Global Scientific JOURNALS

GSJ: Volume 9, Issue 12, December 2021, Online: ISSN 2320-9186

www.globalscientificjournal.com

# THE EFFECT OF SOIL DEGREADATION FACTORS ON THE BIOPOTENCY OF FOREST PLANTS IN THE CONDITIONS OF KHOREZM REGION OF UZBEKISTAN.

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**Abstract.** Focusing on some features of the soils of the Lower Amudarya region, the scientists noted that the region is characterized by very weak natural groundwater flow and lack of artificial drainage structures. This factor enhances soil salinity and secondary salinity. In particular, wind erosion is affecting soil fertility. In irrigated lands, such soils make up 19.1%. In the Lower Amudarya region, 85-90% of water is used for irrigation. According to the research of the international project "Ecological and economic improvement of land and water use in Khorezm", between 1982 and 1999, the water use capacity of Khorezm farmers decreased by 16%, and the risk of crop failure is increasing. Analyzes show that there will be less water in the region in the future. To prevent this, some farmers are now blocking drainage ditches and raising the groundwater level. Proper distribution of water, in general, requires finding ways to further increase the efficiency of crop irrigation. According to scientific studies on natural trees planted on very low-yielding (abandoned) lands, trees thrive even when 40% of the irrigation is less than normal. However, in order to care for trees in a specific area, their species must be carefully selected. This is because trees can be used for a variety of purposes, such as growing biomass fuel, animal feed, or increasing the amount of organic matter in the soil by leaving it on the ground. It is known that trees also play a role in bio-drainage. Although they cannot completely replace technical drainage, they are a powerful tool in lowering groundwater levels and preventing secondary salinization. In addition to preventing land degradation, afforestation will also help rehabilitate abandoned areas.

**Key words.** Afforestation, salinization, land degradation, irrigation fields, biomass, forest, bio-drainage.

**Introduction**. Tackling the problem of soil degradation is one of the most acute problems of our time, and, in fact, it is about preserving soil fertility in the arid zones of the Central Asian republics with the aim of efficient and sustainable food provision. The soil is one of the national wealth of the state and belongs to the strategic natural resources [Akhtyrtsev B.P. 2000, Dobrovolsky G.V. 2002]. Fertility is the specific and unique property of soil to transform solar energy by creating organic matter with the help of plants. The historical experience of the development of civilization shows that the rise and fall of any state is directly related to the factor of soil fertility. At present, the processes of soil cover degradation are intensifying all over the world [Akhtyrtsev B.P. 2000, Muravyov A.G. 2000].

Land degradation is a serious economic and environmental problem in Central Asia that directly influences on the living population. The causes of land degradation and desertification are mainly due to climate fluctuations and anthropogenic activities [Dobrovolsky G.V. 2002, Muravyov A.G. 2000, Khamzina A. et. al. 2005].

Desertification refers to the degradation of land in arid, semi-arid areas as a result of various factors, including climate change and human impacts. Desertification of the steppe is accompanied by the formation of desert natural complexes. These changes disrupt the species diversity and structure of phytocenoses and lead to a shift in biological equilibrium, to a decrease in biological productivity, and, ultimately, to a decrease in the role of one of the most important factors of soil formation - vegetation [Akhtyrtsev B.P. 2000, Heupermen A.F. et. al., Khamzina A. et. al. 2005].

Saline soils are an essential component of both natural and anthropogenic landscapes in arid areas. Salinity is one of the main genetic traits of arid soils, as well as a property that limits their fertility. The issues of classification, genesis and reclamation of soils in arid regions cannot be solved without a detailed study of saline soils, accurate accounting of their distribution and development forecast [Akhtyrtsev B.P. 2000, Dobrovolsky G.V. 2002].

Soil degradation is defined as a temporary or permanent decrease in soil fertility that occurs under the influence of geological, geomorphological, and human factors [Katyal J.C. and Vlek P.L. 2000]. According to the data obtained, it is indicated that 21% of the available soils have become unusable soil owing to the impact of degradation [FAO 2009]. In Uzbekistan, 24% of soil is physically and chemically degraded as a result of agricultural activities. 13% of them have been irreversibly degraded over the past 40 years.

