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Review Article

Ecology and establishment of fiber producing taxa naturally growing in the Egyptian deserts



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ABSTRACT

The natural plant life of The Egyptian deserts is formed mainly of xerophytes and halophytes rich with fiber taxa that could be considered renewable resources for various fiber industries. Fourteen of these species were described ecologically. The fiber contents of seven species, namely, *Thymelaea hirsuta*, *Cyperus papyrus*, *Desmostachya bipinnata*, *Typha domingensis*, *Typha elephantina*, *Juncus rigidus* and *Juncus acutus* were measured. The long fibers (1200–6100 μm) represent about 60% of the fiber contents of the first five species; the reverse was true in the two *Juncus* species. *Juncus* spp. are halophytes proved experimentally to produce good quality paper. Successful field experiment to establish *Juncus* spp. in saline soil of Egypt's desert was conducted. Irrigation of the experiment was carried out using the non-fresh water of Manzala Lake.

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1. Introduction

Egypt, being part of the arid region, is an almost rainless country (mean annual rainfall = 10 mm). Egypt's deserts (Western, Eastern and Sinai) occupy more than 95% of its total area (1,019,600 km^2) [1]. Vast areas of these deserts are practically barren, however, natural vegetation usually occurs in the narrow northern Mediterranean coastal desert which enjoys, relatively, considerable amounts of rainfall (mean annual = 60–250 mm). Also, desert vegetation is a characteristic feature of the oases and depressions in the inland part of

the Eastern Desert where the ground water is shallow or even exposed. In the Eastern and Sinai Deserts, the natural vegetation occurs in the main stream and deltas of the wadis as well as on the slopes of the mountains that receive orographic rainfall with mean annual up to 60 mm [2,3]. On the other hand, the narrow areas of the fertile lands of the River Nile Region (Nile Valley and Nile Delta), through occupy less than 5% of Egypt's area, yet they represent the backbone of the cultivation of the traditional crops that are fully utilizing the freshwater of the River Nile. Thus, there is no surplus of Nile water that could be used for any agro-industrial and social activities in Egypt's deserts which should depend mainly upon

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their own natural resources of water to grow and establish non-conventional crops having low water requirements to be selected from the desert plants.

Ecologists are claiming that the green areas of the world are getting smaller as a result of uncontrolled felling of forest trees associated with ill advised land and water management. This may indicate that the pulp importing countries, mostly in arid regions, could face some difficulties. The pulp exporting countries may reduce and/or stop cutting their woods to maintain environmental equilibrium [4]. Thus, Egypt and other pulp importing countries should search for sufficient amounts of local raw materials for their paper and other fiber industries.

The present paper is an attempt to brief the environmental factors and main groups of the desert vegetation as well as to throw light on representative most well-known fiber producing plants naturally growing in Egypt's deserts. Their ecological characteristics are described. In addition; establishment of two of these species under desert conditions is discussed.

2. Desert vegetation in Egypt

2.1. Physical environment

The land of Egypt occupies the north eastern corner of The African continent (lat. 23°N–22°N) with total area of 1,019,600 km² including the Sinai Peninsula (the Asian part of Egypt) [1]. Being an arid country, apart from the fertile land of the River Nile region (Nile valley and Nile Delta), which occupies less than 5% of its total area, Egypt is ecologically, hot and dry desert. The country forms part of the great desert belt that stretches from the Atlantic Ocean across the whole North Africa through Arabia.

The Egyptian deserts are: Western Desert (west of the Nile, about 681,000 km²), Eastern Desert (east of the Nile, about 223,000 km²) and Sinai Desert (about 610,000 km²). The western Desert is characterized by oases and depressions and one mountain (Gebel Uweinat) in its south-western corner whereas both Eastern and Sinai Deserts are characterized by several wadis and chains of mountains [3].

