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Study Of Drought Tolerance Parameters In Fruit Trees Growing In Semi-arid Zone

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Abstract:

The plants under investigation are characterized by the presence of compound leaves, amphistomatous nature and single layered epidermis except Eugenia which is hypostomatous and with multilayered epidermis. Presence of spines in Aegle and Feronia and the presence of thick and fleshy nature of the leaves reflect on their drought tolerance capacity. The stomatal density is higher (800/mm²) in Eugenia while lower in Tamarindus (300/mm²) and in Aegle almost equal in both the epidermis. Stomatal index is higher in Eugenia as compared to other plants.

KEYWORDS:

Drought tolerance, fruit, trees, Morphological characters.

INTRODUCTION:

In Maharashtra, Solapur district comes under drought prone area and characterized by low and irregular rainfall, high temperature conditions almost throughout the year except few days of rainy season and less availability of other natural sources of water. The vegetation of this area is xerophytic in nature. Therefore, naturally, plants growing in these regions experience drought.

The fruit trees growing in this drought prone area are well adapted to these environmental conditions. Therefore, it is very interesting to study how these fruit trees are growing very happily in drought prone area. In other words, what is the mechanism of drought resistance or tolerance in these plants? Hence, the present study was undertaken and the plants selected for the study were Aegle marmelos (wood apple), Feronia elephantum (elephant apple), Emblica officinalis (Amla), Eugenia jambolana (Black plum) and Tamarindus indica (Imali).

Water is one of the most important critical resources, which will remain a decisive constraint for suitable production in the 21st century. Drought at any phenophase can affect almost every aspect of growth of above and below ground parts. The numerous physiological responses of plant to water deficits generally vary with the severity as well as the duration of water stress (Mathews et al 1984, Weber and Gates 1990, Rose et al 1993, Thakur et al 1998, Li Chunyang 2000, Coreia et al 2001, Pane and Goldstein 2001, Pita and Pardes 2001, Weight 2001).

The fruit trees under investigation are not only interesting from stress physiology point of view but these plants play an important role in ecology, environment and economy of Solapur district as they have great nutritional and medicinal importance.

MATERIAL AND METHODS

In the plants under investigation, external morphological characters were studied. Leaf anatomy was studied by taking transverse sections of fresh leaves and stomatal studies by peeling technique. The

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stomatal density and stomatal index were determined by using peeling technique. The investigations were carried out on mature and well-established tree plants.

RESULTS AND DISCUSSION

Table 1 reveals that distinct spines are present in *Aegle marmelos* and *Feronia elephantum* & thick, fleshy & shining leaves are present in all species, however leaves of *Emblica officinalis* and *Tamarindus indica* are sour in taste, Presence of compound leaves except in *Eugenia jambolana*. All these characters reflect on the drought tolerance capacity of the plants under investigation by means of which the loss of water through transpiration is minimized.

Table 2 Shows the anatomical features of the leaves. Dorsiventral leaf anatomy is a common feature but the thickness of the palisade and spongy tissues varies from plant to plant. Multilayered epidermis in *Eugenia* shows its adaptations to drought. Sphaeraphides are present in *Feronia elephantum* and *Emblica officinalis* while oil glands are present in *Aegle marmelos*, *Feronia elephantum* and *Eugenia Jambolana*. However *Tamarindus* does not show presence of such structures.

Table No: 1. Morphological characters

Morphological Characters ↓	<i>Aegle</i>	<i>Feronia</i>	<i>Emblica</i>	<i>Eugenia</i>	<i>Tamarindus</i>
Habit	A small tree with strong straight sharp thorns	Moderate sized tree with rough straight sharp strong thorns	Small middle sized tree	Large tree, bark thick, and rough.	Large tree, spineless
Type of Leaves	Trifoliolate compound	Imparipinnate compound	Pinnate compound	Simple	Bipinnate compound
Texture of leaves/leaflets	Soft and fleshy	Thick fleshy, evergreen, shining	Thick glabrous	Smooth, leathery, shining, pellucid dotted	smooth, glabrous
Taste of leaves	Not sour	Not sour but citrus scent when crushed	Sour astringent	Not sour	Sour
Flowering Season	April-May	Feb-May	April-May	March-May	May-June
Types of fruits	Berry (Globose rind gray)	Berry	Schizocarpic,	Berry, Succulent globose dark-purple	Lomentum
Native	India	India	India	India	Exotic

