# EFFECTS OF DIFFERENT STUMPING INTERVALS AND STUMP HEIGHTS ON THE NUTRITIONAL COMPONENTS AND REGENERATION OF *SALIX PSAMMOPHILA*

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**Abstract.** The Inner Mongolia Autonomous Region is one of the areas with relatively severe soil desertification in China. Previous studies have shown that the establishment of psammophilous shrubs can effectively alleviate the problem of soil desertification. Meanwhile, psammophilous shrubs can serve as raw materials for livestock feed and possess a certain economic value. Taking the artificial *Salix psammophila* forest in Hanggin Banner, Ordos City as the research object, this study selected post-harvest stands that had grown for 1 year (1a), 2 years (2a), and 3 years (3a) after stumping, as well as non-stumped stands, as the control (CK). By setting different treatments, the effects of different stump heights (0, 5, 10, 15 cm) were compared under the same stumping interval (1a) and ground-level stumping under different intervals (1a, 2a, 3a, CK) on the regenerability of *S. psammophila*. Meanwhile, it explored the monthly variations of branch/leaf nutrients during the growing season and dynamic changes in microclimate and soil wind erosion under different stumping intervals. The study aims to provide theoretical basis for rational and efficient utilization of *S. psammophila* resources. The main conclusions are as follows:(1) During the growing season, *S. psammophila* foliage nutrients (crude protein, fat, ash, acid/neutral detergent fiber, lignin, Ca, P, RFV) fluctuated. Crude fat and protein peaked in May, while acid/neutral detergent fiber and lignin reached the lowest levels in June. (2) Stumping mitigates growth decline and promotes height/basal diameter growth. 10 cm stumps showed optimal regeneration rate and shoot density, while 5 cm stumps showed the fastest basal diameter growth. No significant differences in regeneration rate were found across stumping intervals, but un-stumped stands showed the poorest shoot germination. (3) The wind speed under the forest shows the order of 3a < 2a < 1a < CK, while there is no obvious pattern in temperature and humidity. All the four sample plots are aeolian deposits, and the deposition amounts in the 3a and 2a plots are relatively low.
**Keywords:** *psammophilous shrubs, feeding value, regeneration ability, microclimate, ecological restoration*

## Introduction

*Salix psammophila*, also known as northern sand willow, plays a critical role in ecological restoration in western Inner Mongolia (De et al., 2021). Studies show that its branches contain approximately 15% fine shoots and tender twigs with nutritional composition including 13.79% crude protein, 14.32% crude fat, 27.47% crude fiber, 27.4% nitrogen-free extract, and 5.04% crude ash (Lin, 1986), making it suitable as a direct forage for cattle, sheep, and camels. Stumping refers to cutting plants at ground level or certain heights to promote straight and robust new stems, which significantly enhances plant growth (Maschinski et al., 1989). Foreign scholars have studied effects


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of grazing, fire, and mowing on plant regeneration (He et al., 2009). Widely applied in artificial shrubbery management across China, stumping serves as a primary rejuvenation method for desert plants (Huang et al., 2022). Optimal stump height is crucial for sustainable growth (Hamback et al., 2003). Grassland management studies indicate low-frequency, low-stump mowing maximizes annual dry matter accumulation (Frame et al., 1971). Chinese research on appropriate stump heights began early: in 1975, Yang Ruyuan found 6–10 cm stumps outperformed 0–3 cm treatments for poplar regeneration (Yang, 1975). In 2011, Lu et al. (2021) reported 10 cm stumps improved Caragana korshinskii growth and canopy compared to 0 cm and 5 cm treatments. A 2021 study by Liu Xiaoyu showed 15 cm stumps optimized Hippophae rhamnoides root fractal characteristics in sandstone areas (Liu et al., 2021).

Currently, *S. psammophila* is mainly stumped during dormancy with cut branches discarded, causing substantial resource waste. Therefore, investigating effects of different stumping methods on regeneration performance and stumping intervals on branch/leaf nutrient dynamics provides important guidance for determining optimal stumping practices balancing forage utilization and ecological restoration in Ordos.

