

Morpho-anatomical Study of 100 Tomato Lines

Ratikanta Maiti^{1*}, D. Rajkumar², Jagan² and P. Vidyasagar²

¹Honorary Professor, Universidad de las Americas, Puebla, Mexico & Chairman, RKM Research Fondation, Kolkata, India

²Vibha Seeds, Vibha Agrotech Ltd. Hyderabad, India

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Correspondence to

*E-mail: ratikanta.maiti@gmail.com

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Abstract

A study has been undertaken of 100 genotypes of tomato grown in polyhouse during summer (April-May 2012) for general morphological and anatomical characters of leaves of one hundred tomato genotypes and its possible relation with drought and heat stress tolerance and resistance to insects probably tospovirus resistance. There existed a lot of variability of leaf morphology, and its anatomy. It is concluded that lines having thick leaves & medium to high density of trichomes, minimum wilting, high number of flowers, may be considered for heat stress and drought tolerance. Lines with high density of trichomes are probably tospovirus resistance which could be confirmed in rainy season in the field. Genotypes with open canopy, thick petiole, and thick leaves expected to be drought resistance. Anatomically compact long palisade tissue and more number of collenchyma layers in petioles offer drought resistance. Five genotypes were selected for good pollen viability. More than thirty genotypes possessed high trichome density which may be expected for TLC and Tospo virus resistance. These lines may be evaluated for TLC and Tospo virus resistance at hotspots. These lines are also expected to be tolerant to drought.

1. Introduction

In tomato, reproductive processes were adversely affected by high temperature, which included meiosis in both male and female organs, pollen germination and pollen tube growth, ovule viability, stigmatic and style positions, number of pollen grains retained by the stigma, fertilization and post-fertilization processes, growth of the endosperm, proembryo and fertilized embryo (Foolad, 2005). Also, the most conspicuous effect of high temperatures on reproductive processes in tomato is the production of an exerted style (i.e., stigma is elongated beyond the anther cone), which may stop self-pollination. Poor fruit set at high temperature has also been coupled with low levels of carbohydrates and growth regulators released in plant sink tissues (Kinet and Peet, 1997). Under high temperatures, fruit set in tomato plants failed due to the disruption of sugar metabolism and proline transport during the narrow window of male reproductive development (Sato et al., 2006). Brassinosteroids have recently been shown to confer thermo-tolerance to tomato and oilseed rape (*Brassica napus*) (Dhaubhadel et al., 1999). In tomato plants under heat stress, HSPs aggregate into a granular structure in the cytoplasm, possibly protecting the protein biosynthesis machinery (Miroshnichenko et al., 2005). Tomato,

though plants are sensitive to high temperatures throughout the plant ontogeny, flowering and fruit set are the most sensitive stages; fruit set is somewhat affected at day/night temperatures above 26/20 °C and is severely affected above 35/26 °C (Berry and Rafique-Uddin, 1988). In some crop species such as tomato, a strong positive correlation has been observed between fruit set and yield under high temperature. Thus, evaluation of germplasm to identify sources of heat tolerance has regularly been accomplished by screening for fruit set under high temperature (Berry and Rafique-Uddin, 1988). In tomato, for example, two undesirable characteristics commonly observed in heat-tolerant genotypes are small fruit and restricted foliar canopy (Scott et al., 1997). The production of small fruit is most likely due to adverse effects of high temperature on the production of auxins in the fruit, and the poor canopy is due to the highly reproductive nature of the heat-tolerant genotypes.

However, despite all the complexity of heat tolerance and difficulties encountered during transfer of tolerance, some heat-tolerant inbred lines and hybrid cultivars with commercial acceptability have been developed and released, at least in a few crop species such as tomato (Scott et al., 1986; Scott et al., 1995).



2. Materials and Methods

One hundred tomato genotypes were grown in big size plastic pots (height 60 cm and diameter 40 cm) during summer, 2012 at Vibha Agrotech Ltd, Hyderabad, India and observed morphological characters include size, thickness, trichome density of leaf petiole transfer section petiole.

