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Analysis on the Conditions of Waterfront Lawn Beds in West Lake Scenic Area of Hangzhou City

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Abstract The West Lake area and water system in West Lake scenic area of Hangzhou City directly affect the soil properties of waterfront lawn beds, which in turn have a significant impact on the growth of waterfront lawns. In order to further improve the quality of lawns, the conditions of 10 waterfront lawn beds in West Lake scenic area were tested and analyzed. The results showed that the waterfront lawn beds in West Lake scenic area were prone to salinization, with moderate or high pH values, moderate overall organic matter content, relatively sufficient nitrogen and phosphorus elements, and relatively deficient potassium elements. The contents of exchangeable calcium in all samples were higher than the lower limit, and the contents of exchangeable sodium, exchangeable magnesium, and available manganese in the soil were moderate or low, while the contents of available copper were moderate or high.

Keywords Hangzhou West Lake, Waterfront lawn, Lawn bed, Soil

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As a cultivated and maintained form of herbaceous vegetation, lawns, not only have ecological functions such as beautifying the environment, regulating the climate and purifying the air, but also stand as a significant emblem of modern societal progress[1-5]. Lawn beds are the foundation of lawn growth, and the nutritional status of lawn beds directly affects the growth status of lawns. In recent years, the lawn area of West Lake scenic area in Hangzhou City has been greatly increased, and the lawn quality has also been significantly improved. For West Lake scenic area as the forerunner of shared green space in Hangzhou, its lawn sharing and opening occupies an important position, so the nutritional status of lawn beds in West Lake scenic area is very important.

However, there are not only outer and inner lakes in West Lake scenic area, but also many water systems, which are distributed in different parks and green spaces, and many lawns are built along the waterfront. These water areas directly affect the soil properties of waterfront lawns, and then have an important impact on the growth of waterfront lawns. In order to further improve lawn quality, the nutritional status of 10 waterfront lawn beds in West Lake scenic area of Hangzhou was detected and analyzed, so as to provide a scientific basis for improving lawn growth, the physical and chemical properties of lawn beds and lawn quality in West Lake scenic area.

1 Materials and methods

1.1 Detection objects

The lawn of Wenying Teahouse in Liulang Wenying Park, i.e., Orioles Singing in the Willows; the lawn of Shuinan Banyin; the lawn of the boulevard in Shengtang scenic area; the lawn of Wangshanping in Taiziwan; the lawn of Bai Causeway; the lawn of Xiaoyaopo in Taiziwan; the lawn of West Lake State Guesthouse in Shengtang scenic area; the lawn of Citizen Forest in Scholar Park; the lawn of Xiaogong Bridge in Liulang Wenying Park; the lawn of Three Pools Mirroring the Moon.

1.2 Detection methods

1.2.1 Detection indexes. The following indexes were detected: pH, total soluble salt in soil, soil organic matter, nitrate nitrogen, ammonium nitrogen, available phosphorus, available potassium, exchangeable calcium, exchangeable magnesium, exchangeable sodium, soil cation exchange capacity, available iron, available manganese, available copper and available zinc.

1.2.2 Data processing. Data were processed by Excel and SPSS. The levels of various indexes ranging from sufficient to deficient were analyzed according to the guideline of minimum soil nutrients of turf grass[6].

2 Results and analysis

2.1 pH of waterfront lawn beds in West Lake scenic area

Soil pH is one of the main factors affecting plant growth and soil nutrient availability. A low or high pH values indicates that other chemicals in soil may have a negative impact on soil structure or plant growth. When soil pH value is in the range of 6.5−7.5, the availability of soil nutrients reaches the best state[7-14]. Fig.1 shows the detection results of pH of waterfront lawn beds in West Lake scenic area.

2.2 Soluble salt contents of waterfront lawn beds in West Lake scenic area

The total amount of soil soluble salt is essential to predicting the secondary salinization of soil. When the total amount of soil soluble salt is less than 1.0 g/kg, it belongs to non-salinized soil and does not cause salt damage to crops. When the total amount of soil soluble salt is in the range of 1.0−3.0 g/kg, plants that are extremely sensitive to salts may be affected[7-14]. Fig.2 shows the detection results of soluble salt in the waterfront lawn beds of West Lake scenic area.

2.3 Organic matter contents of waterfront lawn beds in West Lake scenic area

Organic matter content will affect the fertility- and water-retaining capacity of lawn soil, and the normal organic matter content should be in the range of 1%−5% (accounting for the dry weight of soil)[7-14]. Fig.3 shows the detection results of organic matter content in the waterfront lawn beds of West Lake scenic area.

