

Retraction

Retracted: Spatial-Temporal Variation Characteristics of Soil Moisture and Nutrients Based on Nanomaterials in the Root Zone of *Haloxylon ammodendron* Seedlings

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

1. Discrepancies in scope
2. Discrepancies in the description of the research reported
3. Discrepancies between the availability of data and the research described
4. Inappropriate citations
5. Incoherent, meaningless and/or irrelevant content included in the article
6. Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] Z. Wang, H. Gu, A. Yan et al., "Spatial-Temporal Variation Characteristics of Soil Moisture and Nutrients Based on Nanomaterials in the Root Zone of *Haloxylon ammodendron* Seedlings," *Journal of Nanomaterials*, vol. 2022, Article ID 9202493, 15 pages, 2022.

Research Article

Spatial-Temporal Variation Characteristics of Soil Moisture and Nutrients Based on Nanomaterials in the Root Zone of Haloxylon ammodendron Seedlings

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Haloxylon ammodendron is the main constituent species in the desert area of Junggar Basin, which plays a key role in biodiversity protection and regional ecological balance. Replenishment and settling capacity of seedlings determine population regeneration and community stability, and soil moisture and nutrients are the main limiting factors of natural regeneration. In view of the serious degradation and low seedling survival rate of Haloxylon ammodendron forest in Junggar, typical degraded Haloxylon ammodendron population was selected in Gurbantunggut Desert. The effects of soil moisture on soil nutrients were explored, and the temporal and geographical fluctuations of soil moisture and nutrients in the root zone of Haloxylon ammodendron seedlings were clarified. The results showed that soil moisture and nutrient content in the root zone of seedlings had obvious temporal and spatial variation characteristics. With the advance of the growth period, it decreased at first and then increased, reaching the maximum in April and the minimum in August. In the soil horizontal space (0~40 cm), with the extension of the horizontal distance, the soil moisture content has an obvious “wet island” effect, and the soil moisture content at the 10 cm level is 1.99 times that at the 40 cm level in August, when the growth period is the driest. The nutrients available in the soil were clearly “poor on the inside and high on the outside.” The degrees of soil natural matter, soluble hydrolyzable nitrogen, accessible phosphorus, and accessible potassium in August were 57.97%, 44.37%, 75.46%, 19, and 55% higher at the 40 cm level of the sapling spine, 10 cm level each. The soil moisture content increased first, then declined, and the soil nutrient content gradually fell in the vertical (0.50 cm) space of soil as soil depth increased. The soil moisture content in the 20~30 cm layer is the highest, reaching 11.04%, 7.90%, 2.92%, and 4.29%, respectively, in each period. Soil water content in 0~30 cm was significantly affected by habitat rainfall ($P < 0.05$), and soil water had a higher effect on soil organic matter, alkali-hydrolyzable nitrogen, and available potassium ($P < 0.05$).

1. Introduction

Vegetation degradation under climate change has become a hot issue in international research, especially focusing on the relationship between vegetation and its environment (soil moisture and nutrients). Seedling settlement is a key link in the process of Haloxylon ammodendron population renewal, and its ecological adaptation mechanism is a research hotspot in the field of ecology. The desert ecological environment is extremely bad, with the problems of serious degradation of Haloxylon ammodendron population and

low survival rate of natural seedlings, resulting in the continuous reduction of the area of natural Haloxylon ammodendron forest, which has been listed as a national class III endangered plant [1], and the continuous reduction of the area of Haloxylon ammodendron forest has caused the disintegration of the ecological balance in the region [2], It not only seriously affects the process of Haloxylon ammodendron population renewal but also hinders the process of desert ecological control.

Haloxylon ammodendron (C.A. Mey.) Bunge (also known as Haloxylon Bunge) is a perennial shrub of

Haloxylon Bunge in *Chenopodiaceae*. It is a constructive species and dominant species in Gurbantunggut Desert. It has the characteristics of drought resistance, barren, saline alkali resistance, and wind sand resistance. It is known as the “desert guard” ([3–6]); the parasitic *Cistanche deserticola* in its roots is known as “desert ginseng”. The desert community formed by *Haloxylon ammodendron* as the dominant species provides habitat and breeding habitat for nearly 200 species of animals and plants. It is an important place for biodiversity protection in desert areas and plays an irreplaceable role in sand prevention and fixation, mitigating desertification, maintaining regional ecological balance, and promoting national economic development [6–10].

The physiological and ecological adaptability of *Haloxylon ammodendron* seedlings determines its survival ability and plays a key role in the recruitment, maintenance, expansion, and recovery of the *Haloxylon ammodendron* population [11]. Under the condition of natural precipitation in the desert, the survival, growth, and development of *Haloxylon ammodendron* seedlings mainly depend on the shallow soil water and nutrients. The theory of the change characteristics of water and nutrient content in the horizontal and vertical space of shallow soil in the root zone, which is most closely related to the survival of seedlings, is not clear, and there is no ready-made and systematic conclusion on the impact of habitat soil water change on soil nutrients. The research of *Haloxylon ammodendron* young seedlings’ temporal and geographic variation features, as well as the effects of soil moisture and nutrients in the root zone, is useful in mastering the adaptive link between seedling growth and environment.

1.1. Research Progress of Desert Soil Moisture Characteristics.

The spatial dispersion aspects of soil dampness and supplements represent the relationship between soil dampness, supplements, and ecological situations. The development, improvement, and circulation of vegetation in the over the ground vegetation framework are totally impacted by the spatial fluctuation of soil dampness and supplements [12]. Previous studies have shown that the desert area on the southeast edge of Junggar has poor environmental conditions (lack of soil moisture and nutrients) which is the main factor limiting plant growth, and it is also a key ecological problem for desert vegetation restoration and renewal [13]. *Haloxylon ammodendron*, as the main sand fixing plant in the desert, has a close relationship between the normal growth and development of *Haloxylon ammodendron* and the soil water conditions of the habitat. Plant morphology, on the other hand, has feedback on the dynamic changes in soil water [14].

The spatial variation characteristics of soil water and its interaction with vegetation are the key contents of water cycle research in the northwest desert area. Li Yan et al. [15] studied the carbon and water balance of *Haloxylon ammodendron* individuals and communities. Studies show that there is a significant relationship between flat ground-water content, evaporation, and precipitation. Under the condition of tending by precipitation alone and limited by

the spatial distribution of *Haloxylon ammodendron* roots, the survival of seedlings mainly depends on shallow soil water. When the density of *Haloxylon ammodendron* exceeds 1333 plants per hectare, it will decline due to water balance problems. Li Jun et al. studied the soil moisture characteristics of *Haloxylon ammodendron* forest land on the southern edge of Gurbantunggut Desert. It showed that the soil moisture content of adult *Haloxylon ammodendron* from the trunk to the edge of the shrub showed a decreasing trend. Yang Yanfeng et al. [16] found that the soil spatial range of the root zone of adult *Haloxylon ammodendron* has an obvious “wet island” effect, and the “wet island” effect in summer is more prominent than that in spring. Zhang Kehai et al. compared and analyzed the soil moisture content of different sand dunes in the desert area. The topographic difference has a prominent effect on the spatial differentiation of soil moisture, and there are areas with relatively rich soil moisture in the soil space of adult shrubs. Zhu Hai et al. study on soil water characteristics of *Haloxylon ammodendron* root area at different tree ages; the younger the *Haloxylon ammodendron* tree age, the higher the utilization rate of shallow soil water (0~50 cm layer) and the stronger the dependence. The shallow soil water content is greatly affected by precipitation, snowmelt water infiltration supply, and evaporation.

1.2. Research Progress on Nutrient Characteristics of Desert Soil.

The growth physiological activities of desert plants are affected not only by water deficit but also by the barren soil nutrients in the desert area [17]. Nutrient content and its dynamic balance in habitat soils directly affect the uptake and utilization of various nutrients by plants, indirectly affect plant productivity levels and the composition of community structures and ecosystem health, and have a significant impact [18]. There are many examinations of soil supplements in plant territories at home and abroad, yet the vast majority of them center around wetland, woods, and meadow biological systems [19–21]. Liu Yunhua et al. [11] showed that adult *Haloxylon ammodendron* has obvious “fat island” effect in the study on the change characteristics of soil nutrients in desert *Haloxylon ammodendron* forest land, and the older the tree age is, the more significant the fat island effect is. Chen Jing et al. found in the study of soil nutrient space of artificial *Haloxylon ammodendron* at different tree ages that the hierarchical changes of soil nutrients were obvious, and the nutrient content of surface soil was significantly higher than that of deep soil.

The distribution characteristics of soil nutrients surrounding the roots of adult *Haloxylon ammodendron* were researched by Li Congjuan et al. [22], and it was discovered that the content of soil nitrogen and phosphorus nutrients in desert areas was low, significantly lower than the national average level. The content of soil nutrients gradually decreased as the depth of the soil profile increased, the rate of soil decomposition in desert areas was low due to a lack of precipitation, and the rate of soil weathering and the ability of soil to store nutrients were low, resulting in low nutrient availability. Previous research has demonstrated that soil nitrogen and phosphorus are the material foundation for

plant life and the primary nutrient limiting variables impacting Haloxylon ammodendron growth and development [2]. Therefore, control the components of complement dispersion of seedlings exposed to various changes in soil moisture and over time Haloxylon ammodendron seedling root soil moisture and complement temporary and spatial. It is necessary to consider the diversity attribute. It is important to understand.