Desertification is one of the main problems in Uzbekistan due to the impact of habitat on the environment or misuse of land. About 90% of the total land area of Uzbekistan is at risk of desertification [FAO 2009]. Soil conditions that increase the susceptibility to degradation include salinization, rising groundwater levels, soil fineness, and susceptibility to erosion. Among them, salinity and alkalinity are the most dangerous, threatening half of the available crop areas [FAO 2009]. Khorezm region is one of the most remote regions of Uzbekistan, located in the lower reaches of the Amu Darya. The low location of Khorezm soils increases their salinity and weakens the drainage system.

An important factor in the stability of desert woody plants is their intraspecific polymorphism. The spatial organization of individual populations of woody desert plant species carries the most important information about the results of their interaction with environmental factors (soil characteristics) and with themselves. The variability of the internal structure of isolated groups makes it possible to judge the possibility of adaptation of its constituent elements to abrupt changes in the environment without significant changes in the gene pool [Shein E.V. 2008, Vorobyova L.A. 2006].

Nevertheless, at present, insufficient attention has been paid to integrated comprehensive studies of the biogeocenotic plan in the Khorezm oasis, the study of soil properties and the direction of soil-forming processes and their influence on the genetic structure of woody vegetation populations, which determine the stable functioning of arid ecosystems.

**Materials and Methods**

Khorezm region is the oldest agricultural region in the world. Irrigated lands in Khorezm expanded and in 2000 accounted for 49% of the region. 40% of them are rated as highly productive. About 15-20% of the area is unusable.

There are three forms of farming in agriculture: state farmers, private farmers and peasant farmers, or farmland. In 2005, all areas were transferred to full farm management. At the same time, 13,839 private farms were established on 188,329 hectares of land, ie an average of 13.6 ha/farmer, and 247,840 dehkan farmers were organized on 48,912 hectares or an average of 0.2 ha/farmer.

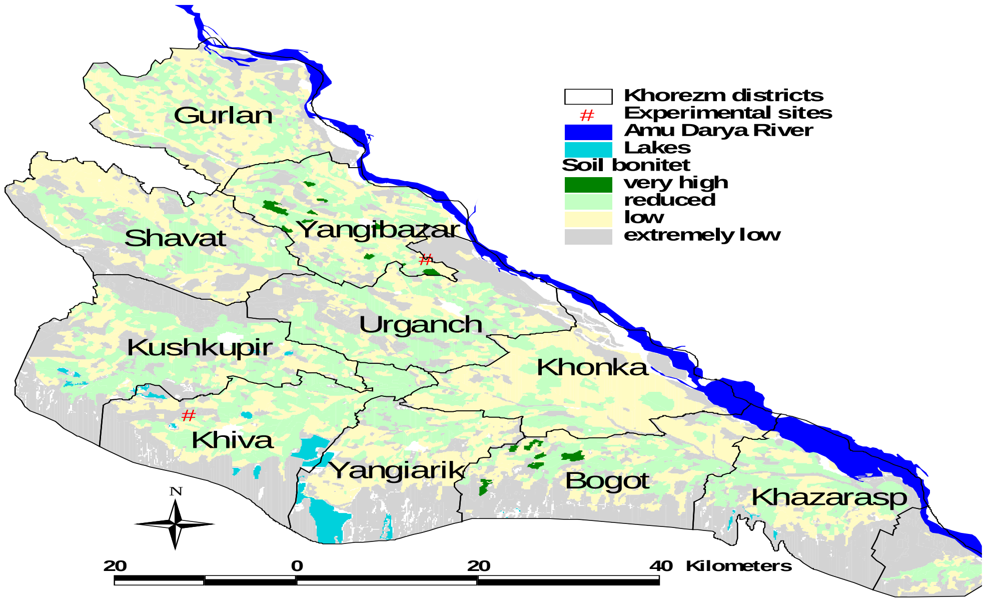


Figure 1. Soil validity for agricultural crops

Irrigation water is distributed among farmers according to the area planted and the types of crop. Agriculture specializes mainly in cotton, rice and wheat. Especially cotton is widely grown, which now accounts for 50% of the crop area.

In addition to preventing soil degradation, trees can serve as timber and fodder for cattle. Wood is a source of heat and is now used in many Uzbek homes. 95% of the timber cut in the country, ie 50,000-80,000 $m^3$, is used as firewood. Demand for wood, as well as gas and electricity, is expected to increase as the population grows by 2% per year. Trees and shrubs can also serve as fodder for cattle.

**Results and Observation.**

Reforestation in degraded lands is carried out taking into account soil salinity, groundwater table (GWT) and low fertility. Then the type of tree is selected depending on these characteristics. When tree species that reduces groundwater level table and salinity (GWTS), are planted, ecological balance is ensured and tree diversity reflects biodiversity potential.