## Materials and methods

The experimental observation plots were located in Xini Town, Hanggin Banner, Ordos City, Inner Mongolia Autonomous Region (108°44′E, 39°49′N), featuring a typical temperate semi-arid plateau continental climate. The study was conducted from April to October 2023 in *S. psammophila* stands aged 1a, 2a, 3a, and over 5a without stumping at Amenqirige Village, Xini Town, Hanggin Banner. All plots were established as 50 m × 50 m square units with average belt spacing of 4–9 m and plant spacing of 2 m.

### *Experimental design*

Stands with certain canopy density and vigorous growth in 1a, 2a, 3a, and CK groups were selected to measure growth indicators. In order to investigate the effect of different stubble heights on the regenerative capacity of *S. psammophila*, in April 2023, stumping treatments were applied with four stump heights (0 cm, 5 cm, 10 cm, and 15 cm) in the 1a plots, each treatment had three replicates. In order to investigate the effects of different stumping intervals on the regenerative capacity of *S. psammophila*. Stump heights for 1a, 2a, 3a, and CK plots were uniformly set at 0 cm, each treatment had three replicates. Followed by measurements of regeneration capacity. Meanwhile, from April to October 2023, ground-level stumping was conducted on all four plot groups. Cut branches and leaves were naturally air-dried, pulverized, and transported to the laboratory for forage nutritional component analysis.

### *Measurement items and methods*

#### *Nutritional component analysis of S. psammophila under different stumping intervals and growth months*

Monthly mid-month samples (April–October) of stumped *S. psammophila* were processed into powder, homogenized, and approximately 1 kg samples were dried to constant weight at 65°C to determine initial moisture and dry weight. Nutritional components were analyzed using standard methods: crude fat by Soxhlet extraction


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(GB/T 6433-2006), crude protein by Kjeldahl nitrogen determination (GB/T 6432-1994), crude ash by gravimetric analysis (GB/T 6438-2007), calcium by titration (GB/T 6436-2002), total phosphorus by spectrophotometry (GB/T 6437-2002), neutral detergent fiber by filtration (GB/T 20806-2006), acid detergent fiber by filtration (NY/T 1459-2007), and lignin by the 72% sulfuric acid method (Zhang, 2007). Each treatment was replicated three times.

*Regenerative capacity under different stumping intervals and heights*

Regeneration observations for same-age stands with different stump heights began one month after stumping. Mid-month measurements included plant height, canopy width, basal diameter, and sprout number. Biomass was recorded at the end of the growing season (late October). For ground-level stumping treatments under different intervals, the same growth parameters were measured.

*Microclimate parameter measurements*

Air temperature and wind speed were measured using a Kestrel 3500 handheld weather station. From May to October 2023, parameters (wind speed, air temperature, humidity, atmospheric pressure) were recorded at 20 cm above ground in stumped stands of different ages. Measurements were taken every 2 h between 8:00–16:00 with three replicates. Soil wind erosion was quantified using the steel pin method (Li et al., 2006). Forty-centimeter-long, 0.5 cm-diameter steel pins were installed in 1 m × 1 m grids (0.2 m × 0.2 m spacing) with 20 cm exposed aboveground. Pin height changes were recorded simultaneously with wind speed measurements.

### *Data processing*

Data organization and tables were prepared in Excel. One-way ANOVA and post-hoc tests were performed using SPSS, while graphs were generated with Origin 2020.

## Results and analysis

### *Nutritional components of Salix psammophila under different stumping periods*

*Table 1* shows that from April to October, crude fat content in *S. psammophila* ranged from 2.94%–4.36%, with significantly higher levels in May compared to April and August ($p < 0.05$). Crude protein content fluctuated between 8.44%–9.51%, peaking in May followed by June, July, September, October, and lowest in April and August. Crude ash content (3.36%–5%) was highest in September, significantly exceeding June, July, and October ($p < 0.05$), with no significant differences between April and May. Both neutral detergent fiber and acid detergent fiber contents showed significant monthly variations ($p < 0.05$), with April having the highest overall levels. Lignin content (12.66%–21%) reached a peak in August and a minimum in June, with no significant differences among other groups, showing a trend of initial decrease, subsequent increase, and final stabilization. Calcium content (1.34%–1.86%) first increased then decreased, reaching a maximum of 1.86% in September. Phosphorus content showed no significant changes. The relative forage value was highest in September at 71.5 and lowest in April at 56.8.