2.4 Nitrogen contents of waterfront lawn beds in West Lake scenic area

Nitrogen is the most needed and key nutrient element for turf grass, and it is not easy to be fixed by soil, making it more prone to deficiency compared with other elements. However, if the nitrogen content is too high, turf grass will have shallow roots and poor resistance to diseases (leaf spot, brown spot and Fusarium wilt, etc.) and adversity (frost, heat or dryness). Ammonium nitrogen can be directly absorbed and utilized by plants, while nitrate nitrogen needs to be reduced to ammonium

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nitrogen in plants before it can be absorbed and utilized[7-14]. Fig.4 and Fig.5 show the contents of nitrate nitrogen and ammonium nitrogen in the waterfront lawn beds of West Lake scenic area, respectively.

2.5 Cation exchange capacities of waterfront lawn beds in West Lake scenic area

Soil cation exchange capacity can keep the "physiological balance" of soil solution and prevent soil nutrients from being leached by rain, and it is an index for evaluating soil fertility[7-14]. Fig. 6 shows the detection results of cation exchange capacity in the waterfront lawn beds of West Lake scenic area.

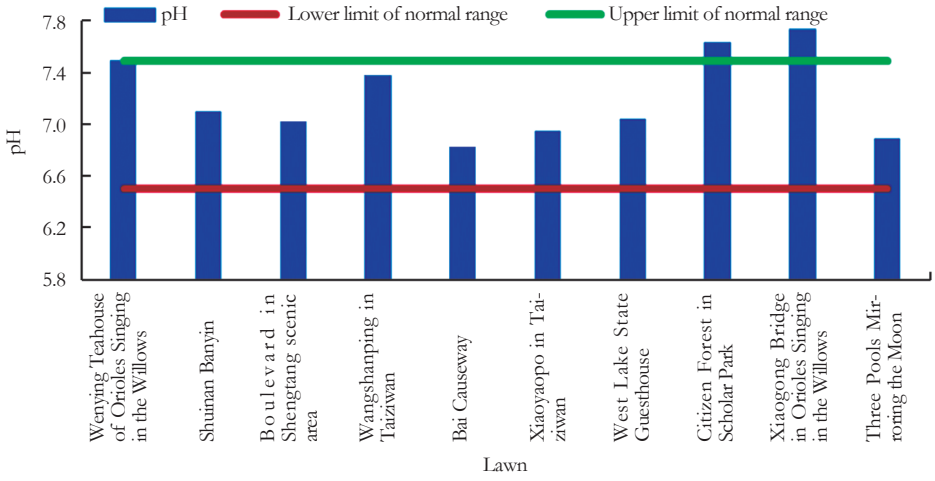

Fig.1 pH of waterfront lawn beds in West Lake scenic area

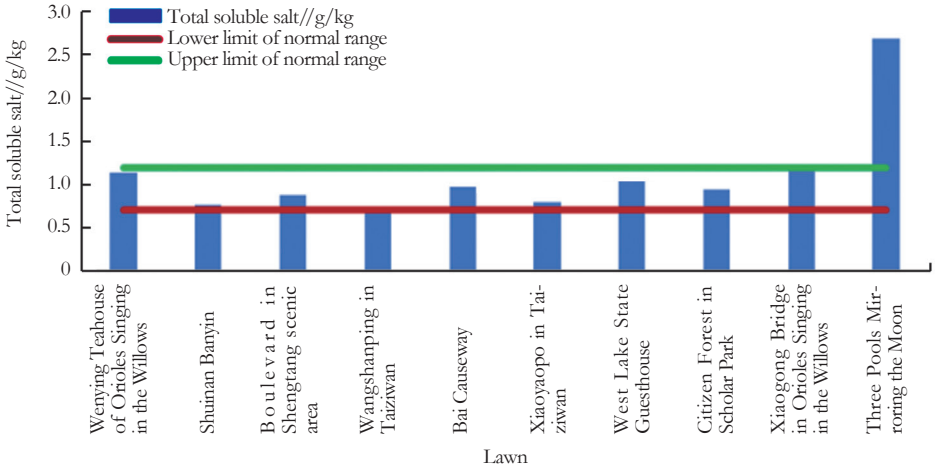

Fig.2 Soluble salts in waterfront lawn beds of West Lake scenic area

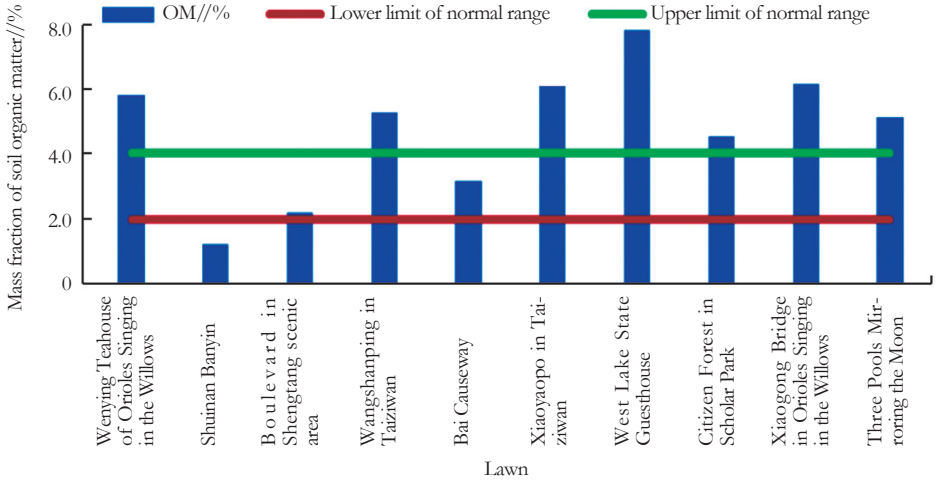

Fig.3 Organic matter contents of waterfront lawn beds in West Lake scenic area

2.6 Available phosphorus contents of waterfront lawn beds in West Lake scenic area

Adequate supply of available phosphorus will promote the growth of turf grass roots and rhizomes, thereby making turf grass grow rapidly, increasing tillers and improving the cold resistance, drought resistance and trampling resistance of lawns[7-14]. The results of available phosphorus content in the waterfront lawn beds of West Lake scenic area are shown in Fig.7.