To sum up, the current research on Haloxylon ammodendron degradation is mainly concentrated in Inner Mongolia and Gansu, while there are few studies on Haloxylon ammodendron degradation and seedling regeneration in Gurbantunggut Desert, Xinjiang, which has the largest distribution area of Haloxylon ammodendron forest. Many studies have been conducted in the past on the evolution law of water and nutrients in the deep soil space of adult Haloxylon ammodendron at the regional scale, but few studies have been conducted on the temporal and spatial variation characteristics of soil water and nutrients in the shallow root zone, which is most closely related to Haloxylon ammodendron seedling survival. As a result, the characteristics of temporal and geographical variation, as well as the interaction relationship between shallow soil water and nutrients in the root zone of a deteriorated Haloxylon ammodendron population, were thoroughly investigated [23–25]. It is of great significance to reveal the survival strategy and adaptive mechanism of Haloxylon ammodendron seedlings in response to adverse environmental changes.

With the aim of investigating the problems of severe deterioration and poor survival of Junggar's Haloxylon ammodendron seedlings, this article discusses the typical degraded Haloxylon ammodendron population in the Gurbantunggut Desert. Select and study the soil of the seedling habitat and study temporal and spatial variability. In the root area of immature Haloxylon ammodendron seedlings, there is a relationship between soil moisture and nutritional properties. In the regeneration seedling habitat area of the degraded Haloxylon ammodendron population, the water and nutrient content in the horizontal and vertical space of the shallow soil in the root area most closely related to the survival of seedlings was dynamically monitored during the growth period, the influence of soil water change on soil nutrient content was analyzed, and the worldly and spatial variety attributes and impact relationship of soil water and supplement in the root area of Haloxylon ammodendron youthful seedlings were uncovered.

2. Materials and Research Methods

2.1. Overview of the Study Area. The study region is in Xinjiang, China, in the Gurbantunggut Desert, on the southeast margin of the Junggar Basin. The geographical location is $44^{\circ}23'39.98''\sim 44^{\circ}46'59.99''\text{N}$, $88^{\circ}40'15.39''\sim 89^{\circ}07'57.34''\text{E}$. The terrain is high in the south and low in the north, with an altitude of 500~700 m. It belongs to a mesotemperate continental semidesert arid climate. It has greater precipitation in the spring; enough water, high temperatures, and hot weather in the summer; drought and little rain in the summer; big evaporation, a lack of water, and a steep tempera-

ture rise and fall in the autumn; and dry and cold weather in the winter. The average annual temperature is about 6.7 degrees Celsius, the average annual precipitation is 165–180 mm, the annual evaporation is 2100–2300 mm, the average annual relative humidity is about 60%, and the overall temperature is 3500–3550°C. The annual sunshine hours are 3100–3200 hours, the frost-free period is 150–170 days, and the groundwater level is 23 m.

Haloxylon persicum is the dominant species in the plant community, accompanied by Haloxylon persicum, krascheninnikovia ewersmannia, Tamarix ramosissima, Reaumuria soongorica, Calligonum leucocladum, Ceratocarpus arenarius, Eremosparton songoricum, Horaninovia ulicina, etc. The soil is mainly fixed and semifixed aeolian sandy soil. The pH of the soil is 8.20, and the total salt content is $1.552.50\text{ g}\cdot\text{kg}^{-1}$, organic matter is $1.173.06\text{ g}\cdot\text{kg}^{-1}$, total nitrogen is $0.250.56\text{ g}\cdot\text{kg}^{-1}$, total phosphorus is $0.321.65\text{ g}\cdot\text{kg}^{-1}$, and total potassium is $10.1018.25\text{ g}\cdot\text{kg}^{-1}$.

2.2. Test Design and Sample Collection

2.2.1. Test Design. From March to October 2018, three typical degraded natural Haloxylon ammodendron forest sample plots were selected in the desert area in the southeast of Gurbantunggut Desert, with a sample plot spacing of 20 km and a sample plot area of $100\text{ m}\times 100\text{ m}$ (see Figure 1). Five test plots ($30\text{ m}\times 30\text{ m}$) are randomly set in each sample plot, with a total of 15 test plots. In each experimental plot, three seedlings with relatively consistent growth, no diseases and insect pests, and normal growth and development were randomly selected as markers, and a total of 45 seedlings were labeled.

2.2.2. Soil Sample Collection and Analysis. In April, June, August, and October of the growth period, take the basal stem of the marked seedling trunk as the center, horizontal distance sampling points; soil augers were placed 10 cm, 20 cm, 30 cm, and 40 cm horizontally from the seedling trunk; and soil samples of 0 to 10 cm, 10 to 20 cm, 20 to 30 cm, 30 to 40 cm, and 40 were collected. Layers of ~50 cm were used at various horizontal distances in the vertical direction of the floor. A total of 45 soil samples (see Figure 2) were collected from each layer of soil in the root zone of young seedlings in each growth period. Measuring factors include soil moisture, organic matter, alkaline hydrolyzable nitrogen, available phosphorus, and available potassium. Soil pesticide analysis is the method of measurement [26]. The soil organic matter content was measured by the potassium dichromate sulfate external heating method, and the soil water content was measured by the dry weighing method. The accessible phosphorus content was determined by sodium bicarbonate extraction, molybdenum antimony antichromolytic analysis, and ammonium acetate flame photometric extraction, and the alkaline hydrolyzable nitrogen content was determined by the alkaline hydrolyzable diffusion method. Calculate the amount of potassium that can be accessed.

2.3. Data Statistical Analysis. The rainfall data in the study area comes from the meteorological station of desert

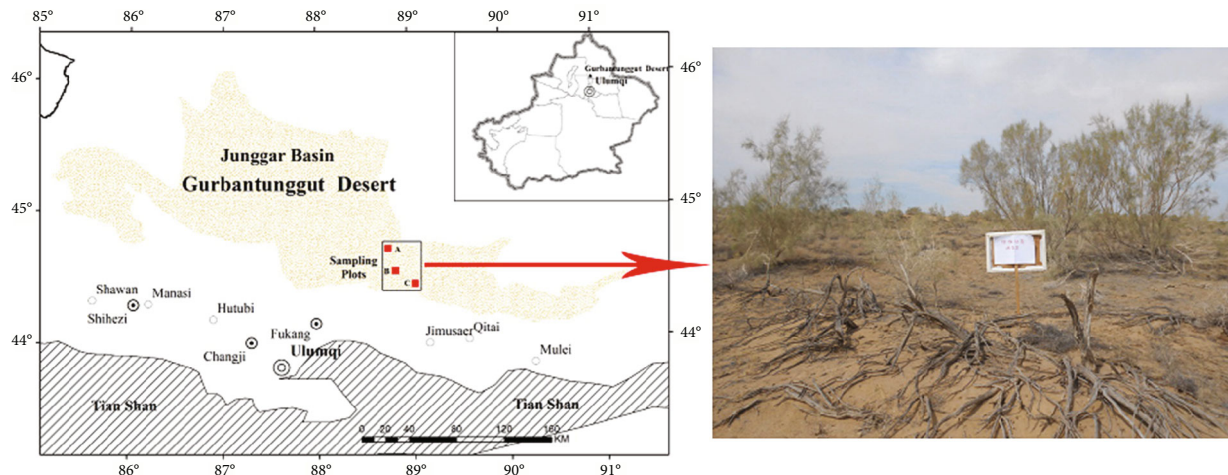


FIGURE 1: Geographical location and typical degraded population of *H. ammodendron* in the study area.

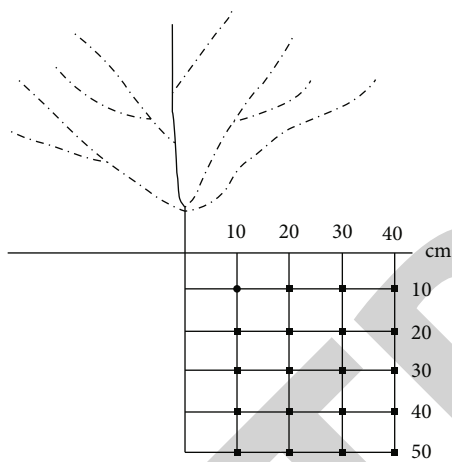


FIGURE 2: Schematic diagram of soil sampling.

management and Protection Station of Jimusar County Natural Resources Bureau, Changji Prefecture, Xinjiang. The statistical periods for precipitation data are early March to mid-April, mid-April to mid-June, mid-June to mid-August, and mid-August to mid-October.

I used Excel 2010 to sort the soil moisture and nutrient data. Experimental data was analyzed using SPSS 19.0 software (SPSS Inc, Chicago, Illinois, USA) including one-way ANOVA, LSD, and Duncan's new complex pole difference test. A two-sided Pearson test was used for the correlation analysis. The data was presented as mean standard error, and the significance level was set to $\alpha = 0.05$.