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***Table 1.*** *Nutritional ingredients of S. psammophila in different stubble periods*

| Month | (CF, %) | (CP, %) | (Ash, %) | (NDF, %) | (ADF, %) | (Lig, %) | (Ca, %) | (P, %) | (RFV) |
|---|---|---|---|---|---|---|---|---|---|
| Apr. | 2.94±0.12e | 8.44±0.02c | 3.36d | 73.96±0.19a | 56.98±0.17a | 16.96±0.64b | 1.41±0.01d | 0.18a | 56.85±0.29d |
| May. | 4.36±0.04a | 9.51±0.06a | 3.48±0.03d | 72.36±0.16b | 55.82±0.1b | 14.95±0.37bc | 1.34d | 0.17ab | 58.38±0.23d |
| Jun. | 3.8±0.08bc | 9.18±0.01b | 4.41±0.05b | 64.74±0.07f | 50.26±0.05e | 12.66±0.74c | 1.68c | 0.18a | 71.48±0.12a |
| Jul. | 3.67±0.2cd | 9.2±0.04b | 4.42±0.02b | 65.43±0.27f | 51.2±0.38d | 15.87±0.89b | 1.73bc | 0.16cd | 69.7±0.7b |
| Aug. | 3.07±0.18e | 8.58±0.06c | 3.99±0.1c | 70.39±0.55c | 52.5±0.45c | 21±1.67a | 1.79±0.05ab | 0.17bc | 63.45±0.96c |
| Sep. | 3.3±0.12de | 9.05±0.14b | 5±0.07a | 66.61±0.15e | 48.4±0.1f | 15.6±0.92b | 1.86±0.01a | 0.16d | 71.5±0.05a |
| Oct. | 4.13±0.14ab | 9.06±0.02b | 4.44±0.06b | 67.74±0.43d | 47.93±0.27f | 14.66±0.36bc | 1.69±0.05c | 0.16cd | 70.82±0.54ab |

Different letters in the same column mean significant difference ($P < 0.05$). The same as below

### *Effects of stumping with different stump heights on the regenerability of S. psammophila*

#### *Effects of stumping with different stump heights on the regeneration speed of S. psammophila*

The monthly changes in the regeneration speed of *S. psammophila* from May to October under different stump height conditions are shown in *Figure 1*. From May to October, in each month, there are significant differences in the regeneration speed of *S. psammophila* with different stump heights ($p < 0.05$). Specifically, in May, when the stump height is 0 cm, the regeneration speed of *S. psammophila* is the lowest; while when the stump height is 5 cm, the regeneration speed is relatively higher. In June, when the stump heights are 10 cm and 15 cm, the regeneration speed of *S. psammophila* is higher, and the two values are similar; when the stump height is 0 cm, the regeneration speed is lower. In July, when the stump height is 15 cm, the regeneration speed of *S. psammophila* reaches the highest, while when the stump height is 0 cm, it is the lowest. In August, still when the stump height is 15 cm, the regeneration speed is the highest, and when the stump height is 0 cm, it is relatively lower. However, the situation in September is different. At this time, when the stump height is 0 cm, the regeneration speed of *S. psammophila* is the fastest, and when the stump height is 15 cm, it is relatively lower. In October, when the stump height is 10 cm, the regeneration speed is the highest, and when the stump height is 15 cm, it is relatively lower. Generally speaking, in the months of May, August, and October, higher stump heights (10 cm, 15 cm) are often associated with faster regeneration speeds. This may be because a higher stump height retains more physiologically active tissues and structures, which is conducive to the accumulation of nutrients and the distribution of growth-regulating substances, thus promoting the regeneration of *S. psammophila*.

