42 The characteristics of tree root system at seadikes and its function on soil conservation

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Introduction

The silty coastal zone of China is mainly distributed in the northern part of Hang-zhou Bay. The area of reclaimable land in this region is 570000ha.. It is suitable to develop agriculture, forestry and animal husbandry in the area after constructing seadikes to prevent backward flow of sea water. Construction of seadikes is the most important protective engineering in coastal zone. Soil erosion caused by rainfall and tidal wave influences on the stability of seadikes seriously, So that a big sum of money is spent on the protection of seadikes every year. On the other hand, forest has been developed on all the seadikes to keep them stable. Some people disagree to plant trees on them, because they worry about the influence of root passage and windfall of trees on their stability. More and more studies on the management and productivity of forest have been done, but there is only a few research on soil conservation function of tree roots at seadikes(Lin 1993, Kang 1994, Zhang, 1995). The purpose of this study is to evaluate the function of root systems on soil conservation and to select tree species for afforestation.

Study area is located at the seadikes of Northern Jiangsu province in the subtropical area of China. Average temperature and mean precipitation are 14.8 ℃ and 1028.5mm respectively. The top widthes of seadikes vary from 8~10m and the height is about 8.0-8.5m. The gradients of outer slope (facing to sea) and inner slope are 8°~10° and 20° ~30° respectively. Tree species on seadikes are mainly black locust (R. pseudoacacia), cryptomeria (C. chinensis), water fir (M. glyptostroboids), small bamboo (Ph. bambusoids) and some chinese fir (C. lanceolata).

The composition of root biomass

There is a greater difference in the composition of root biomass among the tree species on seadikes(Fig.1). 60%~70% of small bamboo's root biomass is composed of rootlets (d<2mm). The rootlet biomass of water fir and cryptomeria take about 20%~25% of their total root biomass. But for black locust, it only takes 3%~5% of its total amount, and the major part of root biomass is composed of bigger roots (d>2mm).

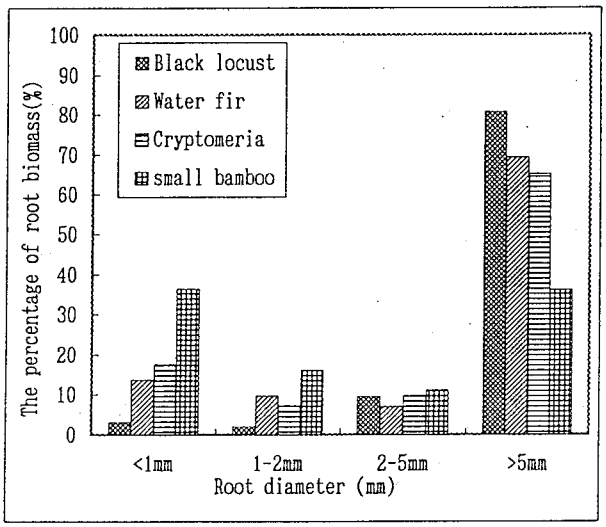

Fig.1 The distribution of tree root biomass

The Influence of tree roots on soil anti-scouribility

Topsoil(0~10cm) usually has bigger anti-scouring index than that of substratum because of the bigger root biomass in it. The anti-scouring index of topsoil on small bamboo land is bigger than those on other forest lands. It is smaller than those of other forest lands when soil depth is over 30cm. The index on cryptomeria forest land is greater than those of water fir and black locust by 14% and 24% respectively. In the case of no improvement of tree roots on soil characteristics, the soil anti-eroding index on bare land is the smallest among all sites mentioned above. On the other hand, statistical analysis has been done with the biomass(X_1/g) and length(X_2/m) of rootlets (d < 2mm), organic matter content of soil(X_3 / %), and soil anti-scouring index(Y). The correlation is as follows.

$Y=0.15+0.06X_1+0.03X_2+0.56X_3$ $R^2=0.85$.

The Influence of tree roots on soil anti-erodibility

Research result shows that there is close correlation between soil anti-eroding index(Y), root biomass(X_1/g), root length(X_2/m) and organic matter content(X_3 / %) as follow.