3. Results and Analysis

3.1. Analysis of Rainfall in *Haloxylon Ammodendron* Seedling Habitat during Growth Period. From Figure 3, during the growth period from March to mid-October, the rainfall in the *Haloxylon ammodendron* habitat area is mainly light rain, and the daily rainfall is less than 5 mm. Among them, the rainfall frequency from early March to mid-April is 13, the cumulative rainfall can reach 28.20 mm, and the

daily average rainfall is 0.71 mm. The frequency of rainfall from mid-April to mid-June is 14, with cumulative rainfall of 49.40 mm and daily average rainfall of 0.80 mm. The frequency of rainfall from mid-June to mid-August is 10, with cumulative rainfall of 25.00 mm and daily average rainfall of 0.41 mm. The rainfall frequency from mid-August to mid-October is 12, the cumulative rainfall can reach 36.50 mm, and the daily average rainfall is 0.64 mm. In different growth stages, the rainfall frequency and cumulative rainfall from mid-April to mid-June are the largest, followed by from mid-August to mid-October and from early March to mid-April. The rainfall frequency and rainfall from mid-June to mid-August are the smallest.

3.2. Temporal and Spatial Variation Characteristics of Soil Moisture in Young Seedling Root Area

3.2.1. Temporal Variation Characteristics of Soil Water Content in Young Seedling Root Zone

(1) Statistical Characteristics of Soil Moisture Content in April of Growth Period. It can be seen from Table 1 that the extreme difference in soil moisture content in the 0~10 cm layer, 10~20 cm layer, 20~30 cm layer, 30~40 cm layer, and 40~50 cm layer in the root zone of young seedlings in April of the growth period is 3.87%, 4.69%, 8.04%, 5.43%, and 3.63%, respectively. The soil moisture content increased first, then declined as soil depth climbed. The 20-30 cm layer had the highest average soil moisture content, up to 11.04 percent, which was much greater than the other levels. The coefficient of variation of soil water content in each stratum ranges from 0.20 to 0.47, indicating a medium amount of variance. The following are the attributes of the soil water content trend factor for different soil layers. 30-40 cm layer > 40-50 cm layer > 20-30 cm layer > 0-10 cm layer > 10-20 cm layer > 30-40 cm layer > 40-50 cm layer > 20-30 cm layer. The skewness coefficient of soil water content varies between 0.15 and 1.02 percent in each soil layer, the kurtosis coefficient between -1.62 and 0.43 percent, and the K-S test result between 0.19 and 0.87 percent.

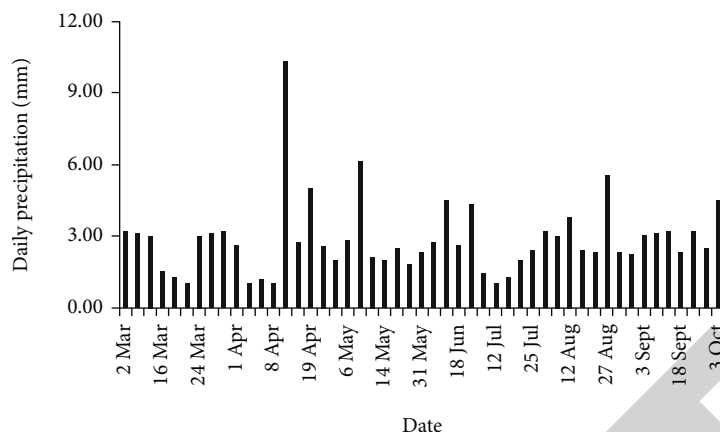
FIGURE 3: Daily rainfall of *H. ammodendron* habitat in 2018.

TABLE 1: Statistical characteristics of soil moisture content in different layers in April.

Soil depth (cm)	Min	Max	Mean	STDE	CV (%)	Skewness	Kurtosis	K-S test
0~10	1.21	5.08	2.48 ^d	1.16	0.47	0.82	-0.32	0.64
10~20	4.30	8.99	5.73 ^c	1.37	0.24	1.02	0.43	0.61
20~30	8.25	16.29	11.04 ^a	2.23	0.20	0.75	-0.23	0.87
30~40	4.48	9.91	6.81 ^b	1.79	0.26	0.15	-1.62	0.19
40~50	3.94	7.57	5.19 ^c	1.07	0.21	0.94	0.40	0.57

Note: test of K-S representing normal distribution. Different lowercase letters showed that the soil moisture content had significant differences in different layers ($P < 0.05$), $n = 45$.

According to the skewness coefficient, kurtosis coefficient, and K-S test, the change in soil moisture content of each soil layer in the root region of young seedlings in April conforms with the normal distribution at the test level of 5%.

(2) *Statistical Characteristics of Soil Moisture Content in June of Growth Period.* It very well may be seen from Table 2 that the attributes of the mean worth of water content in various soil layers of the dirt vertical profile in the seedling root zone are as per the following: layer 20~30 cm > layer 30~40 cm > layer 10~20 cm > layer 40~50 cm > layer 0~10 cm. Among them, the mean value of soil water content in the 20~30 cm layer is 7.90%, which is significantly higher than that in other layers. The extreme value difference of each soil layer is 1.56%, 2.13%, 3.50%, 2.88%, and 1.63%, respectively. The coefficient of variation of soil water content in each layer is between 0.13 and 0.55, which belongs to the medium variation level, and the coefficient of variation in the 0~10 cm layer is the largest, which is 0.55. The skewness coefficient of soil water content in each soil layer is between 0.28% and 0.50%, the kurtosis coefficient is between -1.68% and 0.88%, and the K-S test result is between 0.03 and 0.63. The skewness coefficient, kurtosis coefficient, and K-S test show that the change of water content in each soil layer in the root area of young seedlings in June accords with the normal distribution at the test level of 5%.

(3) *Statistical Characteristics of Soil Moisture Content in August of Growth Period.* It very well may be seen from Table 3 that with the increment of soil profundity, the dirt

dampness content expands first and afterward diminishes. The typical worth of soil dampness content in the 20~30 cm layer is the biggest, up to 2.92%, which is altogether higher than that in other soil layers. The extreme difference of soil moisture content in each soil layer was 0.64%, 0.90%, 3.60%, 1.83%, and 0.82%, respectively. The coefficient of the variety of soil water content in each dirt layer is somewhere in the range of 0.18 and 0.56, which has a place with the medium variety level. The variety coefficients of soil water content in various soil layers are 0 ~ 10 cm layer > 20 ~ 30 cm layer > 30 ~ 40 cm layer > 10 ~ 20 cm layer > 40 ~ 50 cm layer. The skewness coefficient of soil dampness content in each dirt layer is between 0.07% and 0.78%, and the kurtosis coefficient is between -1.47% and 1.18%. The analysis of skewness coefficient, kurtosis coefficient, and K-S test shows that the change of soil moisture content in the young seedling root zone in August of the growth period conforms to normal distribution at the test level of 5%.

(4) *Statistical Characteristics of Soil Moisture Content in October of Growth Period.* It very well may be seen from Table 4 that the qualities of soil dampness content in the upward profile of soil in the root zone of seedlings are 20 ~ 30 cm layer > 30 ~ 40 cm layer > 10 ~ 20 cm layer > 40 ~ 50 cm layer > 0 ~ 10 cm layer. Among them, the typical worth of soil dampness content in the 20~30 cm layer is 4.29%, which is altogether higher than that in other soil layers. The extreme value difference of each soil layer is 1.24%, 1.86%, 3.69%, 2.01%, and 1.91%, respectively. The coefficient of variation of soil water content is between 0.25 and 0.55,

TABLE 2: Statistical characteristics of soil moisture content in different layers in June.

Soil depth (cm)	Min	Max	Mean	STDE	CV (%)	Skewness	Kurtosis	K-S test
0~10	0.32	1.88	0.93d	0.51	0.55	0.40	-1.25	0.42
10~20	2.09	4.22	2.90c	0.70	0.24	0.50	-1.08	0.38
20~30	6.52	10.02	7.90a	1.05	0.13	0.47	-0.88	0.63
30~40	2.43	5.31	3.69b	1.03	0.28	0.28	-1.56	0.37
40~50	2.02	3.65	2.62c	0.58	0.22	0.40	-1.68	0.03

Note: test of K-S representing normal distribution. Different lowercase letters showed that the soil moisture content had significant differences in different layers ($P < 0.05$), $n = 45$.

TABLE 3: Statistical characteristics of soil moisture content in different layers in August.

Soil depth (cm)	Min	Max	Mean	STDE	CV (%)	Skewness	Kurtosis	K-S test
0~10	0.11	0.75	0.33 ^d	0.19	0.56	0.71	-0.55	0.32
10~20	0.92	1.82	1.24 ^c	0.28	0.22	0.49	-1.03	0.53
20~30	1.69	5.29	2.92 ^a	1.07	0.37	0.78	-0.23	0.97
30~40	1.03	2.86	1.86 ^b	0.59	0.31	0.07	-1.47	0.45
40~50	0.71	1.53	1.02 ^c	0.18	0.18	0.52	1.18	0.63

Note: test of K-S representing normal distribution. Different lowercase letters showed that the soil moisture content had significant differences in different layers ($P < 0.05$), $n = 45$.