Table No: 2. Anatomical characters

Anatomical details	<i>Aegle</i>	<i>Feronia</i>	<i>Emblica</i>	<i>Eugenia</i>	<i>Tamarindus</i>
Epidermis	Single layer uniseriate	Single layer tangentially elongated	Single layer uniseriate	2 to 3 layers Sub-epidermal secretory cavities	Single layer uniseriate
Cuticle	Present on both side	Present on both side	Present on both side	Present on both side	Present on both side
Waxy coating	Absent	Present on both side	Present	Present on adaxial side	Present
Palisade tissue	Two layers	Two to three layers	Single layer	Two layers	Single layer
Spongy tissue	Two to three layers loosely arranged	Two to five layers isodiametric, chlorenchymatous cells	Three to four layers irregular spongy parenchymatous	Three to four layers spongy parenchymatous	Three to four layers spongy parenchymatous
Vascular Bundles	Conjoint, Bicolateral open	Conjoint, Bicolateral open	Crescentric, Protoxylem pointed towards upper epidermis	Conjoint Bicolateral	Crescentric, Protoxylem pointed towards upper epidermis
Oil bodies, resins, sphaeraphides	Oil glands are found bellow upper epidermis	Oil glands and large sphaeraphides are distributed in palisade and spongy tissue	Sphaeraphides in spongy parenchyma	Lysigenous cavities in mesophyll containing Etherial oils	Absent
Stomata	Sunken amphistomatous Paracytic type	Anisocytic and anomocytic amphistomatous	Amphistomatous anomocytic	Hypostomatous paracytic	Amphistomatous paracytic

Table No: 3 Stomatal density and stomatal index

Name of the Plant	Stomatal density /mm ²		Nature of the stomata	Stomatal index /mm ²	
	Upper Surface	Lower Surface		Upper Surface	Lower Surface
<i>Aegle marmelos</i>	325	450	Paracytic/Rubiaceous type	11.50	15.25
<i>Feronia elephantum</i>	3-4	850	Anomocytic/Ranunculaceous type	0.10	18.05
<i>Emblica officinalis</i>	15-30	700	Anomocytic/Ranunculaceous type	1.18	21.87
<i>Eugenia jambolana</i>	-	800	Paracytic/Rubiaceous type	-	27
<i>Tamarindus indica</i>	60	300	Paracytic/Rubiaceous type	4.76	20

Stomata play a pivotal role in conservation of water and photosynthetic efficiency. So structure, function and distribution of stomata is an adaptive feature of the plants to the ecological conditions in which they grow. All these factors decide the gaseous exchange for photosynthesis, transpiration and respiration. Hence it is very essential to study stomatal characteristics to understand the mechanism of stress tolerance in the plants under investigation.

From the results, it is very clear that Aegle is amphistomatous in nature, Eugenia strictly hypostomatous, and in remaining plants maximum number of stomata are present in lower epidermis and very few in upper epidermis.

Carpenter and Smith-(1975) and Kramer and Kozlowskr-(1979) revealed that all tree species studied by them are hypostomatous in nature.

Bawachkar, and Hegde, (1984), have noted distribution of stomata on both the surface in mango and cashew. They have also observed the maximum stomatal density in the lower epidermis and very few stomata present in the upper epidermis.

The Stomatal studies regarding nature show that anomoacytic stomata are present in Feronia and Emblica which is supposed to be a primitive character, while Paracytic stomata are present in Aegle, Eugenia, and Tamarindus. Anomoacytic stomata are found in mango while paracytic in cashew (Bawachkar, and Hegde, 1984)

Stomatal density is higher in Feronia, Emblica and Eugenia which are more or less hypostomatous and ranging from 700-850 stomata/mm². Aegle is ampistomatous in nature, the stomatal density being 325 and 450 stomata /mm² in upper and lower epidermis respectively. Comparatively less stomatal density in Tamarindus which is also hypostomatous. Higher the stomatal density, greater is the rate of transpiration and photosynthesis, so in the plants under investigation, the rate of transpiration may be greater provided if the stomata remain fully open throughout daytime.

Stomatal index values in all the plants under investigation lie in the range 15 to 27 in the lower epidermis. The highest stomatal index seen in Eugenia followed by Emblica and other plants.

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