#### *Influence of stumping at different stubble heights on the number of sprouts of S. psammophila*

There were significant differences in the number of newly sprouted branches of *S. psammophila* at different stubble heights (*Fig. 2*). Statistical tests showed that there was an extremely significant difference ($P < 0.01$) in the number of new shoot sprouting between the 0 cm and 10 cm stubble height treatments. The 10 cm stubble height treatment group had an extremely significantly higher number of new shoot sprouting than other stubble height treatments ($P < 0.01$). The 0 cm and 5 cm stubble height treatments had relatively fewer new shoots with no significant difference between them, indicating that lower stubble heights had no obvious promoting effect on new shoot


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sprouting in *S. psammophila*. The 15 cm stubble height treatment had a moderate number of new shoots, which was extremely significantly lower than that of the 10 cm stubble height treatment. Further analysis of the data distribution characteristics of germination numbers in each treatment group revealed varying degrees of dispersion among different stubble height treatments. The 0 cm and 10 cm stubble height treatment groups had a larger box range, indicating higher variation in germination numbers among individuals within these groups; the 5 cm and 15 cm stubble height treatment groups had relatively smaller box ranges with more concentrated data distributions.

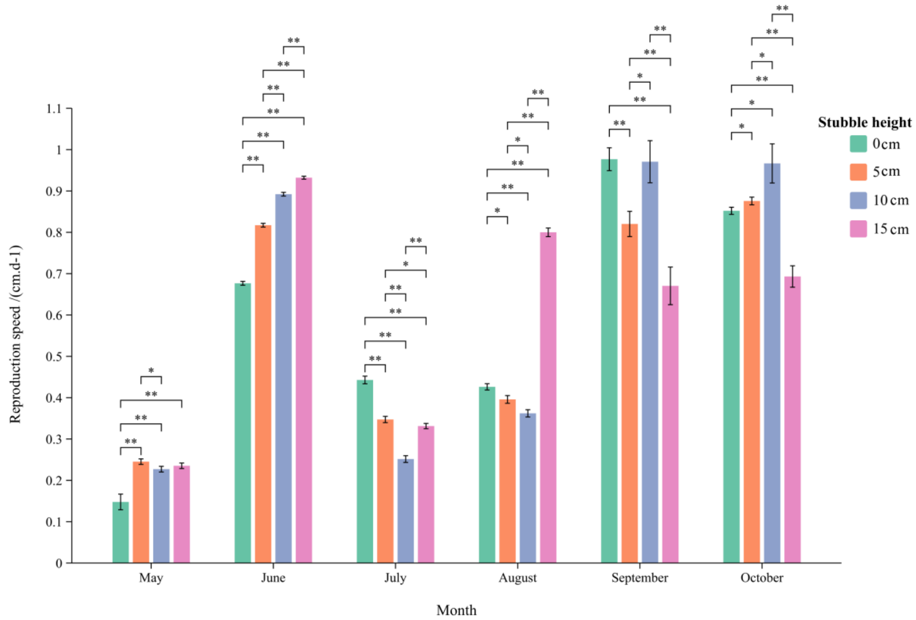


***Figure 1.*** *The effect of different stubble heights on the regeneration speed of S. psammophila*

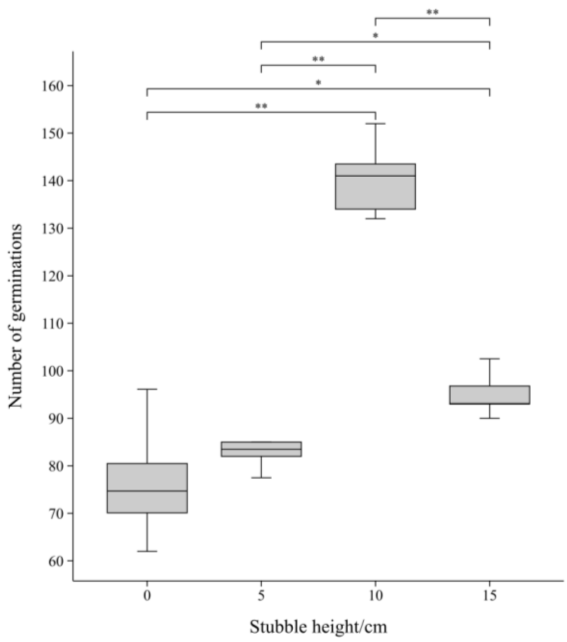


***Figure 2.*** *The effect of different stubble heights on the number of germinations of S. psammophila*


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*Influence of different stubble heights on the crown width, plant height, basal diameter and biomass of S. psammophila*

The effects of different stubble heights on the average crown width, average height, average basal diameter, and biomass of S. psammophila are shown in *Figure 3*. Overall, different stubble heights had little effect on the average crown width and average height of S. psammophila, but had a certain impact on the average basal diameter. The 5 cm stubble height treatment showed the best performance, with a significant difference ($p < 0.05$) compared to the 10 cm stubble height treatment, while no significant differences were observed among other stubble heights for these indicators. In terms of biomass, the 15 cm stubble height treatment had relatively higher values, though not reaching statistical significance.