Biological drainage is used to increase the transpiration ability of plants, reduce salinity. Therefore, a simple drainage system requires a large amount of money, and bio-drainage is an alternative [Heuperman A.F. et. el. 2002, ].

In order to effectively use bio-drainage in reducing salinity in the fields, it is necessary to choose the type of tree carefully and take into account its evaporation of water. In this case, the deep rooting and horizontal spread of the tree is important for biological drainage [Lamers J.P. et. al. 1994].

The water use (WU) leaf unit differs from one tree species to another. In this case, the leaf axils also change under the influence of water. WU and leaf area (LA) units are not the main indicators in determining tree species [Muravyov A.G. 2000, Lamers J.P., et. al. 2005]. WO was studied in the areas that dry acacia seyal del. was cultivated. In Uzbekistan, the properties of trees in local conditions have been extensively studied [Stroganova M.N. et. al. 2001, Shein E.V. 2001, Robinson S. and Engel E. 2008], using gravimetric methods, the differences in the change in weight of tree leaves per unit time were analyzed.

Studies have shown that LA does not depend on tree species even in agroecological conditions in Khorezm. The diversity of high-yielding trees requires farmers to use inexpensive biodegradable technology when WU is at a certain salinity.

The research was conducted at the Khiva Scientific Station of the Forestry Institute. Figure 2 below shows the evaporation from the leaf (based on various parameters of the atmosphere).

In two fields of plantations, salinity levels were reduced prior to the experiment, with the same increase observed. Water retention was determined using field-specific field capacity (FC) and wall pressure (WP) methods in a nearby laboratory.

