STUDIES ON DIFFERENT CULTIVARS OF DATE PALM (*PHOENIX DACTYLIFERA* L.) AND THEIR COMPARATIVE ROOT ANATOMY

Ghayoor Fatima[1, 2], Iqrar Ahmad Khan[2], Muhammad Jafar Jaskani[2] and Qurrat-ul-Ain Rasool[3]
[1]Organic Plant Production & Agroecosystems Research in the Tropics and Subtropics, University of Kassel, Germany
[2]Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan
[3]University of Agriculture, Faisalabad (sub-campus Dera Ghazi Khan) Pakistan
[1]Corresponding author: ghayoor.fatima@gmail.com

ABSTRACT: *Worldwide Pakistan is the 5th largest producer of date palm (Phoenix dactylifera L.) and the species ranks third among the country's fruit crops after citrus and mango. The > 325 date cultivars growing in Pakistan comprise native and exotic ones which differ widely in morphological and anatomical characteristics. Adventitious roots of fourteen cultivars from the collection at Jhang Date Palm Research Station were used to characterize these differences. To this end a 2 cm piece form each root-shoot junction was placed in FAA (formalin acetic alcohol) solution and root parameters were measured by an ocular micrometer under a compound microscope, which was calibrated with the help of a stage micrometer. The collected data on dermal, ground, and vascular tissues subjected to ANOVA.*

All fourteen cultivars can tolerate mild environmental stresses, had very specific anatomical features which indicate their adoption to a variety of environmental conditions and also play vital role in taxonomic identification of cultivars. The results indicate different evolutionary routes for the date palm cultivars studied which merit further molecular genetic study.

Keywords**:** Date palm, root anatomy, sclerenchyma thickness, diversity

INTRODUCTION

The date palm (*Phoenix dactylifera* L.) is one of the oldest fruit trees [1] which have low cultivation and harvesting costs and many useful products like fruit for food and fodder; leaves for covering and basketry; fibres for ropes and wood for construction and fuel [2]. All above qualities and its tolerance to extremely adverse environmental conditions compared with others, make it most important fruit crop in the Middle East, North of Africa and some Arabic countries, such as Saudi Arabia [3]. Among date producing countries Pakistan comes at fifth place with more than 325 date varieties [4].

Date palm is a monocot, produces fasciculated and mostly fibrous roots. Seeds give birth to the primary roots; from where secondary roots originated. Whereas secondary roots build up the tertiary roots, these are of same type and have approximately same diameter through their length [5]. Water is mainly stored in the cortex tissues of the roots [6] while wide metaxylem vessels also have the same ability [7]. Transport capacity of the roots is linked with the root aging and radial growth which results in the increasing number of the xylem vessels [8] and the diameter of largest vessels [9]. Aerenchyma formation in the roots of date palm, due to transfer of the cortex, may enhance diffusion of the atmospheric and photosynthetic oxygen from the shoot to roots [10] [11]. Collapse of cortex can be prevented through the compactness of exodermal and hypodermal layers in the roots and is also an important structural framework for the formation of aerenchyma. Extreme environmental conditions like water potential, air humidity and CO_2 during cultivation can cause abnormalities in structure of the root vascular tissues [12].

Epidermal cells in the roots of date palm may be of spindle, rectangular or hexagonal shape which ranges from isodiametric or elongated with the longitudinal and an oblique elongation into the spindle [13]. Rupturing of the epidermis and proliferations of the sub epidermal cells result into irregular and longitudinal pattern of the white rings of the surface eruptions in all orders of the roots. Proliferated cells have spherical shape, thin walls, highly suberize and many intercellular spaces. Thick walled exodermal cells and outer cortical cells seem as enlarge and undergo into one or two cell divisions which are internally paradermal [14].

Root structure is extremely imperative in the survival and growth of the date palm and various cultivars of date palm can also be differentiated on the basis of their anatomical characteristics. Keeping the above mentioned facts in mind, the present project was designed and some root structures i.e. epidermis thickness, sclerenchyma cell thickness, cortical region thickness, endodermis thickness and vascular region thickness were studied to differentiate the fourteen cultivars of date palm, obtained from Date Palm Research Station, Jang, on the basis of their root anatomy.