2.7 Available potassium contents of waterfront lawn beds in West Lake scenic area

Potassium can improve the resistance and resilience of turf grass after injury, balance the absorption of other nutrients by turf grass, and reduce the problem of shallow roots caused by nitrogen. However, excessive application of potassium fertilizer will destroy the soil block structure and aggregate structure, and eventually lead to soil hardening[7-14]. The results of available potassium content in the waterfront lawn beds of West Lake scenic area are shown in Fig.8.

2.8 Exchangeable calcium contents of waterfront lawn beds in West Lake scenic area

Ca^{2+} is the most important cation in fine soil, which plays a vital role in the flocculation of clay and organic particles. Calcium can promote the growth and development of grass roots and neutralize cell endotoxin[7-14]. Fig.9 shows the exchangeable calcium contents of waterfront lawn beds in West Lake scenic area.

2.9 Exchangeable magnesium contents of waterfront lawn beds in West Lake scenic area

Magnesium is an important component of chlorophyll, and it can also improve the disease resistance of plants. Magnesium deficiency can cause the leaves to lose their green color in strips or spots, and in severe cases, the leaves will dry up[7-14]. Fig. 10 shows the exchangeable magnesium contents of waterfront lawn beds in West Lake scenic area.

2.10 Exchangeable sodium contents of waterfront lawn beds in West Lake scenic area

When the content of exchangeable sodium in soil exceeds 110 mg/kg, it will lead to soil quality problems and affect the normal growth of plants. In addition to phytotoxicity