Pollens are collected from four plants of each replication. Pollens are treated with Iodine Potassium Iodide (IKI) and kept for 10 minutes. Viable pollen grains are stained and turned to dark blue color. Non-viable pollen grains remain pale yellow in colour (unstained). The stained pollen grains of a microscopic field (under 10X magnification) were counted by compound microscope. For each entry, 10 readings are taken and calculated the percentage of pollen viability.

3. Results and Discussions

3.1. Leaf

Lot of variability was observed in leaf morphology with respect

to leaf colour, leaf thickness, petiole thickness, and trichome density. The breeders may select desirable lines. Genotypes have been classified on various characters such as leaf size, leaf thickness, trichome density, canopy structure.

3.1.1. Leaf in transverse section

Genotypes having open canopy type and thick, glabrous/high trichome leaves with small to medium size are expected to be drought tolerant. More importantly these genotypes anatomically showed high trichome density, compact-long palisade tissue which reduces transpirational loss of water form leaves.

3.1.2. Petiole transverse section

3.1.2.1. Trichome density

Tomato plant consists of glandular trichomes which offer insect resistance to insects by secreting volatile chemical compounds and entrapped in the exudates. Several plant viral diseases transmit through insects. Among this Tomato Leaf Curl virus (TLC) and Tospo virus is important which highly reduces yield