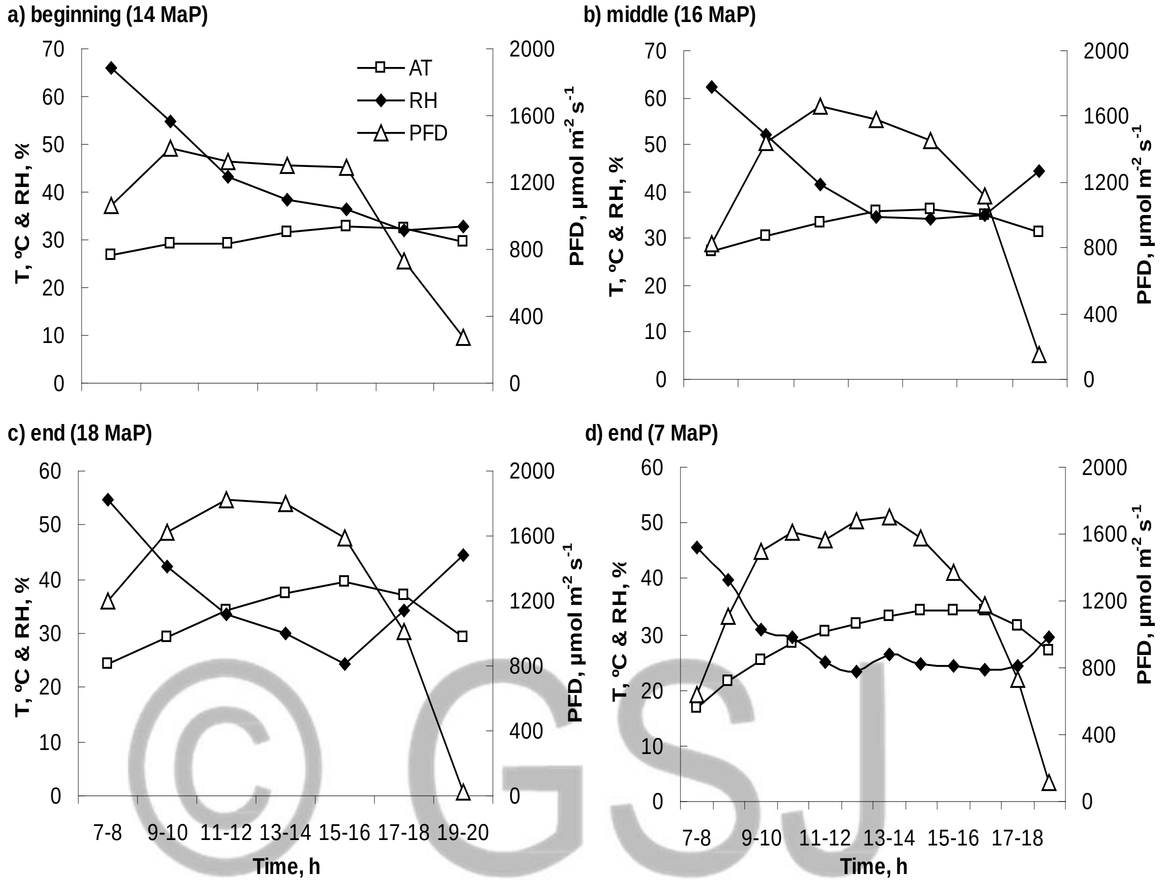


**Figure 2. The indicators for T (temperature), RH (relative humidity) and photon flux density (PFD) were given for the beginning, middle and end of the agricultural season.**

In areas where irrigation is widespread, GWT levels are high near rice fields, and surface irrigation is typical for trees in loamy areas. In sandy areas, one watering was sufficient during the growing season. In other cases, the trees were affected by GWT. During the experiment, the humidity was maintained at a normal level (Fig. 3) and the moisture content of the tree roots was dependent on the evapotranspiration potential caused by atmospheric factors. Soil salinity did not increase in the 2 areas surveyed and remained at low salinity until the end of the season. In sandy soils, the salinity level was relatively high.

The experiment was conducted in six iterations using the randomization method.

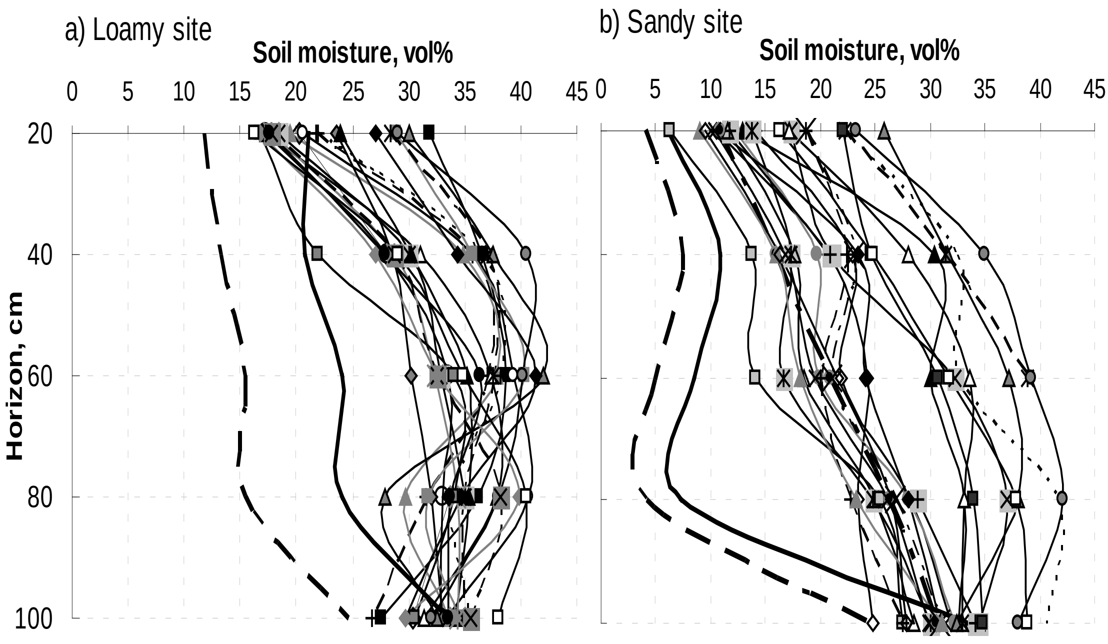


**Figure 3. Soil moisture was studied in the experimental fields in 2002-2003. Here, the barcode lines and full lines indicate the FC and WP of the soil moisture, while the narrow lines indicate the soil moisture observed at different periods of the 2002-2003 agricultural year.**

Initially the amount of dry mass was determined at 7 months of the experiment, it was found to be higher in all species of trees in sandy areas, but at 19 months it was found to be higher in some tree species in loamy areas.

In sandy areas, the trunks and leaves of trees were usable at 7 months, but at 19 months, many tree species in these two areas did not differ significantly from each other when compared. Especially in sandy soils, no difference was observed between tree species at 19 months compared to 7 months (Fig. 4). *E. angustifolia*, *P. nigra* var. *pyramidalis* and *U. pumila* showed the highest dry mass production, regardless of soil type and date of harvest. While the growth and development of the *U. pumila* species has shifted to the underground dry mass, other tree species, such as *E. angustifolia*, have devoted more of their energy to the above-ground dry mass. Although *P. euphratica* was proved to grow well in the sandy soil, it was infertile in the loamy soil. *S. nigra* and *M. alba*, however, achieved the highest total dry mass production at 19 ECOs.