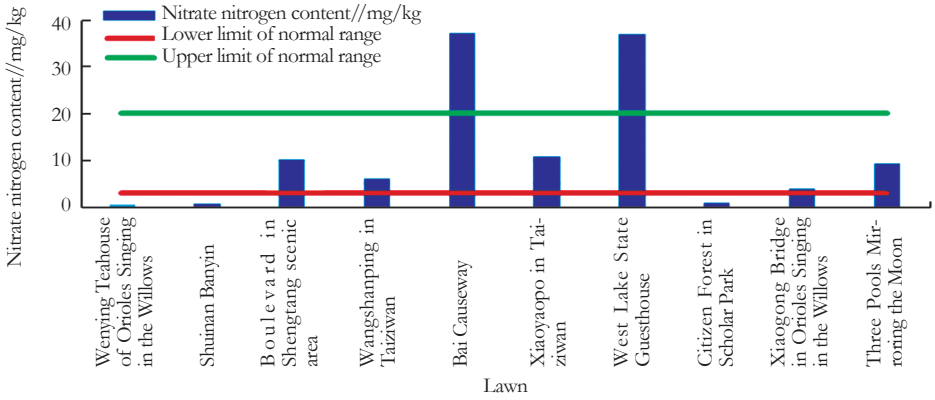

Fig.4 Nitrate nitrogen contents of waterfront lawn beds in West Lake scenic area

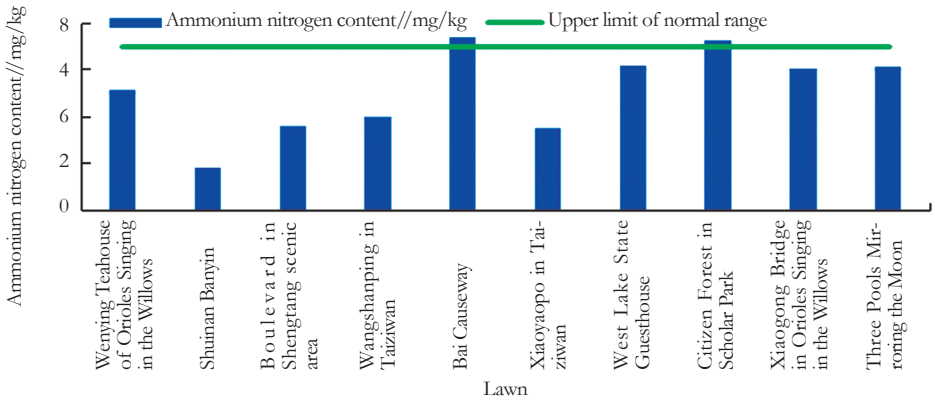

Fig.5 Ammonium nitrogen contents of waterfront lawn beds in West Lake scenic area

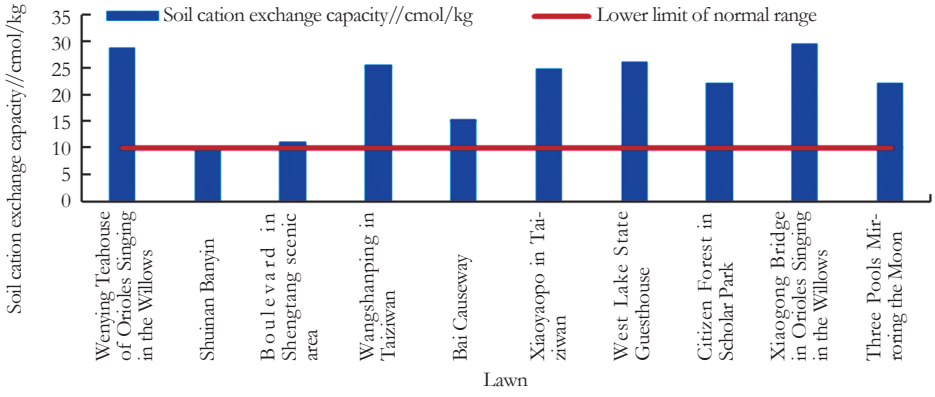

Fig.6 Cation exchange capacities of waterfront lawn beds in West Lake scenic area

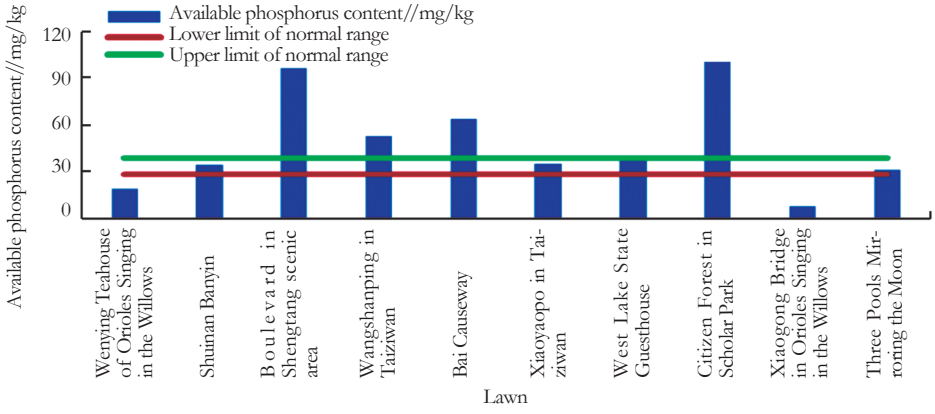

Fig.7 Available phosphorus contents of waterfront lawn beds in West Lake scenic area

to the roots of turf grass, it can also destroy soil structure by flocculating soil aggregates or dispersing them into blocks with limited porosity, thus limiting water transport and root growth[7-14]. Fig.11 shows the exchangeable sodium contents of waterfront lawn beds in West Lake scenic area.

2.11 Available iron contents of waterfront lawn beds in West Lake scenic area

Iron plays a very important role in photosynthesis of plants. It can make plants grow healthily, enhance disease resistance and turn lawns green[7-14]. Fig.12 shows the available iron contents of waterfront lawn beds in West Lake scenic area.

2.12 Available manganese contents of waterfront lawn beds in West Lake scenic area

Manganese is an important component of many enzymes, which can activate important metabolic reactions of plants and assist the synthesis of chlorophyll, and plays a vital role in plant photosynthesis[7-14]. Fig.13 shows the manganese contents of waterfront lawn beds of West Lake scenic area.

2.13 Available copper contents of waterfront lawn beds in West Lake scenic area

Copper is a component of many oxidases in plants, or an activator of some enzymes, which is closely related to carbon assimilation, nitrogen metabolism and redox process in plants[7-14]. Fig. 14 shows the copper contents of waterfront lawn beds in West Lake scenic area.

