SALT TOLERANCE IN HERBAGE AND ITS APPLICATION TO GREENING THE DESERT

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ABSTRACTS

Canadian peat moss was used as water holding material and the efficacy of mixing the peat with the sand on water holding capacity of the sand, and the adaptability of alfalfa (AL), burmudagrass (BG), bahiagrass(BH), weeping lovegrass (WL) and Japanese lawngrass(JL) to dry and saline conditions were investigated. Without mixing peat, pF value of the sand did not change for 6 days after watering, but rose markedly up to 2.9 after 18 days. With mixing peat at the rate of 2% by the sand weight, the value did not change for 20 days, and rose gradually up to 2.5 on 30th. The yield of the herbages was the highest in the sand with peat at 2%, and WL showed the highest value followed by BG. Salt tolerance at germination and seedling tests was the strongest in BG and WL. Under the 100mM NaCl condition, the pattern of cation uptake in BG and WL showed lower Na uptake and K decline than in AL, BH and JL. Oxygen production in thylakoid membrane was the highest in BG and WL.

KEYWORDS

Cation, greening, herbage, peat, salt tolerance

INTRODUCTION

Greening the desert has been performed at the point of irrigation, application of water holding materials, soil mulch and planting of native vegetations (Murai,1995). Though it was reported that strong grazing induced desertification of grassland (Nemoto et al.,1994), it is ideal from grassland ecology to organize the cycle of soil, grass and animal, and the selection of grass species is an important subject. On the other hand, in oil producing countries in the Middle and Near East, turf management in soccer stadiums and golf courses has become as serious a problem regarding water consumption and green maintenance. Though the knowledge about herbage production in dry regions could apply to the greening, the animal production and sports facilities, there is little technology. In this study, Canadian peat moss was used as water holding material and the efficacy of mixing the peat with the sand on water holding capacity, and the adaptability of several herbages to dry and saline conditions were investigated.

MATERIALS AND METHODS

Peat moss in this study was produced in Canada and chemical-treated to hold more water (Yamaguchi and Tsukakoshi,1992). The sand mixed with this treated peat at the rate of 0, 2 and 5% by weight was filled in 1/5,000a Wagner pots. Alfalfa (*Medicago Sativa* L., AL), burmudagrass (*Cynodon dactylon* (L.) Pers., BG), bahiagrass (*Paspalum notatum* Flügge, BH), weeping lovegrass (*Eragrostis curvula* Nees,WL) and Japanese lawngrass (*Zoysia japonica* Steud., JL) were sown in each pot at the rate of 3kg/10a. After watering 1,000ml per pot, all pots were kept in growth chamber (temperature 30°C and RH50%) and the pF value of the sand was determined. The grass yield was determined on 30th after watering. Salt tolerance at germination was decided to the germination ratio under 100mM NaCl. The seedlings of each herbage were cultured in standard solution for 10 days, then NaCl was applied to the solution to adjust its concentration to 0 and 100mM. Ten days after NaCl application, the plants were harvested to measure the weights and the cation contents. The relative value of dry weight increase in plant during NaCl treatment to that during standard solution culture was used as an indicator of salt tolerance (Maeda and Takenaga, 1993). Cation contents were measured by ion chromatography, and O_2 production in thylakoid membrane as an indicator of photosynthetic capacity by O_2 electrode.

RESULTS AND DISCUSSION

Changes in pF value were shown in Fig.1. Without peat, pF value ranged from 1.50 to 1.53 till 6 days after watering, but rose up to 2.92 for the following 12 days. With mixing peat with the sand at the rate of 2% , the value did not change for 20 days, and rose up to 2.50 on 30th day. With mixing peat at 5%, the value stayed constant at 1.50 for 6 days, and rose gradually up to 2.70 on 30th day. Many attempts have been tried to maintain water holding capacity of the soil with water holding materials. These contain two patterns (1) preventing evaporation by mulching soil with asphalt and high polymer emulsions (2) mixing water holding materials with soil. This study was performed from (2). The result of the changes in pF value indicated that the water holding capacity of the sand with peat increased by about twice that of control sand, which showed clear effect of mixing peat.

Parameters of salt tolerance in herbages were shown in Table 1. The yield was the highest of the herbages cultured in the sand with peat at the rate of 2%, and WL showed the highest yield followed by BG. At 100mM NaCl, the germination ratios of AL, BG and WL were ranged from 85 to 88%, but those of BH and JL showed low values of 48~50%. Salt tolerance judged by the relative growth rate was the strongest in BG and WL, the weakest in AL. In the mechanism of salt tolerance considered from the pattern of cation uptake, BG and WL with strong salt tolerance showed low Na uptake and K decline. On the other hand, AL with the weakest salt tolerance showed the highest uptake of Na and the marked decline of K. O_2 production in thylakoid membrane was the highest in BG and WL while the lowest in AL. In the deserts, the accumulation of salt caused by the evaporation from soil surface was great, thus salt tolerance is an important factor for greening as well as drought resistance. In general, the mechanisms of salt tolerance include (1) Na exclusion and control of Na transfer to upper part of plant at root (2) regulation of osmotic pressure in the cell (3) maintenance of selective absorption of essential elements (Tadano, 1993). In this study, the tendency of the salt tolerance between germination and seedling tests was similar, and the mechanism of the tolerance from cation dynamics showed the type of Na exclusion. Also, the plants with stronger salt tolerance showed higher photosynthetic activity.

In conclusion, the water holding capacity was increased by mixing the peat with the sand at 2%, and BG and WL seemed to be available herbages to green the desert from the points of salt tolerance and drought resistance.

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Table 1
Grass yield and parameters in salt tolerance of herbages.

Grass species	Yield (kg/10a)			Parameters in salt tolerance at 100mM NaCl				
	0	2	5[A)]	Germination (%)	Relative Growth rate[B)]	Increase rate of Na[C)]	Decrease rate of K[C)]	O_2 production[D)]
Alfalfa	30.2	281.6	251.7	85	75	430	30	2.72
Burmudagrass	82.3	333.1	308.2	88	95	110	5	20.51
Bahiagrass	51.9	231.3	178.1	48	83	180	18	8.38
Japanese lawngrass	53.1	279.7	211.5	50	87	200	13	12.50
Weeping lovegrass	92.3	379.2	340.3	87	95	95	4	23.81

A) % of mixed peat to sand.
B) Growth rate shows the relative dry weights of plants grown in 100mM NaCl solution to in 0mM.
C) Rates of plants grown in 100mM NaCl solution to in 0mM.
D) Expressed as µM/mg Chlorophyll/hr.

Figure 1
Changes in pF value