TABLE 4: Statistical characteristics of soil moisture content in different layers in October.

Soil depth (cm)	Min	Max	Mean	STDE	CV (%)	Skewness	Kurtosis	K-S test
0~10	0.25	1.49	0.68 ^d	0.37	0.55	0.52	-0.85	0.62
10~20	1.42	3.28	2.08 ^b	0.59	0.28	0.83	-0.19	0.65
20~30	2.49	6.18	4.29 ^a	1.19	0.28	0.05	-1.34	0.94
30~40	1.85	3.86	2.72 ^b	0.71	0.26	0.16	-1.54	0.20
40~50	0.95	2.86	1.75 ^c	0.43	0.25	0.49	0.80	0.73

Note: test of K-S representing normal distribution. Different lowercase letters showed that the soil moisture content had significant differences in different layers ($P < 0.05$), $n = 45$.

which belongs to the medium variation level, and the coefficient of variation of the 0~10 cm layer is the largest, which is 0.55. The skewness coefficient of soil water content in each soil layer is between 0.05% and 0.83%, the kurtosis coefficient is between -1.54% and 0.80%, and the K-S test result is between 0.0 and 0.94. The analysis of the skewness coefficient, kurtosis coefficient, and K-S test shows that the change of water content in each soil layer in the root area of young seedlings in October of the growth period conforms to the normal distribution at the test level of 5%.

(5) *Variation Characteristics of Soil Moisture in the Root Zone of Young Seedlings during the Whole Growth Period.* As can be seen in Figure 4, the mud water content in the 0-50 cm layer at seedling heights of 10 cm, 20 cm, 30 cm, and 40 cm after April of the developmental period decreases first and then increases as the time frame develops. The aver-

age value of soil moisture content in the 0~50 cm layer at each horizontal distance decreased from 6.25% in April to 3.61% in June, with a decrease of 73.27%, then decreased to 1.48% in August, with a decrease of 144.42%, and then increased to 2.30% in October, with an increase of 55.90%. The characteristics of soil water content in the root zone of young seedlings in the growth period are April > June > October > August. In April, the soil moisture content of each layer at 10 cm, 20 cm, 30 cm, and 40 cm of the seedling level reached the maximum, which were 8.20%, 6.79%, 5.20%, and 4.80%, respectively, which were 4.06, 4.03, 4.56, and 4.54 times higher than that in August.

3.2.2. Spatial Variation Characteristics of Soil Water Content in Young Seedling Root Zone

(1) *Spatial Variation Characteristics of Soil Water Content in April of Growth Period.* The progressions of soil dampness at various level distances of seedlings are unique. It tends to be seen from Figure 5 that in April of the development time frame, the dirt dampness content of each layer at 10 cm and 20 cm is fundamentally higher than that at 30 cm and 40 cm. Among them, the dampness content of the 0~10 cm layer, 10~20 cm layer, 20~30 cm layer, 30~40 cm layer, and 40~50 cm layer at the 10 cm level arrives at the most extreme, 140.59% higher than that of a similar layer at 30 cm level 57.40%, 42.78%, 72.33%, and 43.21%, which are 165.73%, 67.54%, 60.77%, 76.110%, and 55.73% higher than a similar layer at the flat 40 cm, respectively. The water content of each soil layer at the 20 cm level is 73.14%, 27.04%, 19.77%, 53.44%, and 15.94% higher than that at the 30 cm level and 91.24%, 35.24%, 34.86%, 56.81%, and 26.07% higher than that at the 40 cm level.

The change in soil moisture content in different soil layers was amazing. Soil moisture in vertical sections 10 cm, 20 cm, 30 cm, and 40 cm from the seedling bottom showed up at the greatest in the 20~30 cm layer, which was 13.97%, 11.72%, 9.79%, and 8.69%, respectively, which were 3.55 times, 4.13 times, 5.97 times, and 5.86 seasons of the least 0~10 cm layer. Contrasted and the past soil layer, the upward 10~20 cm layer and 20~30 cm layer of the dirt profile show an increment. The increase of 20~30 cm layer at each horizontal distance is the largest, up to 85.40%, 82.68%, 104.39%, and 93.22%, respectively. The 30~40 cm layer and 40~50 cm layer show a decrease. The decrease of 30~40 cm layer at each horizontal distance is the largest, up to 35.81%, 31.86%, 46.82%, and 41.40%, respectively.

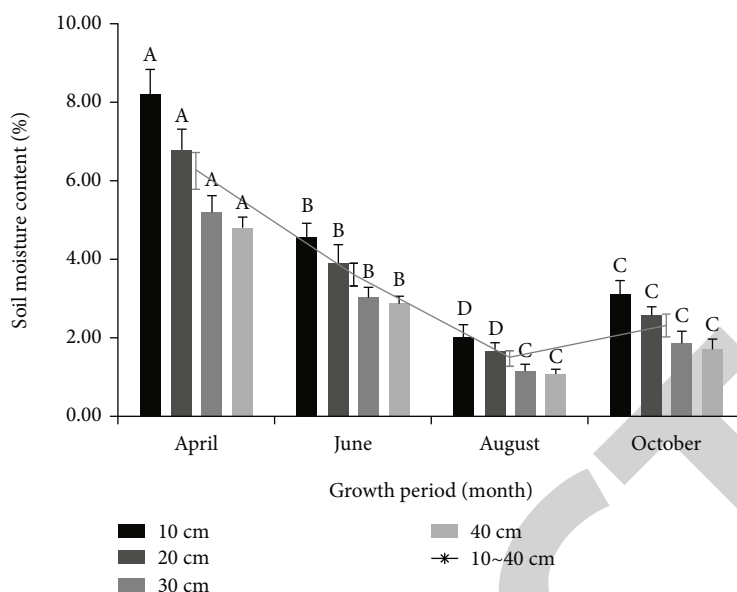


FIGURE 4: Variations of soil moisture characteristics at the roots of 0-50 cm seedlings. Note: other lowercase letters refer to soil moisture in the same layer. Significant differences in different growth periods ($P < 0.05$).

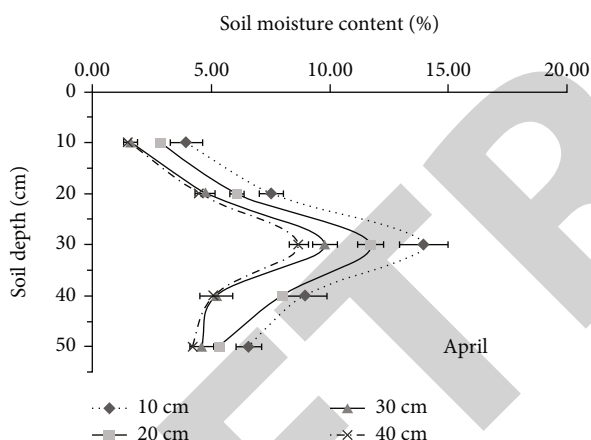


FIGURE 5: Spatial variation characteristics of soil moisture content in root zone of seedlings in April.

(2) *Spatial Variation Characteristics of Soil Water Content in June of Growth Period.* It very well may be seen from Figure 6 that in June of the development time frame, the water content of each layer at various flat distances of the seedlings is altogether higher than that at 30 cm and 40 cm at the degree of 10 cm and 20 cm. Among them, the water content of each soil layer at the level of 10 cm is the maximum, which is 201.56%, 51.87%, 29.90%, 75.39%, and 47.05% higher than that at the same layer at the level of 30 cm, 276.95% and 60.78% higher than that at the same layer at the level of 40 cm 33.73%, 88.17%, and 56.28%, with a significant difference. The water content of each soil layer at the 20 cm level is 112.19%, 35.04%, 17.67%, 45.91%, and 29.84% higher than that at the 30 cm level and 165.23%, 42.96%, 21.14%, 56.54%, and 38.00% higher than that at the 40 cm level.

The soil moisture content in the vertical profile increases from 0~10 cm layer to 20~30 cm layer. Among them, the increase of the 20~30 cm layer is the largest at each horizontal distance, up to 152.39%, 157.13%, 195.08%, and 203.45%, respectively, while the soil moisture content decreases from 20~30 cm layer to 40~50 cm layer. The decrease of the 30~40 cm layer is the largest at each horizontal distance, up to 45.40%, 49.86%, 59.56%, and 61.20%, respectively. The moisture content of a layer of 20-30 cm at a height of 10, 20, 30, and 40 cm from the bottom of the seedling is the most elevated, at 9.23 percent, 8.36 percent, 7.10 percent, and 6.90 percent, individually, which was essentially higher than the water content of different layers and was 5.74 times, 7.38 times, 13.32 times, and 16.17 times that of the least 0-10 cm layer.

(3) *Spatial Variation Characteristics of Soil Water Content in August during Growth Period.* It can be seen from Figure 7 that in August of the growth period, the soil moisture content of each layer at the level of 10 cm and 20 cm is significantly higher than that at the level of 30 cm and 40 cm. Among them, the moisture content of each layer at the level of 10 cm reaches the maximum, which is 221.70%, 47.16%, 103.51%, 77.63%, and 27.23% higher than that at the level of 30 cm, 184.17%, 57.05%, 120.95%, 90.63%, and 44.36% higher than that at the level of 40 cm. The difference is significant. The water content of each soil layer at the level of 20 cm is 119.81%, 16.59%, 63.16%, 63.64%, and 13.09% higher than that at the level of 30 cm and 94.17%, 24.43%, 77.14%, 75.61%, and 28.32% higher than that at the level of 40 cm.