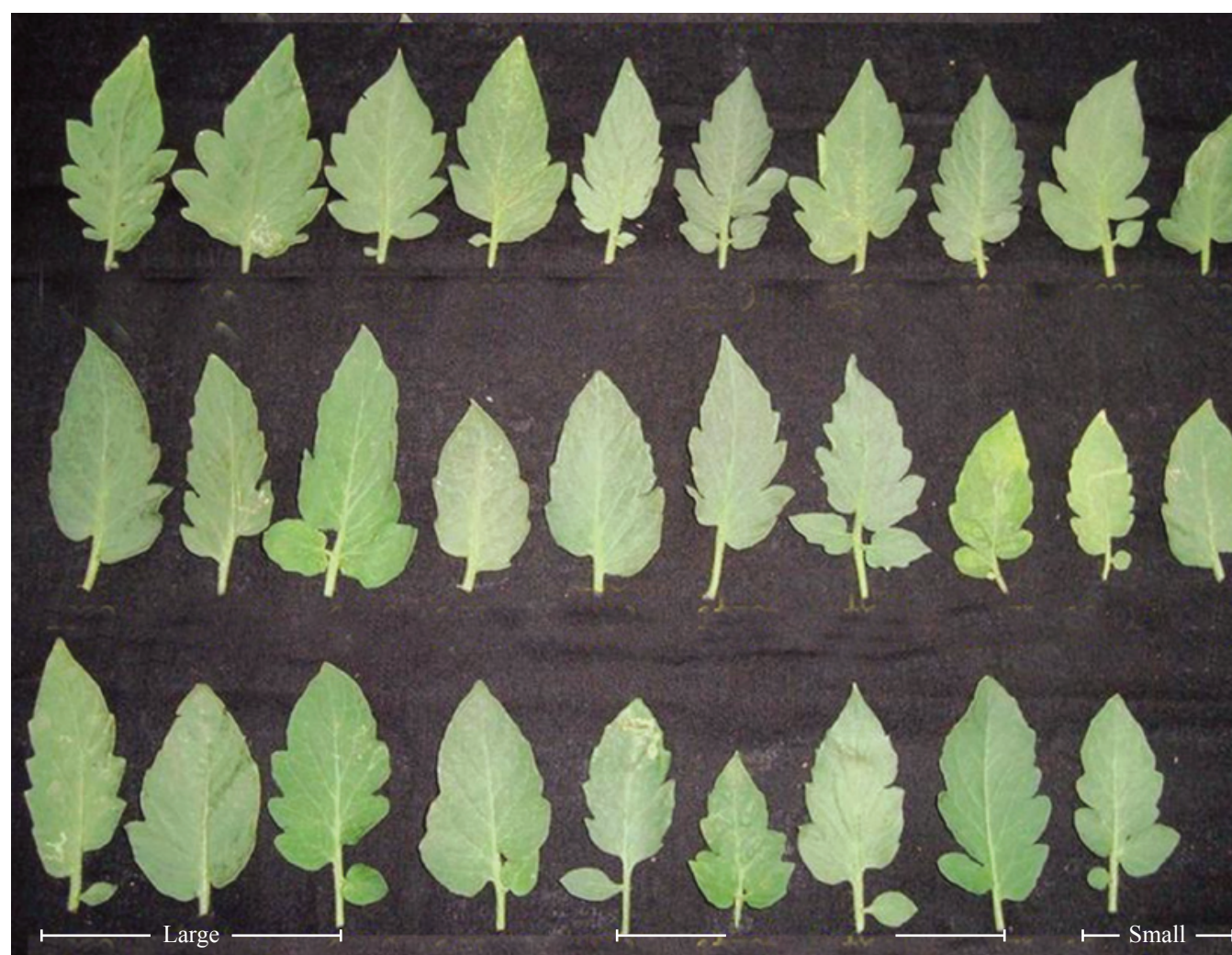


Figure 1: Above figure shows the variability in leaf morphology (large, medium and tomato) of tomato genotypes

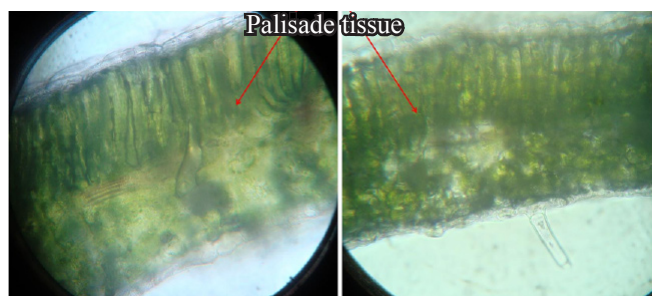


Figure 2: Thick palisade tissue offers drought resistance (left) reduces transpirational loss of water

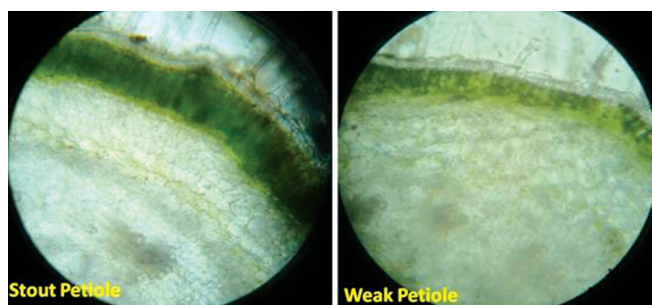


Figure 3: Petiole transverse section showing variability in collenchyma thickness and length. Stout petiole with compactly arranged long collenchyma cells compared with weak petiole



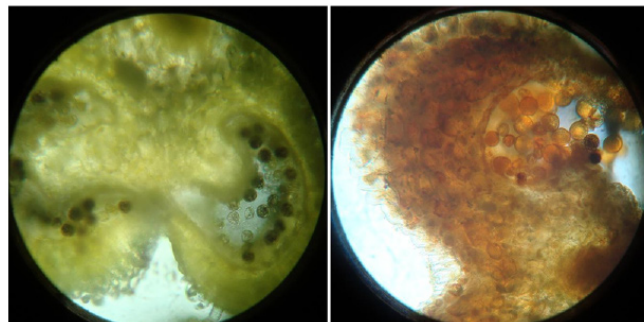
Figure 4: Above figure shows the response of heat tolerant & susceptible lines to heat stress. Heat Susceptible line was showing wilting



Heat stress: Flower dropping

Figure 5: Heat stress induced flower drooping in susceptible lines

loss in tomato. Several studies revealed insect resistance of trichomes on leaves. Trichome density on lower epidermis is important for insect resistance because most of insects feed on lower surface of the leaves. Based on this concept, 100 Tomato lines were studied for trichome density on leaf surface and stem