2.14 Available zinc contents of waterfront lawn beds in West Lake scenic area

Zinc can promote the synthesis of indoleacetic acid in plants, thus promoting the growth and development of stem tips, young leaves and roots, and it is also a component and activator of various enzymes in crops. However, when the zinc content is too high, it can cause disorder of plant metabolism, hinder growth and development, and even cause death[7-14]. Fig.15 shows the available zinc contents of waterfront lawn beds in West Lake scenic area.

3 Conclusions and discussion

(1) The detection results showed that the pH values of soil samples from the lawn of Citizen Forest in Scholar Park and the lawn of Xiaogong Bridge in Liulang Wenying Park were high, while other samples showed moderate pH. The soil samples from the lawn of Wenying Teahouse in Liulang Wenying Park, the lawn

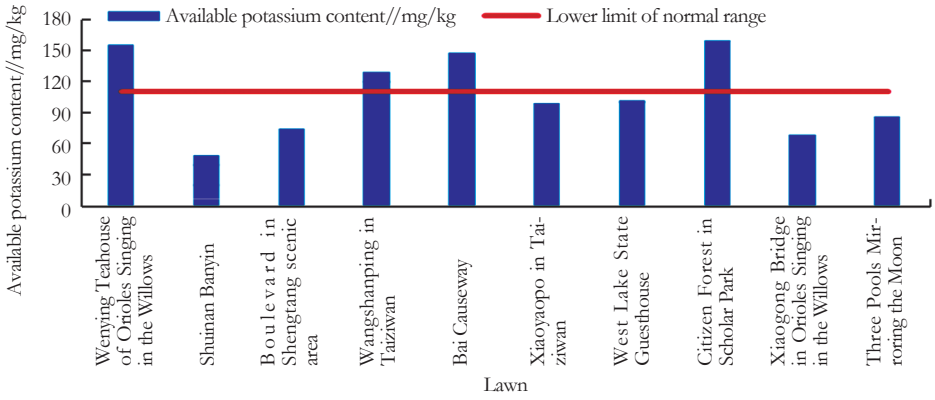

Fig.8 Available potassium contents of waterfront lawn beds in West Lake scenic area

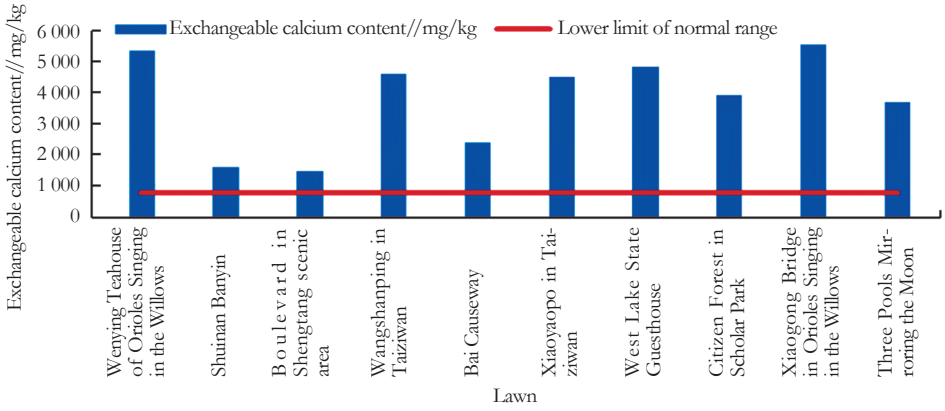

Fig.9 Exchangeable calcium contents of waterfront lawn beds in West Lake scenic area

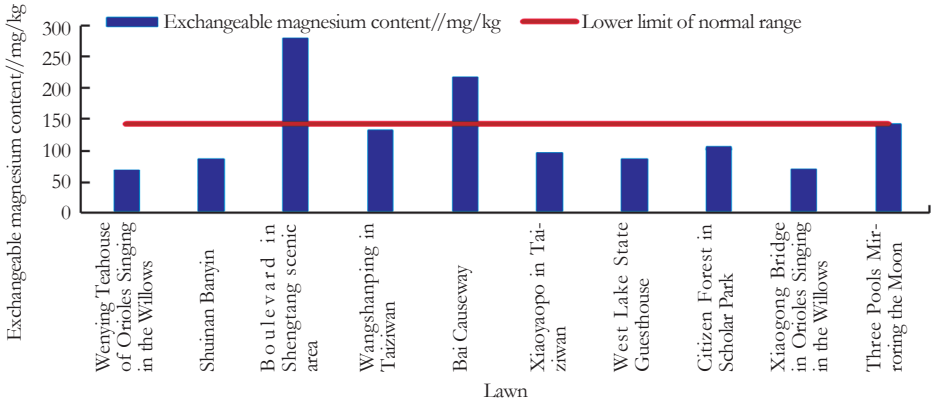

Fig.10 Exchangeable magnesium contents of waterfront lawn beds in West Lake scenic area