The water content of soil vertical areas at 10 cm, 20 cm, 30 cm, and 40 cm at the foundation of seedlings arrived at the most extreme in the layer of 20~30 cm, which was

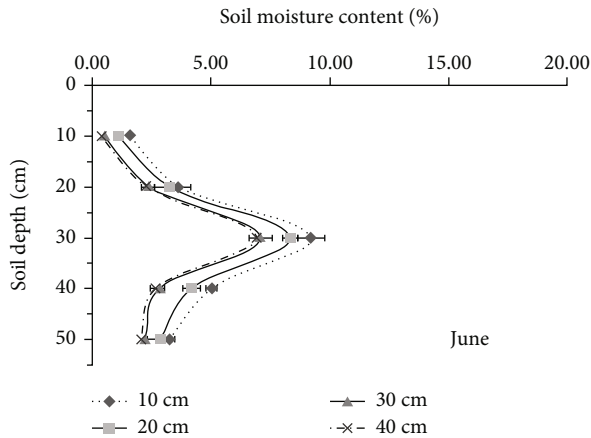


FIGURE 6: Spatial variation characteristics of soil moisture content in root zone of seedlings in June.

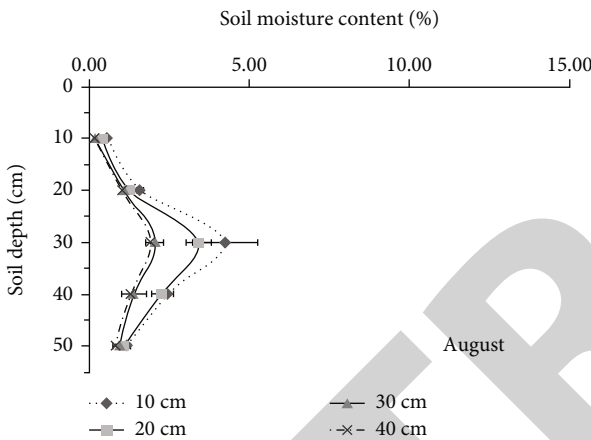


FIGURE 7: Spatial characteristics of soil moisture content in root zone of seedlings in August.

4.25%, 3.41%, 2.09%, and 1.93%, respectively, which were 7.48 times, 8.78 times, 11.83 times, and 9.63 seasons of the layer with the least water content of 0~10 cm. Contrasted and the past soil layer, the upward 10~20 cm layer and 20~30 cm layer of the dirt profile showed an increment, and the increment of the 20~30 cm layer at every flat distance was the biggest, up to 166.39%, 169.57%, 92.63%, and 89.34% individually. The 30~40 cm layer and 40~50 cm layer showed a decrease, and the decrease of the 30~40 cm layer at each horizontal distance was the largest, up to 41.81%, 33.14%, 33.33%, and 32.55%, respectively.

(4) *Spatial Variation Characteristics of Soil Water Content in October of Growth Period.* It can be seen from Figure 8 that in October of the growth period, the soil water content at 10 cm and 20 cm of the seedling level is significantly higher than that at 30 cm and 40 cm. Among them, the water content of each soil layer at 10 cm reaches the maximum, which is 192.47%, 59.35%, 71.32%, 62.71%, and 42.66% higher than the same layer at 30 cm, 251.26%, 75.43%, 85.97%, 71.84%, and 60.36% higher than that at 40 cm. The difference is sig-

nificant. The water content of each soil layer at the 20 cm level is 103.35%, 11.11%, 46.26%, 52.38%, and 17.58% higher than that at the 30 cm level and 144.22%, 22.32%, 58.76%, 60.94%, and 32.17% higher than that at the 40 cm level.

From 0~10 cm layer to 40~50 cm layer, the dirt dampness content expanded first and afterward diminished. Among them, the increment of the 20~30 cm layer at every level distance was 100.99%, 146.08%, 86.94%, and 89.60%, respectively, and the abatement of the 30~40 cm layer was 39.84%, 34.00%, 36.65%, and 34.89% individually. The water content of the 20-30 cm layer of soil at 10 cm, 20 cm, 30 cm, and 40 cm of the seedling level arrived at a limit of 5.77 percent, 4.92 percent, 3.37 percent, and 3.10 percent, individually, which was fundamentally higher than the water content of different layers, which was 4.95 times, 6.08 times, 8.45 times, and 9.35 times that of the most reduced 0-10 cm layer.

3.3. Temporal and Spatial Variation Characteristics of Soil Nutrients in Young Seedling Root Area

3.3.1. *Temporal and Spatial Variation Characteristics of Soil Organic Matter in Young Seedling Root Area.* Figure 9 shows that the change characteristics of soil organic matter content in each soil layer at 10 cm, 20 cm, 30 cm, and 40 cm of the seedling level are as follows: with the advancement of the seedling growth period, it decreases first and then increases. The characteristics of soil organic matter content at 10 cm of the seedling level in different periods are as follows: April > June > October > August. The characteristics of soil organic matter content at 20 cm, 30 cm, and 40 cm are as follows: April > October > June > August. Among them, the substance of soil natural matter in each dirt layer at the degree of 10 cm, 20 cm, 30 cm, and 40 cm arrived at the most extreme in April, which was 62.96%, 78.10%, 64.75%, and 44.88% higher than that in August. With the augmentation of flat distance, the substance of the natural matter in each dirt layer expanded. In April, the natural matter substance in the 0~10 cm soil layer at the 40 cm level was 68.75%, 58.82%, and 29.69% higher than that in the 0~10 cm soil layer at 10 cm, 20 cm, and 30 cm. The substance of soil natural matter in the 10~20 cm layer was 66.21%, 65.07%, and 37.71% higher than that in a similar layer at different distances. The substance of soil natural matter in the 20~30 cm layer was 71.05%, 69.57%, and 45.52% higher than that in a similar layer at different distances.

With the increment of soil profundity, the substance of the natural matter in various soil layers diminished. In April, when the natural matter substance is the biggest in the development time frame, the natural matter substance of the 0~10 cm layer at various distances is the most extreme, which is 1.98 times, 1.99 times, 2.14 times, and 1.95 seasons of the base 40~50 cm layer, respectively. Contrasted and the past layer, the decline of the 10~20 cm layer is the biggest, coming to 21.38%, 28.08%, 30.86%, and 23.24% individually. In August, when the natural matter substance was the most minimal in the development time frame, the natural matter substance in the 0~10 cm layer was 1.57 times, 1.75 times,

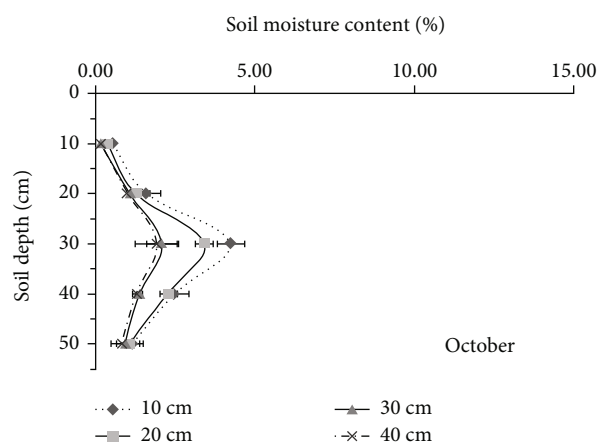


FIGURE 8: Spatial characteristics of soil moisture content in root zone of seedlings in October.

1.81 times, and 2.09 times that in the 40~50 cm layer, respectively. Compared with the previous soil layer, the decrease in the 10~20 cm layer was the largest, reaching 30.99%, 17.98%, 41.84%, and 41.38%, respectively.

3.3.2. Temporal and Spatial Variation Characteristics of Soil Alkali Hydrolyzable Nitrogen in Young Seedling Root Area. It can be seen from Figure 10 that the size characteristics of soil alkali hydrolyzable nitrogen content at 10 cm, 20 cm, 30 cm, and 40 cm at the seedling base level during different periods are as follows: April > June > October > August. The substance of soil antacid hydrolyzable nitrogen in each dirt layer at various level distances of seedlings arrived at the greatest in April. The substance of soil dissolvable base hydrolyzable nitrogen in the surface layer of 0~10 cm at the levels of 10 cm, 20 cm, 30 cm, and 40 cm was $113.35 \text{ mg}\cdot\text{kg}^{-1}$, $120.43 \text{ mg}\cdot\text{kg}^{-1}$, $128.86 \text{ mg}\cdot\text{kg}^{-1}$, and $135.38 \text{ mg}\cdot\text{kg}^{-1}$, respectively, which was 18.93 percent, 17.70 percent, 16.37 percent, and 26.23 percent higher than that in August with the most unjoyous. With the expansion of even distance, the substance of salt hydrolyzable nitrogen in each dirt layer expanded constantly. In April, when the soluble base hydrolyzable nitrogen content was the biggest in the development time frame, the antacid hydrolyzable nitrogen content of the 0~10 cm layer at the 40 cm level was 19.44%, 12.41%, and 5.06% higher than that of the 0~10 cm layer at 10 cm, 20 cm, and 30 cm, and the salt hydrolyzable nitrogen content of the 10~20 cm layer was 15.67%, 10.47%, and 5.51% higher than that of the similar layer at different distances. The antacid hydrolyzable nitrogen content of the 20~30 cm layer was 15.55%, 7.49%, and 4.25% higher than that of the similar layer at different distances.