The analysis of ANOVA showed the interaction of all root growth parameters except species, soil, and maximum length of coarse roots. The maximum length of the coarse roots differed significantly only in the trees in the loamy area. In 7 ECO, in the dry mass and in the main part, it was noted that the total length of the fine roots was higher in the heavy loamy area.

The growth of root structures in the soil composition was not uniform. Over time in heavy loamy soils the roots of *M. alba, S. nigra and P. armeniaca* developed well. But its coarse roots did not differ much from each other in any soil type. The roots of other species were observed to grow well in sandy soils. In both areas, tree roots passed down through the small capillaries of the groundwater tables (GWT).

When three-fourths of the apex side of each tree was illuminated, leaves were measured every two hours (total of 30 hours) during the flowering period. A hairy leaves of *T. barossowii* was not suitable for measurement with aperture cap. Also, the slender leaves of *P.euphartica*, which grows in loamy soil, were not suitable.

As a result of the logical limitation, only three species were measured in the sandy soil during the second season. They showed high growth in 7 months. At 19 months, this trend continued, but in loamy areas, some *P. armeniaca and C. bignonioides* tree species were almost not bad. The dry mass of *M. alba* is an exception, as more than 50% of the root was in the heavier loamy soil than in the sandy soil.

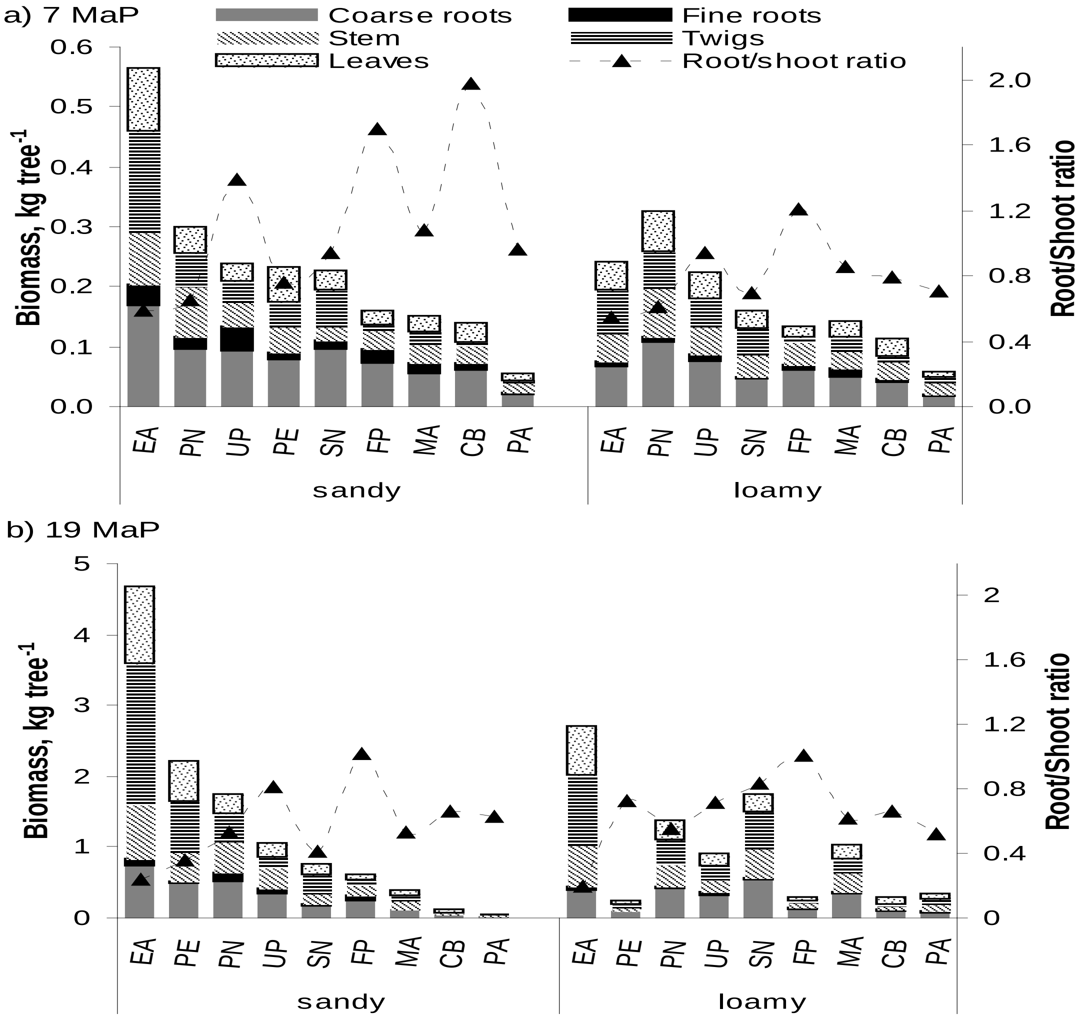


**Figure 4. The biomass production of the nine tree species is divided into: coarse and fine roots, stems, twigs and leaves, and the root/shoot ratio according to soil type and date of harvest. Species are classified in descending order according to total biomass**

**in sandy soils. PA = *P. armeniaca,* CB = *C. bignonioides,* EA = *E. angustifolia,* FP = *F. pennsylvanica,* MA = *M. alba,* PE = *P. euphratica,* PN = *P. nigra* var. *pyramidalis,* SN = *S. nigra,* UP = *U. pumila.***

The growth of root structures in the soil composition was not uniform. Over time in heavy loamy soils the roots of *M. alba, S. nigra and P. armeniaca* developed well (Fig. 5). But its coarse roots did not differ much from each other in any soil type. The roots of other species were observed to grow well in sandy soils. In both areas, tree roots passed down through the capillaries of groundwater table (GWT).