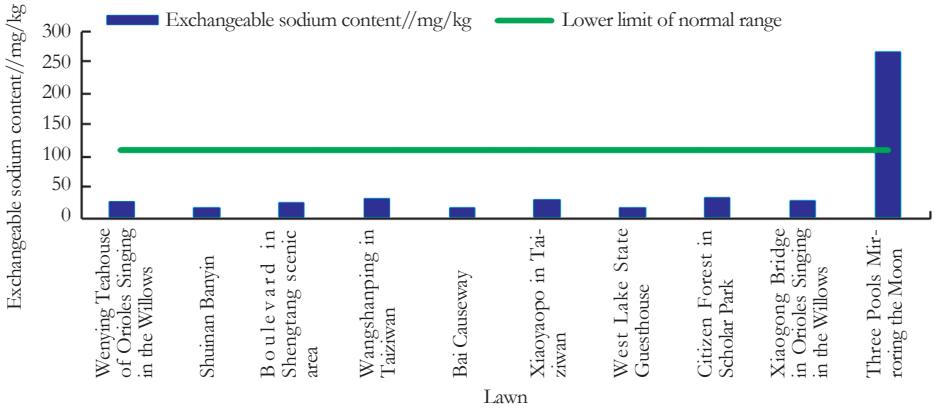

Fig.11 Exchangeable sodium contents of waterfront lawn beds in West Lake scenic area

of West Lake State Guesthouse, the lawn of Xiaogong Bridge in Liulang Wenying Park and the lawn of Three Pools Mirroring the Moon belonged to salinized soil, while other samples belonged to non-salinized soil.

(2) The content of soil organic matter was slightly low in the soil samples from the lawn of Shuinan Banyin, but moderate in the soil samples from the lawn of the boulevard in Shengtang scenic area and the lawn bed of Bai Causeway, but high in other samples. The contents of soil nitrate nitrogen in the soil samples from the lawn of Wenying Teahouse in Liulang Wenying Park, the lawn of Shuinan Banyin and the lawn bed of Citizen Forest in Scholar Park were low, while the contents in soil samples from the lawn of Bai Causeway and the lawn bed of West Lake State Guesthouse were slightly high, and the contents in other samples were moderate. The contents of soil ammonium nitrogen in soil samples from the lawn of Bai Causeway and the lawn bed of the Citizen Forest of Scholar Park reached the upper limit, while the contents in other samples were in the normal range. The content of available phosphorus was slightly low in soil samples from the lawn of Wenying Teahouse in Liulang Wenying Park and the lawn bed of Xiaogong Bridge in Liulang Wenying Park, but moderate in the lawn of Shuinan Banyin, the lawn of Xiaoyaopo in Taiziwan and the lawn of Three Pools Mirroring the Moon, and high in other samples. The contents of available potassium in soil samples from the lawn of Wenying Teahouse in Liulang Wenying Park, the lawn of Wangshanping in Taiziwan, the lawn of Bai Causeway and the lawn of Citizen Forest in Scholar Park were moderate, but the contents in other samples were slightly low.

(3) The detection results of various nutrient elements needed for the growth and development of turf grass showed that the contents of exchangeable calcium in all samples were higher than the lower limit. The content of exchangeable magnesium was moderate in the soil samples from the lawn bed of the boulevard in Shengtang scenic area, the lawn of Bai Causeway and the lawn bed of Three Pools Mirroring the Moon, but low in other samples. The contents of available iron in soil samples from the lawn of Wenying Teahouse in Liulang Wenying Park, the lawn of Citizen Forest in Scholar Park, the lawn of Xiaogong Bridge in Liulang Wenying Park and the lawn of Three Pools Mirroring the Moon were slightly high, but the contents in other samples were slightly low. Available manganese was high in the lawn of Wenying Teahouse in Liuyang Wenying Park,