MATERIALS AND METHODS

Different cultivars of date palm (*Phoenix dactylifera* L.) not only from all over Pakistan but also from some other countries like Saudi Arabia, Iran, Iraq and Egypt have been cultivated at the Date Palm Research Station, Jhang. 14 different cultivars of date palm from this station were selected to study their comparative root anatomy. A sample of adventitious roots was collected from each cultivar and immediately placed in polythene sample bags. A 2 cm piece form the root-shoot junction was taken for root anatomy and placed in FAA (formalin acetic alcohol) solution (v/v 5% formalin, 10% acetic acid, 50% ethanol and 35% distilled water). After that material was subsequently transferred to acetic alcohol solution (v/v acetic acid 25%, ethanol 75%) for long-term preservation.

Free hand sectioning technique was used for the preparation of permanent slides of root transverse sections. The sections were passed through a series of ethanol grades for dehydration following [15] methodology. For staining, safranin was used for lignified tissues (sclerenchyma, xylem vessels) and fast green for subrinized and parenchymatous tissues. The sections

Table 1. Root anatomical characteristics of date palm

Cultivars	Epidermis thickness (µm)	Sclerenchyma thickness (µm)	Cortical region thickness (µm)	Endodermis thickness (µm)	Vascular region thickness (µm)
Akhrot	43.57	176.25	607.30	34.51	358.28
Angoor	32.68	136.16	547.39	44.51	408.56
Aseel	32.68	196.08	738.02	34.51	343.14
Begum Jhangi	38.12	138.89	661.77	30.23	439.98
Berehmi	59.91	125.27	659.04	39.95	438.45
Champa Kali	29.95	192.59	563.73	34.51	431.05
Chohara	27.23	184.42	667.21	40.85	471.98
Daanda	35.40	127.99	517.43	40.85	317.43
Daglut Noor	38.12	100.76	703.38	24.51	412.75
Dakki	52.80	130.72	534.97	34.51	334.97
Halawi-1	43.57	171.57	641.18	38.06	441.18
Halawi-2	21.78	178.97	673.09	37.23	354.03
Jaman	35.40	171.57	503.81	36.51	397.60
Jansohaar	21.78	179.74	---	34.51	407.30

($P<0.01$)

were finally mounted in Canada balsam for permanent slides and photographed with the help of camera-equipped compound microscope. Measurements of anatomical parameters i.e. dermal, ground and vascular tissues were obtained with the help of ocular micromerter under a compound microscope, which was calibrated with the help of stage micrometer. Data were recorded and analysis of variance and interaction between various parameters was calculated via DMR by using SPSS17.

RESULTS

Measurements of different root anatomical parameters i.e. epidermis thickness, sclerenchyma cell thickness, cortical region thickness, endodermis thickness and vascular region thickness, were done with the help of calibrated ocular micromerter under a compound microscope to compare the different root structures of all 14 cultivars, named as Akhrot, Angoor, Aseel, Begum Jhangi, Berehmi, Champa Kali, Chohara, Daanda, Daglut Noor, Dakki, Halawi-1, Halawi-2, Jaman and Jansohaar (Table I). The in detail root characteristics and comparison of all cultivars are given below,

Epidermis thickness

Epidermis thickness varied significantly ($P<0.01$) in all fourteen cultivars of date palm (Table I). Two cultivars Berehmi (59.91 µm) and Dakki (52.8 µm) surpassed all the other cultivars in relation to this parameter. The maximum epidermis thickness was recorded in Berehmi (59.91 µm) while minimum thickness was observed in Jansohar (21.78 µm) and Halawi-2 (21.78 µm).

Sclerenchyma cell thickness

All fourteen date palm cultivars were significantly varied ($P<0.01$) in Sclerenchyma cell thickness (Table I). Cultivar Aseel showed high Sclerenchyma cell thickness (196.08 µm) followed by Champa Kali (192.593 µm), Chohara (184.42 µm) and Jansohar (179.74 µm) cultivars whereas Berehmi (125.2733 µm) and Deglut Noor (100.763333 µm) have minimum thickness.

Cortical region thickness

Variation among the different cultivars according to the cortical region thickness was significant ($P<0.01$) in all the studied cultivars (Table I). Cultivar Aseel (738.0233 µm) had the greatest cortical region thickness while Jaman (503.8167 µm) showed least.

Endodermis thickness

Endodermis thickness varied significantly ($P<0.01$) in all the studied cultivars of date palm (Table I). Cultivar Angoor (44.51 µm) showed the maximum endodermis thickness while Deglut Noor (24.51 µm) have the minimum value.