The amount of soil salt hydrolyzable nitrogen decreased as the depth of the soil increased. In April, when the salt hydrolyzable nitrogen content is at its highest in the development time frame, the dirt soluble base hydrolyzable nitrogen content of the 0~10 cm soil layer which is 1.32 times, 1.31 times, 1.34 times, and 1.32 times higher than that of the base 40~50 cm soil layer at the degrees of 10 cm, 20 cm, 30 cm, and 40 cm is 1.32 times, 1.31 times, 1.34 times, and

1.32 times higher than that of the base 40. When compared to the previous soil layer, the decline in the 10~20 cm soil layer is the greatest, with 10.44 percent, 8.29 percent, 10.68 percent, and 10.20 percent, respectively. The soluble base hydrolyzable nitrogen content of the 0~10 cm soil layer was 1.29 times, 1.27 times, 1.36 times, and 1.15 times greater than that of the 40~50 cm soil layer at various distances in August, when the antacid hydrolyzable nitrogen concentration was lowest in the development time frame. With 7.50 percent, 8.99 percent, 7.63 percent, and 6.43 percent, respectively, the abatement of the 20~30 cm soil layer was the greatest as compared to the previous soil layer.

3.3.3. Temporal and Spatial Variation Characteristics of Soil Available Phosphorus in Young Seedling Root Area. It can be seen from Figure 11 that with the advance of the seedling growth period, the content of available phosphorus in each soil layer decreases first and then increases. The characteristics of soil available phosphorus content at the horizontal distance in different periods are as follows: April > October > June > August. During the growth period in April, the content of available phosphorus in the surface soil at the level of 10 cm, 20 cm, 30 cm, and 40 cm was 33.70%, 29.71%, 25.53%, and 18.89% higher than that in August, which was the lowest. With the extension of horizontal distance, the content of soil available phosphorus in each soil layer increased continuously. Available phosphorus content in the soil layer 0~10 cm at 40 cm level is 47.12 percent, 33.68 percent, and 15.67 percent more than that of the 0~10 cm soil layer at 10 cm, 20 cm, and 30 cm in April, when the available phosphorus content is at its highest throughout the growth season. The accessible phosphorus content of the 10~20 cm soil layer is 55.13 percent, 38.17 percent, and 19.53 percent greater than that of the same layer in other places, while the available phosphorus content of the 20~30 cm soil layer is 71.43 percent, 51.38 percent, and 25.00 percent higher.

The difference is significant.

With the increment of soil profundity, the substance of soil accessible phosphorus diminished. In April, when the accessible phosphorus content is the biggest in the development time frame, the accessible phosphorus content in the 0~10 cm soil layer at various level distances is the greatest, which is 2.08 times, 1.90 times, 1.77 times, and 1.59 seasons of the base 40~50 cm soil layer, respectively. Contrasted and the past soil layer, the downfall of the 20~30 cm soil layer is the biggest, coming to 29.09%, 27.98%, 22.16%, and 16.82% individually. In August, when the mobile phosphorus content was lowest, the mobile phosphorus content was 1.85, 1.68, 1.57, and 1.44 times higher in the soil layer of 0~10 cm compared to the soil layer of 40~50 cm. In the case of the previous soil layer, the 10 to 20 cm soil layer decreased the most, respectively, to 30.57%, 25.60%, 23.33%, and 18.15%.

3.3.4. Temporal and Spatial Variation Characteristics of Soil Available Potassium in Young Seedling Root Area. It can be seen from Figure 12 that with the advance of the seedling growth period, it decreases first and then increases. The size

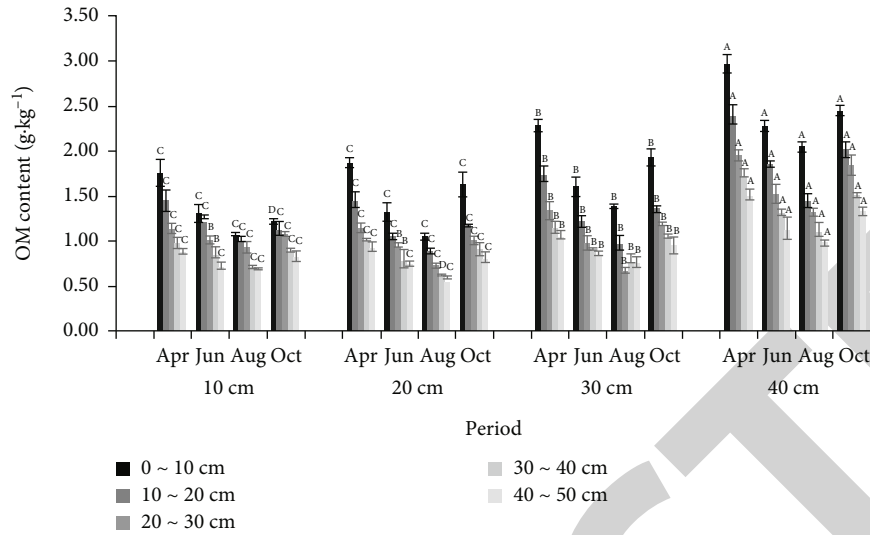


FIGURE 9: Content of organic matter at soil horizontal-vertical space in the root zone of seedlings in growth period. Note: different capital letters showed that the soil moisture content of the same layer in the same period has significant differences at different horizontal distances ($P < 0.05$).

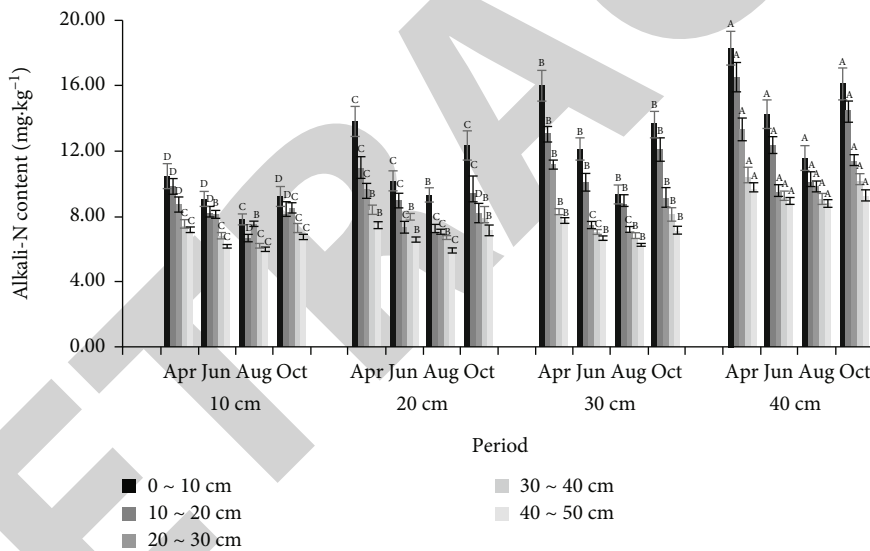


FIGURE 10: Content of alkali hydrolyzable nitrogen at soil horizontal-vertical space in the root zone of seedlings in growth period. Note: different capital letters showed that the soil moisture content of the same layer in the same period has significant differences at different horizontal distances ($P < 0.05$).

characteristics of soil available potassium content are April > October > June > August. The content of available potassium in each soil layer at different horizontal distances reached the maximum in April, which was 33.70%, 29.71%, 25.53%, and 18.89% higher than that in August. With the extension of horizontal distance, it shows an increasing trend. In April, when the content of available potassium was the highest in the growth period, the content of available potassium in the 0~10 cm soil layer at the 40 cm level was 47.12%, 33.68%, and 15.67% higher than that in the 0~10 cm soil layer at 10 cm, 20 cm, and 30 cm. The content of available potassium in the 10~20 cm soil layer was 55.13%, 38.17%, and 19.53% higher than that in the same layer at other distances. The content of available potassium

in the 20~30 cm soil layer was 71.43%, 51.38%, and 25.00% higher than that in the same layer at other places. The difference was significant.