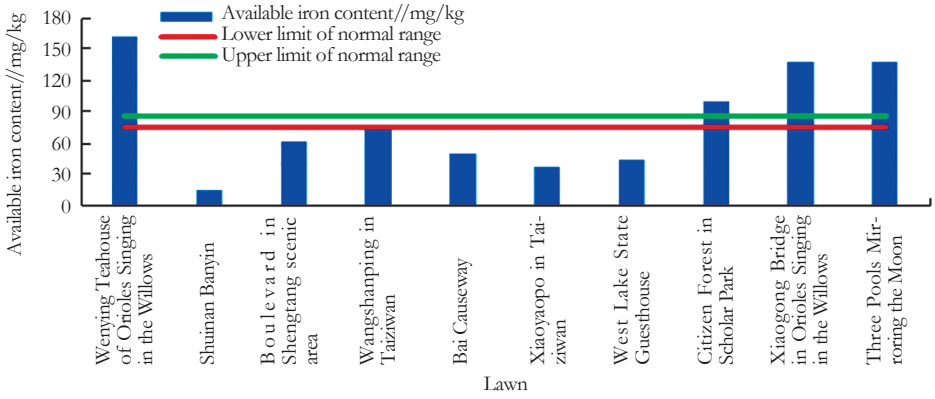

Fig.12 Available iron contents of waterfront lawn beds in West Lake scenic area

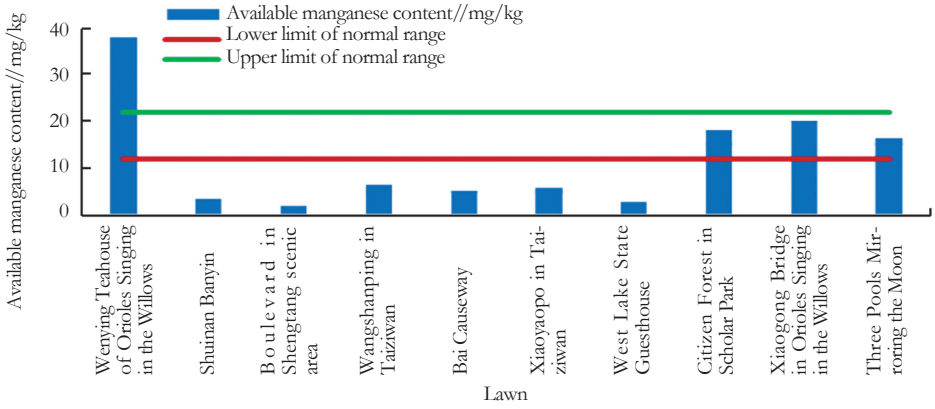

Fig.13 Available manganese contents of waterfront lawn beds in West Lake scenic area

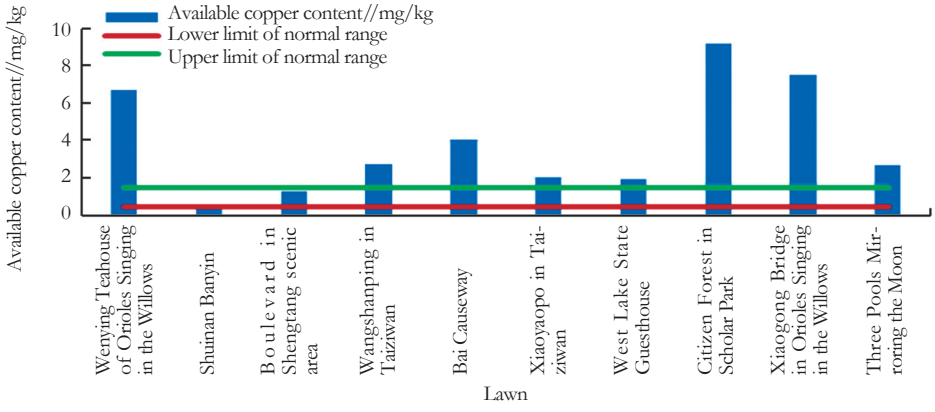

Fig.14 Available copper contents of waterfront lawn beds in West Lake scenic area