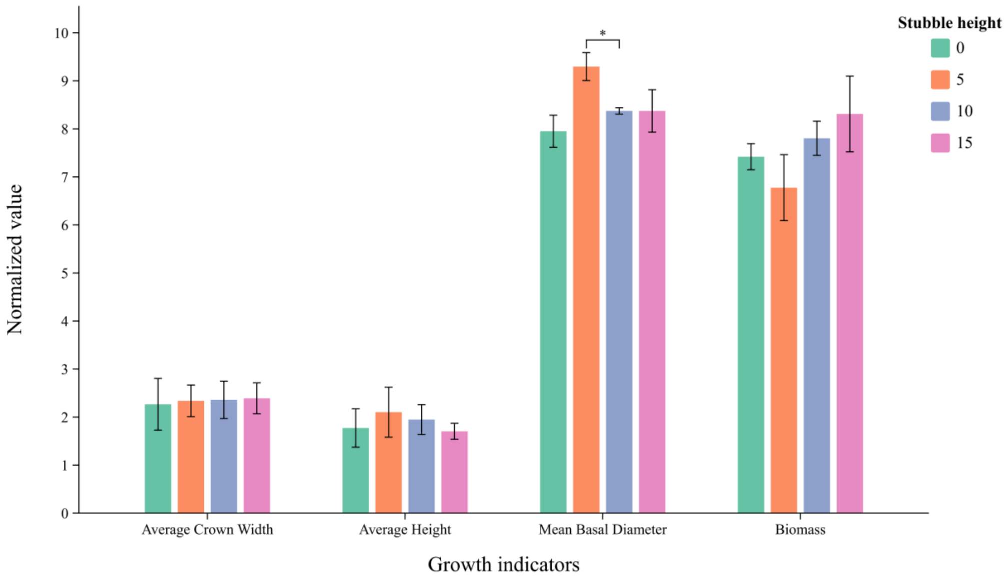


***Figure 3.*** *The effect of different stubble heights on the crown width, plant height, base diameter, and biomass of S. psammophila*

## ***Influence of stumping at different stumping intervals on the regenerability of S. psammophila***

*Influence of different stumping intervals on the regeneration rate of S. psammophila*

The stumping treatment at the ground level was carried out for the four groups with different stumping intervals. The changes in the regeneration rate of *S. psammophila* from May to October are shown in *Figure 4*. In June, the propagation rates of the 1a, 2a and ck groups were extremely significantly higher than that of the 3a group ($P < 0.01$), and there was no significant difference in the other months. Generally speaking, the regeneration rates were relatively fast in June and August, and there was little difference in the regeneration rates of new branches among the stumping treatments with different intervals.

*Influence of different stumping intervals on the number of sprouts of S. psammophila*

As shown in *Figure 5,* the number of new shoot sprouting in Salix psammophila under different stumping intervals indicated extremely significant differences ($P < 0.01$) between the 1a, 2a, and 3a treatments and the control group (CK). The 1a, 2a, and 3a


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treatment groups all had extremely significantly higher new shoot sprouting numbers than the CK group (P < 0.01), indicating that stumping promoted shoot sprouting in Salix psammophila, with the promoting effect decreasing as the stumping interval increased. The 1a and 2a treatment groups had larger box ranges, suggesting greater variation in germination numbers among individuals within these groups; the 3a treatment group had a relatively smaller box range with more concentrated data distribution.