Vascular region thickness

Variation regarding the vascular region thickness in the date palm cultivars was significant ($P<0.01$) as shown in Table I. Two Cultivars Chohara (471.96 µm) and Halawi-1 (441.18 µm) showed the maximum vascular region thickness while minimum thickness was observed in Daanda (317.4333 µm) cultivars.

DISCUSSION

Root anatomy of Date Palm (*Phoenix dactylifera* L.) cultivars planted at Date Palm Research Station Jhang showed significant variations (Table I). The size of epidermis cells, size and shape of outer cortical region, presence of sclerification in outer cortex and endodermal layer thickness also showed the significant diversity. Cultivar Akhrot showed two distinct portions of cortical region which were separated by the well developed sclerenchyma. Epidermis was composed of thick walled cells. Distinct sclerenchyma bundles were present in inner cortex. Thick epidermis with intensive sclerification in the cortical region not only prevents the water loss from the roots as [16] but also provides mechanical strength to the root and this is extremely important under harsh ecological conditions such as drought [17]. Additionally the increased cortical region with densely packed cells, capable of storing additional water and this is vital for surviving under limited moisture environment. This cultivar also showed thick walled endodermis and this is important for checking radial flow of water in the roots [18].

Cultivar Dakki had distinct sclerenchyma region inside the outer cortex with small sclerenchyma bundles in the inner cortex [19]. This cultivar showed large and few metaxylem vessels and intensive sclerification in pith region. This root structure indicated the tolerance of Dakki cultivar to variety of environmental stresses mainly drought, salinity and water logging. This justifies its wide cultivation in the southern KPK province.

Epidermis in cultivar Aseel was comprised of extremely large cells and very well developed sclerenchyma in outer cortical region. Outer cortex was composed of very much reduced parenchymatous cells, whereas in larger rounded and densely packed cells. Distinctive sclerenchyma bundles were recorded in inner cortex. Intensive sclerification was also recorded in the vascular region. The variation in parenchymatous cells that is a small tightly packed cells in the outer cortex. Larger cells in the inner cortex with distinctive sclerenchyma region and sclerenchyma bundles may indicate the high tolerance level of this cultivar to variety of environmental condition [20].

Cultivar Halawi-1 showed poorly developed sclerenchyma in outer cortex and irregularly shaped cells in the inner cortex. Intensive sclerification present in the vascular region. Large phloem area may be responsible for increased translocation of photosynthate [21]. Overall the root structure in Halawi-1 indicated relative sensitivity of cultivar to environmental stresses. This may be the reason of its limited cultivation in Jhang and Faisalabad region.

Distinctive anatomical features in Chohara cultivar were large root area, large vascular region with intensive sclerification in pith region. Well developed sclerenchyma in the outer cortex. Thick roots are known to be characteristic feature of drought and salt tolerant plant [22]; this may justify the wide cultivation of this cultivar in Punjab, Sindh and KPK as it can tolerate a variety of environmental stresses.

Cultivar Berehmi showed typical characteristics in the root anatomy with well developed sclerification in cortical region and highly enlarged phloem. Moreover intensive sclerification was also recorded in the endodermal cell walls. Such modifications can help in transport of solute and reserve food [23] and helpful in controlling radial flow of water [24].

Anatomical features in Daanda, Angoor and Halawi-2 were very similar. All these cultivars showed large epidermal cells and distinct sclerenchyma in the cortical region, thick endodermis and intensive sclerification in vascular region. Epidermis along with intensive sclerification in cortex as well as vascular region is characteristics of drought tolerant plants [25].Therefore all these cultivars can be rated as suitable for arid and semi arid regions [26].

Highly enlarged vascular region with large metaxylem vessel was recorded in Jaman, Jansohar, Beghum Jhanginand Champa Kali. These cultivars also showed distinctive sclerenchyma in cortical region and prominent sclerenchyma bundles. On these bases it can be concluded that these cultivar can perform better under moderate climate [27].

Distinct modification in the root anatomy of cultivar Deglut Noor was observed. Very prominent sclerification was recorded in epidermal and hypodermal region. This cultivar was characterized by small aerenchyma and highly sclerified pith region. These anatomical features are typical of xeric nature with the main function of efficient transport of water and prevention of water loss through the roots [28].

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