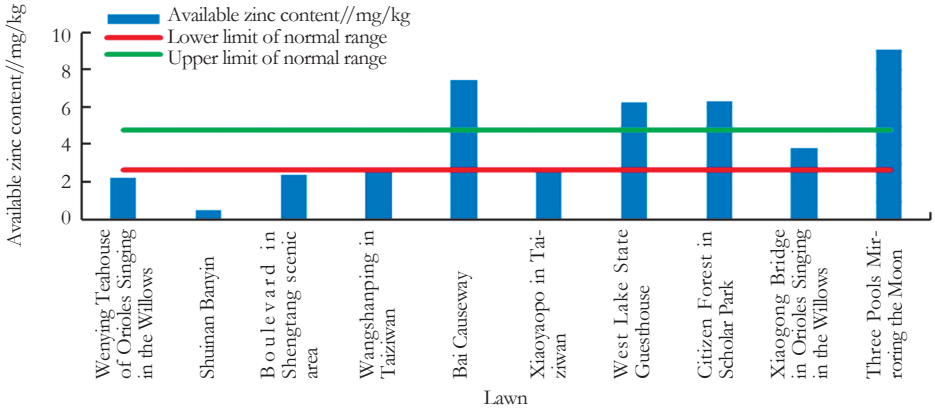

Fig.15 Available zinc contents of waterfront lawn beds in West Lake scenic area

moderate in the lawn of Citizen Forest in Scholar Park, the lawn of Xiaogong Bridge in Liuyang Wenying Park and the lawn of Three Pools Mirroring the Moon, and low in other samples. The contents of available copper in the samples from the lawn of Shuinan Banyin and the lawn of the boulevard in Shengtang scenic area were moderate, but the contents in other samples were high. The contents of available zinc in the soil samples from the lawn of Wenying Teahouse in Liulang Wenying Park, the lawn of Shuinan Banyin, the lawn of the boulevard in Shengtang scenic area and the lawn bed of Wangshanping in Taiziwan were slightly low, but the contents in the soil samples from the lawn of Xiaoyaopo in Taiziwan and the lawn bed of Xiaogong Bridge in Liulang Wenying Park were moderate, and the contents in other samples were high. The content of soil exchangeable sodium in the soil samples from the lawn bed of Three Pools Mirroring the Moon was beyond the normal range, and the contents in other samples were slightly low.

(4) The waterfront lawn bed in West Lake scenic area of Hangzhou City can be properly supplemented with potassium and magnesium fertilizers to improve the resistance of turf grass and improve the color of lawns. Meanwhile, it should be noted that the exchangeable sodium in the soil of the lawn bed of Three Pools Mirroring the Moon exhibited a content exceeding the standard, and it may destroy the soil structure and produce phytotoxicity to the root system.

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(To be continued in P73)

2.4 Evaluation of post-design satisfaction

After the completion of the naturalized decoration construction, the post-test questionnaire was issued, and the post-use satisfaction was evaluated. 37 valid questionnaires were collected. In the evaluation of the satisfaction of the environment after decoration, the number of patients who are "very satisfied" is 23, and the number of patient who are "satisfied" is 8; 3 patients feel that the environment after decoration is "general", and 1 patient is "somewhat dissatisfied", while 2 patients are "very dissatisfied". For the evaluation of the satisfaction of the specific decoration effect, 23 patients are satisfied with the "overall visual experience of the wards", and 16 patients are satisfied with the "natural decoration in the wards". 15 patients are satisfied with the "walls, roofs, floors, door and window decorations", and 13 patients are satisfied with the "environmental color". The number of patients who are satisfied with the "feelings and emotions triggered by the environment (such as hope, vitality, peace and pleasure brought by the environment)" is 13, and the number of patients who are satisfied with the "hearing, smell and touch experience of the wall ward environment" is 5, while the number of patients who are satisfied with the "placement and display of natural ornaments" is 11.

As for the subsequent improvement of the ward environment, two patients hope to increase the number of green plants, and one patients proposes that the number of science books on the shelves of the wards is small. One hopes to reduce the frequent visits of staff, and a small window can be installed to dispense medication.

3 Conclusions

(1) The remarkable effect of naturalized decoration. The naturalized decoration design and satisfaction after the construction of HSCT wards of Peking University First Hospital were evaluated, and the results show that naturalized decoration has a significant effect on improving the psychological state and rehabilitation environment of patients. Specifically, the introduction of decorative themes such as "living in the sun" and "secret forests" and other plants and natural landscape could effectively enhance patients' sense of hope, vitality and overall mood. Most patients and medical staff are satisfied with the visual experience after decoration, environmental color and positive emotions aroused, and especially the overall visual experience of the wards is highly recognized by 23 patients.

(2) The effectiveness of design strategies. Based on evidence-based design (EBD) method, questionnaire survey, literature research and field investigation, scientific and reasonable strategies for naturalized decoration design were put forward. For instance, appropriate decorative themes, materials and presentation, such as easy-to-clean stickers and nature-themed hanging pictures, can be used to meet the requirements of a sterile environment, create a quiet, comfortable healing environment and give people a sense of hope and vitality. These strategies are proved to be effective and feasible in practical application.

(3) Determination of priority improvement areas. Through IPA analysis and on-site investigation, areas that are prioritized for naturalized decoration were determined, including visiting corridors, external windowsills of inside wards, inside wards, nurses' lounges and doctors' lounges. These areas have a high usage rate and human flow, so their decorative effect has a significant effect on the psychology of patients and medical staff. The pictures of decoration effect show that the naturalized decoration of these areas significantly improves the beauty and comfort of the environment, and verifies the scientificity and practicality of the design scheme.

Future research directions. Although the study validates the positive role of naturalized decoration in HSCT wards, there are still some aspects that deserve further exploration. For example, the combination of more sensory experiences, such as the introduction of natural sounds and smells, can be considered to further enhance patients' healing environment. Besides, the evaluation of long-term effects and application in different hospital environments are also important directions for future research. Through continuous research and practice, naturalized decoration design will bring well-being to more patients and medical staff, and provide more empirical evidence and design strategies for hospital environment design.

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