$Y = 0.15 + 0.06X_1$ $R^2_1 = 0.75$

$Y = 0.10 + 0.41X_2$ $R^2_2 = 0.82$

$Y = 0.05 + 0.66X_3$ $R^2_3 = 0.90$

From the correlation coefficients(R^2_1; R^2_2 & R^2_3), it is found that the content of soil organic matter has the greatest function on increasing soil erosion resistance. The length of rootlets is the second and the biomass is the smallest one.

The Influence of tree roots on soil infiltration rate

Soil with a lot of tree roots usually have higher soil porosity and stronger infiltration capability. Topsoil has greater infiltration rate than that of substratum (10-40cm or 40-80cm). The time arriving steady infiltration of topsoil is also shorter than that of substratum. The correlation equation between soil non-capillary porosity(X) and the steady infiltration rate(Y) is as follows.

$Y=-507.93+148.73\ln X$ $R^2=0.86$

The evaluation of roots' function on soil conservation

Fig.2 shows that the anti-scouring index, anti-eroding index and steady infiltration rate on bare land are much smaller than those on forest lands. Its soil erosion modulus is bigger than those on forest lands by 40%~60%. Soil erosion modulus on small bamboo land is only 210t/km^2.year, because there are so many rootlets in topsoil to keep soil particles and to improve soil characteristics. Erosion modulus on black locust forest land is bigger than those on small bamboo, cryptomeria and water fir lands by 98.3%, 25.1% & 10.4% respectively. Erosion modulus on cryptomeria forest land is smaller than that on water fir land by 10.4%, because the former has bigger rootlet biomass and anti-scouring index than those of the later. The order of soil conservation function is small bamboo forest > cryptomeria forest > water fir forest > black locust forest > bare land.

Conclusion

The paper mainly deals with the characteristics of tree root system on seadikes and its function on soil conservation. Some main results are as follows: Tree roots, especially, the rootlets and fibrils (diameter< 2mm) have great network function on soil particles and could increase soil anti-scouribility and anti-erodibility obviously. Soil with many tree roots will have higher non-capillary porosity and stronger infiltration capability. In the tree species on seadikes, small bamboo forest has the greatest function on soil conservation. Cryptomeria forest is the second, water fir forest is the third and black locust forest is the smallest, but much bigger than bare land.

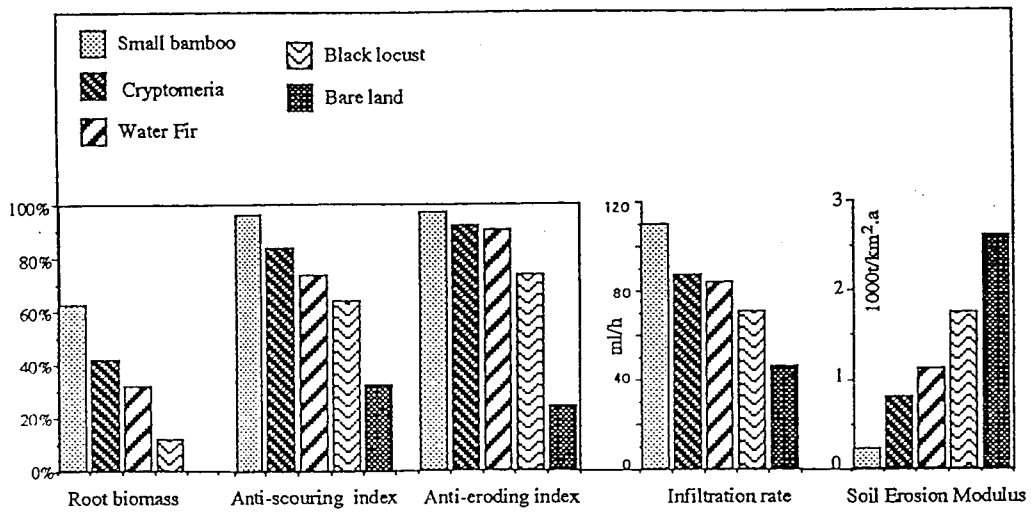

Fig.2 the function of root system on soil conservation