With the increment of soil profundity, the substance of soil accessible potassium diminished. During the April development period, the available potassium content in the 0~10 cm soil layer at 10 cm, 20 cm, 30 cm, and 40 cm was 2.08, 1.90, 1.77, and 1.59 times higher than that in the 40~50 cm soil layer, respectively. Compared to the previous soil layer, the 20-30 cm soil layer decreased the most, reaching 29.09%, 27.98%, 22.16%, and 16.82%, respectively. In August, when the available potassium content decreased the most in terms of development, the available potassium content in the 0~10 cm soil layer was 1.85 times, 1.68 times,

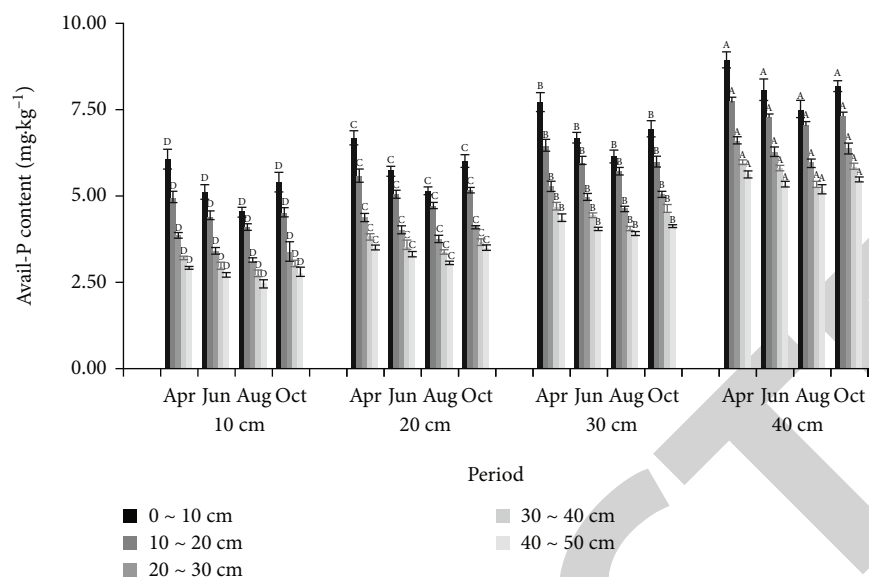


FIGURE 11: Content of available phosphorus at soil horizontal-vertical space in the root zone of seedlings in growth period. Note: different capital letters showed that the soil moisture content of the same layer in the same period has significant differences at different horizontal distances ($P < 0.05$).

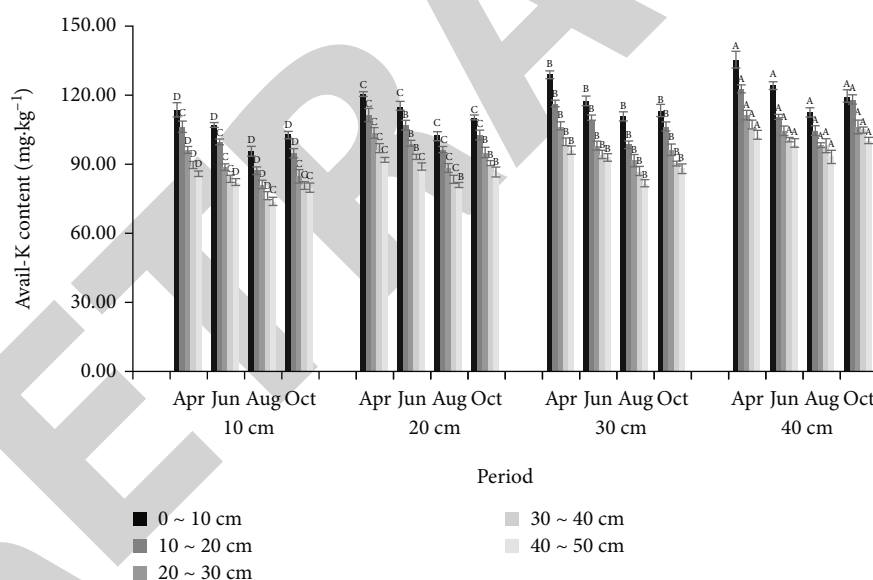


FIGURE 12: Content of available potassium at soil horizontal-vertical space in the root zone of seedlings in the growth period. Note: different capital letters showed that the soil moisture content of the same layer in the same period has significant differences at different horizontal distances ($P < 0.05$).

1.57 times, and 1.44 times higher than those in 40~50 years. See the soil layer. Compared with the previous soil layer, the reduction of the soil layer of 10 to 20 cm was the largest, reaching 30.57%, 25.60%, 23.33%, and 18.15%, respectively.

3.4. Analysis of the Relationship between Rainfall and Soil Moisture in Seedling Habitat. It very well may be seen from Table 5 that there is no critical relationship between precipitation in April of the development period and water content of each dirt layer ($P < 0.05$). There was a huge positive con-

nection between precipitation in June and soil water content in the 0~10 cm layer and 10~20 cm layer, and the relationship coefficients were 0.564 and 0.473, which had a feeble connection with water content in other soil layers ($P < 0.05$). There was a critical positive relationship between precipitation in August and soil dampness content in the 0~10 cm layer, 10~20 cm layer, and 20~30 cm layer, and the connection coefficients were 0.865, 0.623, and 0.519, respectively, which had a frail relationship with soil dampness content in different layers ($P < 0.05$). There was a critical positive

TABLE 5: Correlation analysis between rainfall and moisture content in different soil layers in growing period.

Growth period	April	June	August	October
0~10 cm	0.374	0.564*	0.865*	0.716*
0~20 cm	0.306	0.473*	0.623*	0.524*
0~30 cm	0.275	0.312	0.519*	0.480*
0~40 cm	0.221	0.246	0.388	0.277
0~50 cm	0.109	0.225	0.362	0.219

Note: * showed significant correlation at 0.05 level.

relationship between precipitation in October and soil water content in the 0~10 cm layer, 10~20 cm layer, and 20~30 cm layer, and the connection coefficients were 0.716, 0.524, and 0.480, respectively, which had a frail relationship with soil water content in different layers ($P < 0.05$). With the increment of soil profundity, the relationship coefficient among precipitation and soil dampness content declines, and the connection degree diminishes.

3.5. Analysis of the Relationship between Soil Moisture and Nutrients in Seedling Habitat. In Table 6, the relationship between the moisture content of the soil and the natural substances in the soil, soluble base hydrolyzable nitrogen, accessible phosphorus, and accessible potassium content in various soil profundities of seedling living space in the development period is unique. Among them, there was a huge positive connection between dirt water content and natural matter substance in the 0~10 cm layer and 10~20 cm layer, and the relationship coefficients were 0.525 and 0.431, respectively. The connection between dirt water content and natural matter substance in other soil layers was feeble ($P < 0.05$). There was a critical positive connection between dirt water content and soluble base hydrolyzable nitrogen content in the 0~10 cm soil layer, and the relationship coefficient was 0.462. The relationship between dirt water content and natural matter substance in other soil layers was feeble ($P < 0.05$). The connection between dirt water content and accessible phosphorus content in various soil layers was frail ($P < 0.05$). There was an exceptionally huge positive connection between dirt water content and accessible potassium content in the 0~10 cm layer, 10~20 cm layer, and 20~30 cm layer, and the relationship coefficients were 0.829, 0.731, and 0.665, respectively ($P < 0.01$). There was a critical positive connection between dirt water content and accessible potassium content in the 30~40 cm layer and 40~50 cm layer, and the relationship coefficients were 0.572 and 0.556, respectively ($P < 0.05$). With the increment of soil profundity, the connection coefficient between soil water content and soil natural matter, antacid hydrolyzable nitrogen, and accessible potassium diminished.

4. Discussion

4.1. Temporal and Spatial Variation Characteristics of Soil Moisture in Young Seedling Root Area. In 3-6 is the relationship between the moisture content of the soil and the natural

TABLE 6: Correlation analysis between moisture content and nutrient content in different soil layers in growth period.

Soil depth	OM	Avail-N	Avail-P	Avail-K
0~10 cm	0.525*	0.462*	0.287	0.829**
0~20 cm	0.431*	0.381	0.212	0.731**
0~30 cm	0.368	0.304	0.185	0.665**
0~40 cm	0.184	0.257	0.163	0.572*
0~50 cm	0.153	0.213	0.147	0.556*

Note: * showed significant correlation at 0.05 level, and ** showed significant correlation at 0.01 level.

substances in the soil. The change of soil water in the seedling root zone is not only affected by terrain, soil texture, groundwater, and other factors but also affected by snow melting, precipitation, evaporation, wind, and other factors [27, 28]. The dirt water content in the seedling root zone diminishes first and afterward increments with the development of the seedling development period, demonstrating that the dirt water content in the seedling root zone has clear occasional variety attributes. The explanation is that the dirt water content in the seedling root zone is unevenly dispersed during the development time frame because of the impact of precipitation and dissipation. In April, which is the growing season, the soil moisture in the root area of the seedlings is the highest compared to other growing seasons. The soil moisture content in the 0~50 cm layer of the soil is 6.25%, which is less than 7.15% of the research results of Dai Yue in the habitat of adult *Haloxylon ammodendron* in the same period in Fukang desert area, Xinjiang. The difference may be related to the precipitation and soil texture of the two regions and the difference in water use efficiency of *Haloxylon ammodendron* at different ages.

During the development time frame, the dirt dampness content of each dirt layer at various even distances in the root zone of youthful seedlings is described by a generally speaking diminishing pattern with the expansion of the flat distance. The change qualities of soil dampness content at every level distance are that it first increments and afterward diminishes with the increment of soil profundity, which is predictable with the examination finishes of Yang Yanfeng et al. [16]. The dirt space in the root zone of *Haloxylon ammodendron* has a self-evident "wet island" impact. The results showed that *Haloxylon ammodendron* seedlings had the ability to accumulate water in the process of adapting to desert and arid environments. This unique ability to accumulate water can obtain more water for seedlings to resist drought, thus reflecting the advantage of *Haloxylon ammodendron* as the main constructive species in Gurbantunggut Desert [29].

