or abiotic tolerance to drought and salinity which has quantitative high yield and desirable fruit qualities. Grafting tomatoes is a widely used horticultural practice to reduce the amount of pesticides applied over the plant.

Tomato Breeding for Biotic Stress

- Disease and insect resistance breeding: In tomato the wild related species of Lycopersicon have been the primary sources of genes for resistance to diseases caused by fungi, bacteria, viruses and nematodes. The species, pimpinellifolium , peruvianum, hirsutum and chilense have been used widely as donors of genes for disease resistance in tomato breeding. As mentioned earlier, in many diseases resistance is governed by a single dominant gene. However, in most of the bacterial diseases and virus diseases, the inheritance of resistance is polygenic. Genes for disease resistance have been successfully transferred from the related Lycopersicon species to the cultivated species, L. esculentum by backcrossing. There are many tomato cultivars and F1 hybrids having multiple disease resistance. Both interspecific and inter varietal hybridizations followed by pedigree selection have been adopted for combining disease resistance with other desirable attributes. Disease resistant tomato varieties developed in India include Pant Bahar (Fusarium wilt, Verticillium wilt), KT-10, KT-15 (buckeye rot), BT-1, BT-10, Arka Abhijit, Arka Shreshta, Sakthi, Anagha, Hisar Lalit and Pusa 120 (root knot nematode) and H-24 and H-36 and TLB 111(tomato leaf curl virus). The variety Pusa Uphar is highly tolerant to fruit borer. Developing disease-resistant and stress-tolerant varieties are major plant breeding priorities. Genetic engineering methods can also be influential in enhancing and growing disease-resistant cultivars.

Breeding for Bacterial Diseases

- Viral and bacterial diseases, as well as nematodes, may cause severe damage and reduce the yield and quality of tomatoes; they more difficult to control than those caused by fungal pathogens. To manage these diseases, integrated pest management has been followed, such as sanitation, crop rotation, using resistant varieties and disease elimination. Devising resistant varieties through breeding is considered one of the most

important means to control these types of diseases. In the past three decades great progresses has been achieved to develop numerous cultivars with resistance to viral diseases, fungal diseases and nematodes, while less work has been directed in breeding programs to provide lines resistant to bacterial disease . Bacterial wilt is caused by Ralstonia solanacearum and bacterial spot by Xanthomonas campestris PV. vesicatoria; tomato and bacterial canker, caused by Clavibacter michiganensis ssp. michiganensis are four common bacterial diseases in tomato

Breeding for Abiotic Stress Tolerance

- **Salinity Stress Tolerance** -Tomato became an important model plant for the study of genetic basis of tolerance to salinity stress due to the possibility of obtaining hybrids from intraspecific and interspecific crosses with the wild relatives of tomato. Successful identification of quantitative trait loci (QTLs) by marker analysis has revealed the genomic locations of salt tolerance genes in tomato (Foolad and Jones 1993). Short- or long-term high temperatures can lead to alterations in morphological, anatomical, physiological, biochemical and on molecular levels. Such alterations are manifested as reduction in growth, yield and quality. The use of advanced genetic tools in breeding for heat stress tolerance aims at creating varieties that have improved thermo-tolerance. Heat tolerance is considered a genetically complex trait due to significant genotype x environment interaction (Plata et al. 1979). Most QTL mapping was carried out on chilling and salinity stress; less work was assigned to mapping in heat-stressed plants

Conclusions and Prospects

Tomato second most important vegetable crops after potato. Most of the tomato cultivars used for crop production is severely affected by number of biotic and abiotic threats. Yield loss in tomato has been observed by these threats across the world. Development of the disease resistance tomato cultivars is challenging issue. Large number of wild species and germplasm lines is available with resistance traits/genes. Utilization of these wild species and germplasm lines may provide strength to the crop improvement program. However, molecular marker based screening of the tomato wild species for the identification of gene of interest must be useful in the marker – assisted backcross breeding for development of improved tomato cultivars. Breeders have incorporated several major and minor genes from wild species to the cultivars to achieve durable resistance for various biotic and abiotic threats. The whole genome sequence of the tomato is available and may useful in the future tomato improvement program.

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