Anther transverse section: Viable (left) & non-viable pollen grains

Figure 6: Viable pollen grains visible in dark blue colour (stained with iodine potassium iodide). Non-viable pollen grains visible in orange yellow colour



Figure 7: Fruit setting was observed in two lines

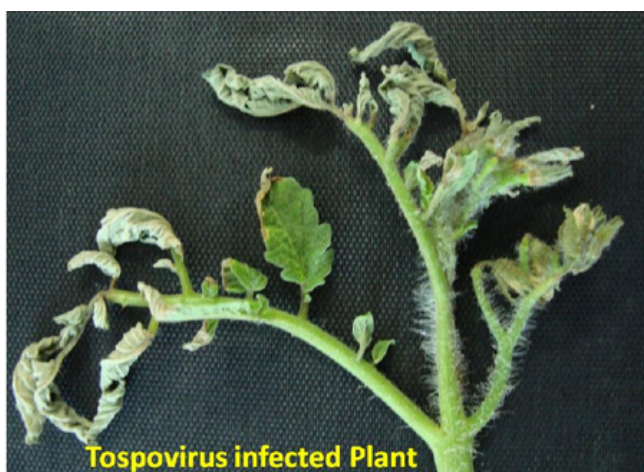


Figure 8: Tomato plant infected with Tospo virus

surface in order to estimate the level of tolerance to TLC virus and Tospo virus. It is also confirmed by twolines has TLC and Tosco virus resistance gene *ty 2*. Field scoring is also needed for level of tolerance to TLC disease to identify the role of trichome density offering disease resistance.

Thirty genotypes were selected for high trichome density on the lower leaf surface. About twenty five genotypes are selected for having high trichome density on the stems which may deter aphids against virus. Tomato genotypes showed variability to heat stress exposed to hot summer.

3.2. Heat stress

3.2.1. Effect on pollen grain development

Continuous exposure of tomato to high temperatures (day/night temperatures of 32/26 °C) markedly reduces the number of pollen grains flower⁻¹ and decreases viability. The effect of heat stress on pollen viability was associated with alterations in carbohydrate metabolism in various parts of the anther during its development. Under control, favourable temperature conditions (28/22 °C), starch accumulate in the pollen grains, where it reached a maximum value at 3 days before anthesis; it then diminish towards anthesis. During anther development, the concentration of total soluble sugars gradually increases in the anther walls and in the pollen grains (but not in the locular fluid), reaching a maximum at anthesis. Continuous exposure of the plants to high temperatures (32/26 °C) prevents the transient increase in starch concentration and led to decrease in the concentrations of soluble sugars in the anther walls and the pollen grains. In the locular fluid, however, a higher soluble sugar concentration was detected under the high temperature regime throughout anther development. This suggests that a major effect of heat stress on pollen development is a decrease in starch concentration 3 days before anthesis, which results in a decreased sugar concentration in the mature pollen grains. These events possibly contribute to the decreased pollen viability in tomato. Continuous exposure of tomato plants to high temperatures has two major effects on pollen grains. First, it reduces the total number of grains and, secondly, it leads to a marked reduction in germination and a more moderate reduction in the viability of those grains.

3.2.2. Days to flowering

Early flowering was observed in some lines ranges from 30-38 days, where one line had late flowering (60 days) compared to remaining lines. Some genotypes have shown high number of flowers under high temperature indicating heat stress tolerance. These lines did not show fruit setting above the 40 °C temperature. Fruit setting was observed only in two lines.

5. Conclusion

From the above study, it was observed that lines having thick

leaves and medium to high density of trichomes, minimum wilting, high number of flowers, may be considered for heat stress and drought tolerance. Lines with high density of trichomes are probably tospovirus resistance. Anatomically compact long palisade tissue and more number of collenchyma layers in petioles offer drought resistance. High trichome density probable play important role in offering TLC and tospo virus resistance. Selected genotypes may be evaluated for TLC and Tospo virus resistance at hotspots.

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