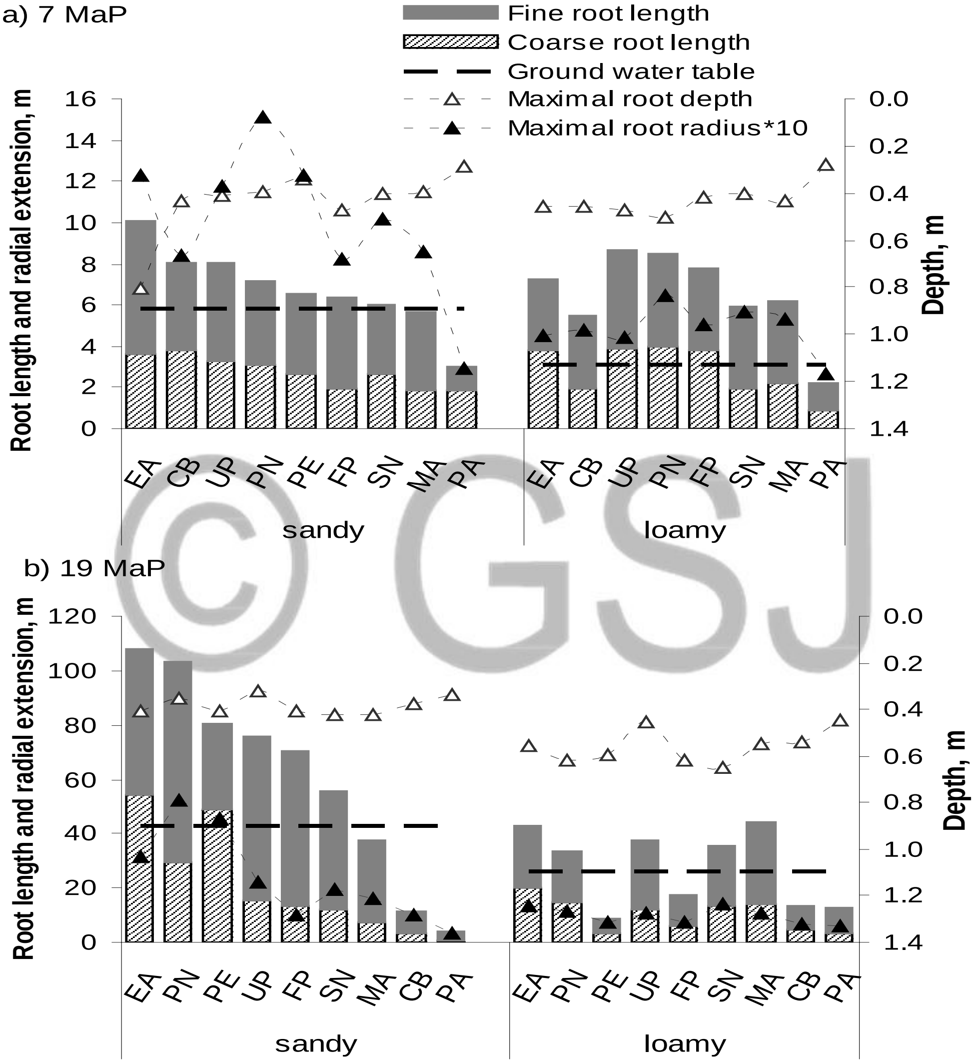


**Figure 5. Coarse and fine roots length of tree species, the maximal root radius and root depth, and groundwater table depending on soil type and date of harvest. Maximal root radius values multiplied by 10 in order to improve visibility. The species are classified in descending order by their total length in the sandy area. PA = *P. armeniaca,* CB = *C. bignonioides,* EA = *E. angustifolia,* FP = *F. pennsylvanica,* MA = *M. alba,* PE = *P. euphratica,* PN = *P. nigra* var. *pyramidalis,* SN = *S. nigra,* UP = *U. pumila.***

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In physiological research, the water use efficiency (WUE) is taken as the ratio of photosynthetic water to evaporation, but for environmental, agricultural and forestry purposes, the ratio of DM to water demand is appropriate. The calculated value of WUE in species differ significantly, according to (WUEA) and root DM (WUEB).