4.2. Temporal and Spatial Variation Characteristics of Soil Nutrients in Young Seedling Root Area. The low satisfaction of different soil supplements in the desert region is one reason for its intense pressure [30, 31]. The items in soil natural matter, soluble base hydrolyzable nitrogen, accessible phosphorus, and accessible potassium in each dirt layer of the

youthful seedling root zone diminished first and afterward expanded with the development of the seedling development period. The dirt supplement content in April of the development period was generally high. The substance of the natural matter in the 20~30 cm layer of soil was $1.14 \text{ g}\cdot\text{kg}^{-1}$, and the substance of quick accessible phosphorus was $3.85 \text{ mg}\cdot\text{kg}^{-1}$, which was not exactly that of Liu Yunhua et al. [11]. The outcomes of Haloxylon ammodendron in the desert region around Ganjiahu Haloxylon ammodendron Nature Reserve were $3.08 \text{ g}\cdot\text{kg}^{-1}$ and $7.13 \text{ mg}\cdot\text{kg}^{-1}$. The justification for the thing that matters is connected with the dirt surface, Haloxylon ammodendron age, and environment in the two regions. The soil nutrient content of the vertical soil profile is in Chen Jing et al. Consistent with the study, it shows a decreasing trend with increasing soil depth (2019): artificial Haloxylon ammodendron forest in the desert area of Inner Mongolia. The effect of fortifying nutrients on the soil surface is clear.

The variation characteristics of soil nutrient content at different horizontal distances in the root zone of Haloxylon ammodendron seedlings are as follows: with the extension of horizontal distance, the overall trend is increasing. Differences in spatial variation characteristics and soil nutrients in the root zone show that there is an obvious characteristic of “low inside and high outside” in the horizontal space of Haloxylon ammodendron seedlings, which is similar to the research results of Chen Jing et al. and Liu Yunhua et al.. On the contrary, adult Haloxylon ammodendron has a typical “fat island” effect. The reason for the difference may be related to the age and soil texture of Haloxylon ammodendron. Most of the nutrients in the surface soil are mainly obtained from the litter materials of plants. Compared with adult Haloxylon ammodendron, Haloxylon ammodendron seedlings have smaller crown width, plant height, and base diameter, resulting in less litter, less nutrient accumulation in the root zone soil, and lower ability of seedlings to accumulate nutrients. In addition, the root system of seedlings is smaller than that of adult Haloxylon ammodendron, and the controlled soil space resources are also small. Its growth continuously consumes the nutrients around its root system, making the soil nutrient content near the root system lower than that in the surrounding area, which is also one of the reasons why Haloxylon ammodendron seedlings are prone to death and low survival rate.

4.3. Effect of Rainfall on Soil Water Content in Seedling Habitat. In desert settings, soil moisture is one of the most important water sources for plants. Soil moisture deficit is one of the main causes of desert shrub forest deterioration, which has a significant impact on ecosystem nutrient cycles [14]. The supply of soil water mainly comes from snowfall, rainfall, and groundwater supplement, and the consumption of soil water mainly includes plant absorption, evaporation, and infiltration. During the growth period from March to October, there are 49 rainfall events during the growth period of Haloxylon ammodendron in the desert, with an average of once every 6 days, mainly small rainfall events and sporadic medium rainfall events, accounting for more than 88.98%, which is consistent with the research results

of Yue yuemeng et al. on Haloxylon ammodendron habitat in Gurbantunggut Desert. The fluctuation range of precipitation in the desert area is small, and there is little difference between soil texture and terrain. The dynamics of soil water mainly depend on the amount absorbed by desert plants. The characteristics of rainfall frequency and average rainfall in Haloxylon ammodendron habitat in different growth periods are as follows: mid-April~mid-June>mid-August~mid-October>early March~mid-April>mid-June~mid-August. It shows that there is seasonal variation in rainfall in the desert area of Xinjiang Uygur Autonomous Region.

The endurance of Haloxylon ammodendron seedlings for the most part relies upon the water invaded by snowmelt and precipitation and utilization of the shallow soil water content [32]. The connection between precipitation in seedling environment and soil water content in various soil layers was unique. There was no critical relationship between the precipitation in April and the dirt dampness content of each dirt layer. There was a critical positive relationship between the precipitation in June and the dirt dampness content of the 0~10 cm layer and 10~20 cm layer. There was a huge positive relationship between the precipitation in August and October and the dirt dampness content of the 0~10 cm layer, 10~20 cm layer, and 20~30 cm layer ($P < 0.05$). With the increment of soil profundity, the connection coefficient among precipitation and soil dampness content abates, and the relationship degree diminishes. It shows that the precipitation in the center and late development phase of desert seedling living space critically affect the difference in soil water content in the shallow layer of 0~30 cm. With the augmentation of soil profundity, the effect diminishes, which is reliable with the examination consequences of Xu Hao et al.. There are not many enormous precipitation occasions in the desert, which affects the dirt water content in the shallow layer; Haloxylon ammodendron for the most part utilizes the shallow soil water framed by precipitation to keep up with its endurance.

4.4. Effect of Soil Moisture Change in Young Seedling Root Zone on Soil Nutrients. Soil nutrient resources in desert areas are absorbed and utilized by plants under the action of water. Therefore, the temporal and spatial changes of soil water directly affect the changes in soil nutrient resources and then affect the nutrient circulation and utilization of ecosystems in arid areas [33]. There was a huge positive connection between dirt water content and natural matter substance in the 0~10 cm layer and 10~20 cm layer in the root zone of Haloxylon ammodendron youthful seedlings at the development stage; there was a critical positive relationship between dirt water content and salt hydrolyzable nitrogen content in the 0~10 cm layer, and the relationship between dirt water content and accessible phosphorus content in various soil layers was frail ($P < 0.05$). This relationship is like the aftereffects of Li congjuan et al. in the review region. Soil dampness essentially affects shallow soil natural matter and accessible nitrogen content, yet not on soil accessible phosphorus content. With the increment of soil profundity, the effect of soil dampness on soil natural matter and accessible nitrogen is debilitating. It shows that dirt dampness

significantly affects the conveyance example of soil supplement assets.

Due to the influence of climate, landform, vegetation, parent rock, precipitation, soil animals, and other soil forming factors and human activities, the distribution of soil nutrient content in the desert area is uneven, and the soil nutrient content is generally low. The growth of desert plants is mainly limited by carbon, nitrogen, and phosphorus nutrients [33, 34]. Most examinations show that the change attributes and corresponding relationship of soil natural matter and soil accessible supplements, which are generally straightforwardly consumed by plants, assume a significant part in the development and advancement of desert plants. In this review, the substance of accessible nitrogen in the shallow soil in the seedling living space differs from 5.96~10.96 mg·kg⁻¹, and the substance of accessible phosphorus changes from 2.45~6.07 mg·kg⁻¹. The typical proportion of accessible nitrogen to accessible phosphorus is 1.87. The difference in accessible nitrogen is not exactly that of Tao Ye et al. on the desert territorial size of Junggar bowl, which is 16.04~25.10 mg·kg⁻¹, and the difference in accessible phosphorus is more prominent than that of 3.61~4.37 mg·kg⁻¹. The available nitrogen phosphorus ratio is less than the result of 5.87, indicating that the soil available nitrogen content in the study area is low, and the available nitrogen phosphorus ratio is far lower than the desert regional scale level, which further reflects the lack of nitrogen nutrients in the soil in the study area, which is related to the scarce precipitation and low soil water content in the study area. In addition, there are fewer types and quantities of soil microorganisms, resulting in a relatively low decomposition rate of soil nutrients. The weathering rate and the ability of soil to store nutrients are low, resulting in low available soil nutrient content [35].

5. Conclusion

The soil moisture and nutrient content in the root zone of seedlings have obvious temporal and spatial variation characteristics. It shows that there is seasonal variation in rainfall in the desert area of Xinjiang Uygur Autonomous Region. In the space of soil level (0~40 cm), with the expansion of flat distance, there is a self-evident “wet island” impact in soil water content and a self-evident “low inside and high outside” trademark in soil supplement content. In the upward (0~50 cm) space of soil, with the increment of soil profundity, the dirt water content expanded first and afterward diminished, and the dirt supplement content diminished. Living space precipitation essentially affected soil water content in 0~30 cm ($P < 0.05$), and soil water highly affected the items in natural matter, soluble base hydrolyzable nitrogen, and accessible potassium in surface soil ($P < 0.05$). The natural succession of soil water and soil nutrient resources in the Haloxylon ammodendron habitat changes very slowly, with long periodicity and small variation range. Therefore, in the degraded area of Haloxylon ammodendron and the area with a low seedling survival rate, strengthening the protection and management of habitat water and nutrient resources with artificial assistance will contribute to the

renewal and rejuvenation of degraded Haloxylon ammodendron population in the desert area of Junggar Basin.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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