Egypt is characterized by a hot and almost rainless climate. The average annual rainfall over the whole country is only about 10 mm. Even along the narrow northern strip of the Mediterranean coastal land where most of the rain occurs, the average annual rainfall is usually less than 200 mm and the amount decrease very rapidly inland (southwards). The scanty rainfall accounts for the fact that the greater part of Egypt (>95%) is barren and desolate desert with very low population density. The reverse is true in the River Nile Region where almost all Egyptians (up to 90 million on 2013) are living. Egypt's fertile land is intensively used for agriculture as well as for establishments of houses, schools, hospitals etc. Unfortunately, the areas of the fertile land are decreasing quickly by increasing population. Thus, Egyptians should move to their deserts to overcome such acute problem.

2.2. Vegetation groups

The permanent framework of the desert vegetation is formed mainly of perennial plants that could be classified under five

groups: xerophytes, halophytes, psammophytes, helophytes and mangroves. The xerophytes are, by far, the most important and characteristic type of the natural plant life of Egypt's desert. Being drought resistant, the members of this group covers vast area of the deserts, mostly shrubs and under shrubs e.g. species of *Calotropis*, *Anabasis*, *Hammada*, *Leptadenia*, *Lycium* and *Zilla*, robust grasses e.g. species of *Panicum* and *Pennisetum* and few trees e.g. species of *Acacia* and *Balanites*. The halophytes (salt marsh plants) are the second most important type of vegetation, occurring in the extensive salt –affected lands along the coastal belts but also in the inland oases and depressions. Halophytes are either succulents, e.g. species of *Arthrocnemum*, *Halocnemum*, *Suaeda*, *Salicornia*, *Salsola* etc., excretives e.g. species of *Aeluropus*, *Limoniastrum*, *Sporobolus* and *Tamrix* and cumulatives e.g. *Juncus rigidus* and *Juncus acutus*. The psammophytes (sand dune vegetation) include species of *Ammophila*, *Euphorbia*, *Silene*, *Thymelaea*, *Halopyrum*, *Aristida*, *Stipagrostis* and *Populu*, limited number of species are helophytes (reed swamp vegetation) e.g. species of *Phragmites*, *Typha* and *Cyperus*. Mangrove vegetation, being tropical formation, occurs only south of Lat. 28°N in the shorelines of the Red Sea coast from Hurghada (Lat. 27°14' N) southwards to Mersa Halaib (Lat. 22°N) as well as in the swamps of Ras Mohammed cap (Lat. 27°45' N) and southern section of the Gulf of Aqaba of Sinai Peninsula. It is represented by two species namely: *Avicennia marina* and *Rhizophora mucronata*.

Although the mountains of the Red Sea coast and Sinai Peninsula are in extremely dry deserts, rainfall is relatively high (up to 60 mm/year, mainly orographic) forming relatively favorable climate for plants than in the other parts of Egypt's deserts. The flora includes species of *Caralluma*, *Cocculus*, *Dodonaea*, *Dracaena*, *Moringa* and *Rhus*. In the high mountains of Sinai Peninsula (up to 2641 m a.s.l.), air temperature are lower than elsewhere in Egypt, being usually below freezing point in winter; some plants of cold regions of the world occur here, e.g. species *Juniperus*, *Crataegus* etc. [3].

Apart from the perennial flora in Egypt's desert, the short-lived plants (therophytes) comprise the greatest number of herbaceous plants that appear only during the short winter rainy season changing the yellow desert into green carpets. These plants (ephemerals, annuals and biennials) get dry with the arrival of the long summer rainless period [5].

3. Ecology of representative fiber producing plants

Many plant species that supply 90% of world's food, fodder, fibers, drugs etc. were domesticated from wild plants in the tropics [6]. Thus the existing wild desert plants, mostly still unclassified and unevaluated, remain interesting to plant ecologists, agronomists etc. to introduce them as non-conventional crops to be cultivated under desert environmental conditions.

Field studies and personal communications with the local Bedouins of the Egyptian deserts enables the authors to determine that, the flora of Egypt's deserts is rich with fiber producing taxa. Out of these 14 most well-known species had been selected for the present study. The followings are short notes on these representative species.

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