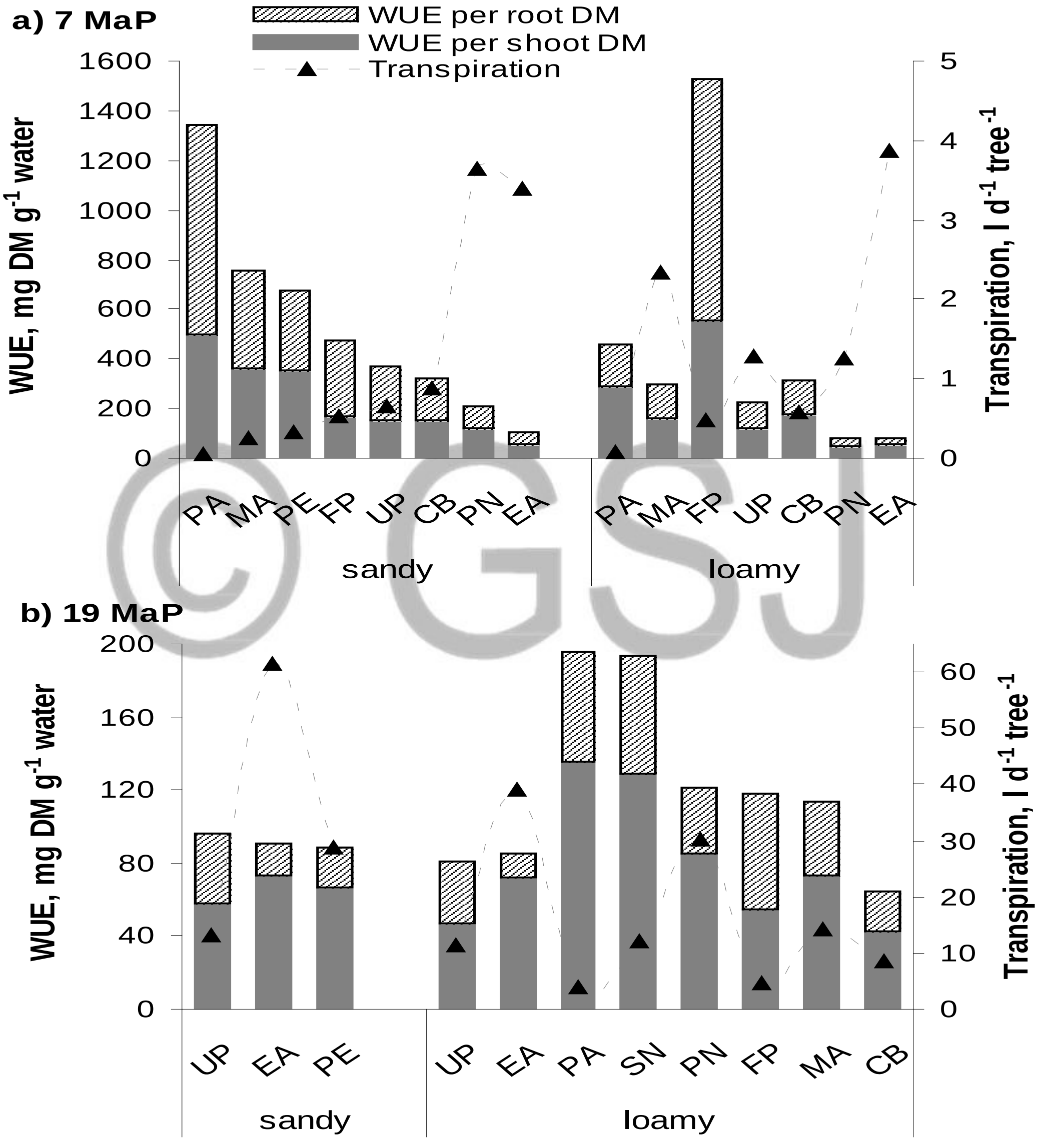


**Figure 6. Root water utilization efficiency (WUE) and daily transpiration are evaluated according to the total amount of WUE in loamy soils in descending order according to soil type and yield time. PA = *P. armeniaca*, CB = *C. bignonioides*, EA = *E. angustifolia*, FP = *F. pennsylvanica*, MA = *M. alba*, PE = *P. euphratica*, PN = *P. nigra* var. *pyramidalis*, SN = *S. nigra*, UP = *U. pumila*.**

For example, at 7 months, the performance of *P.armeniaca* in loamy soil and *F.pennsylvanica* in heavy soil was higher than other varieties. This trend was not observed for 18 months. The WUE value was also higher in specimens strongly developed from the surface part of the root. At 18 months, WUEA was higher *in P.armeniaca and S.nigra*, while WUEB was higher in *F.pennsylvanica*. According to the age of the tree, WUE has the largest amount for *F.pennsylvanica,* and the smallest variation for the *E. Angustifolia and R.nigra var.Pyramidalis*. At 7 months, full WUE was higher in sandy soils than in heavy soils. At 7 months, WUE was found to be inversely proportional to daily evaporation. At 18 months, this trend was not observed.

In assessing the potential of different trees for saline soils in Khorezm conditions, it is necessary to take into account water demand, salinity resistance and leaf formation of the tree based on field experiences. In three-year-old trees, the transpiration property of the leaf varies according to the type. The ability of water to evaporate from trees that grew when there was sufficient water in both soils was consistent with the development of their root system. The correlation of WU with LA was particularly characteristic of heterogeneous young trees. *E. angustifolia, U. pumila, P.euphratica* and *P.nigra var.Pyramidalis* can be shown as leading in terms of WU, root development and adaptation to the environment, *P.armeniaca* and *M. elba* had low performance in terms of biological drainage. Considering that *E. angustifolia* and *U. pumila* also absorb nitrogen, as well as the fact that they also have a high wood value, they can be said to be suitable candidates for biodrainage.

**Conclusion.**

The growth of trees planted in an area with high salinity and low groundwater levels was satisfactory, with 40% of the intended amount of water used. The water supplied had an effect on soil moisture, but soil salinity increased as a result of trees absorbing water. But long-term research is needed to fully consider this factor. Due to the slow growth of *U.rumila* initially and the length of its life span, the surface to root ratio is normal. *P.euphratica grows* well in drip irrigation conditions, only the difficulty of adapting it to the new location prevents it. It has been found that its root system is well developed in irrigation, which is explained by its effort to overcome adverse environmental conditions.

Assuming that the purpose of irrigation was to ensure the normal development of the trees by supplying water, an irrigation system would not be required at all in soils with high salinity and high groundwater levels.

Forest management improves the ecological situation by ensuring that farmers in saline soils receive valuable products from degraded soil. However, in order to get effective results from forest management, it is necessary to study the trees of the appropriate species in detail.

This research is so important for Khorezm that it can be used to develop future assessment methodologies.

Forest management in the degraded lands of Khorezm region requires a tree species that is resistant to salinity and nutrient deficiencies in the soil, easily adapts and grows quickly. Also, the tree type should be a valuable source for fruit, leaves, or firewood to justify farmers 'commitments. Examination of 10 species of trees showed that *E.angustifola* and *T.varossowii* had the highest growth potential in sandy and heavy soils in terms of growth. Along with these two tree species, *U. pumila*, *P. nigra var.Pyramidalis* and *P.euphratica* species were also examined and their growth rates were observed as a parameter (root or surface part) or soil structure digestibility and protein content analysis of 2-3 year old trees leads to the conclusion that it does not meet the needs of cattle when preparing fodder.

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