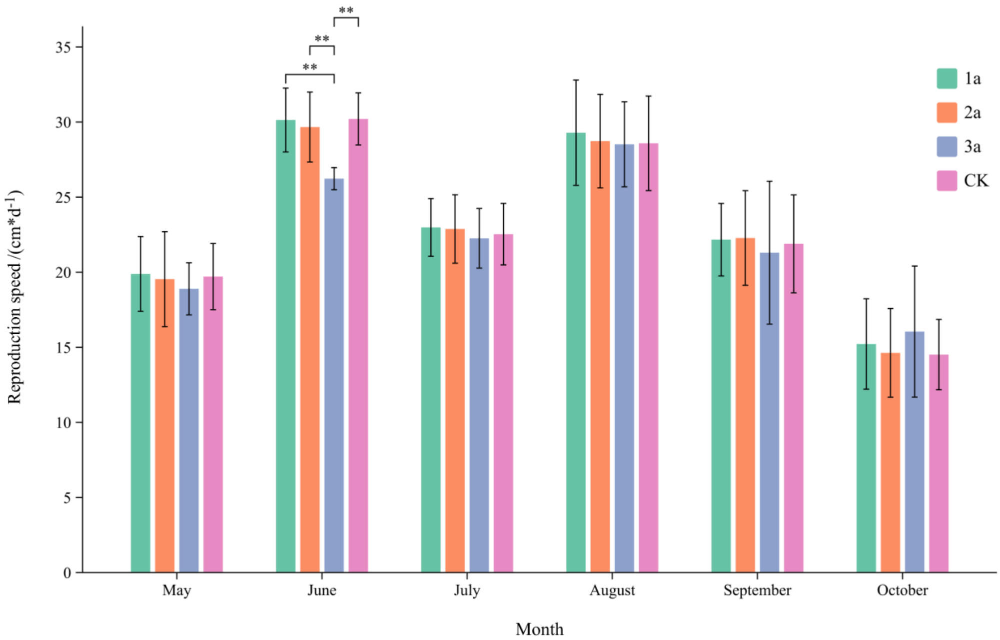


***Figure 4.*** *The effect of different stumping intervals on the regeneration speed of S. psammophila*

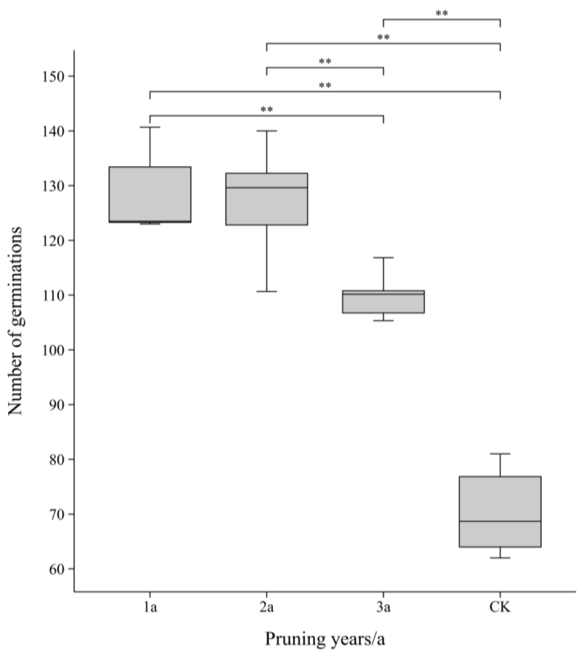


***Figure 5.*** *The effect of different stumping intervals on the number of germinations of S. psammophila*


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*Influence of different stumping intervals on the number of sprouts of S. psammophila*

The average wind speeds in different months are shown in *Figure 6*. Among them, there are significant differences between CK and the 2a and 3a groups in May. In June, there are significant differences between the 3a group and the 1a and CK groups. In July, there are significant differences between CK and the 1a and 3a groups. In August, there are extremely significant differences between the 3a group and other groups. The wind speeds in all sample plots in September and October are relatively close, approximately between 0.8 m/s and 1.1 m/s. Specifically, the average wind speed of CK is the highest in May and July, reaching 1.8 m/s, while the wind speeds of other groups are relatively low, approximately between 1.2 m/s and 1.4 m/s. Generally speaking, the average wind speed of the 3a group is lower than that of other groups most of the time.

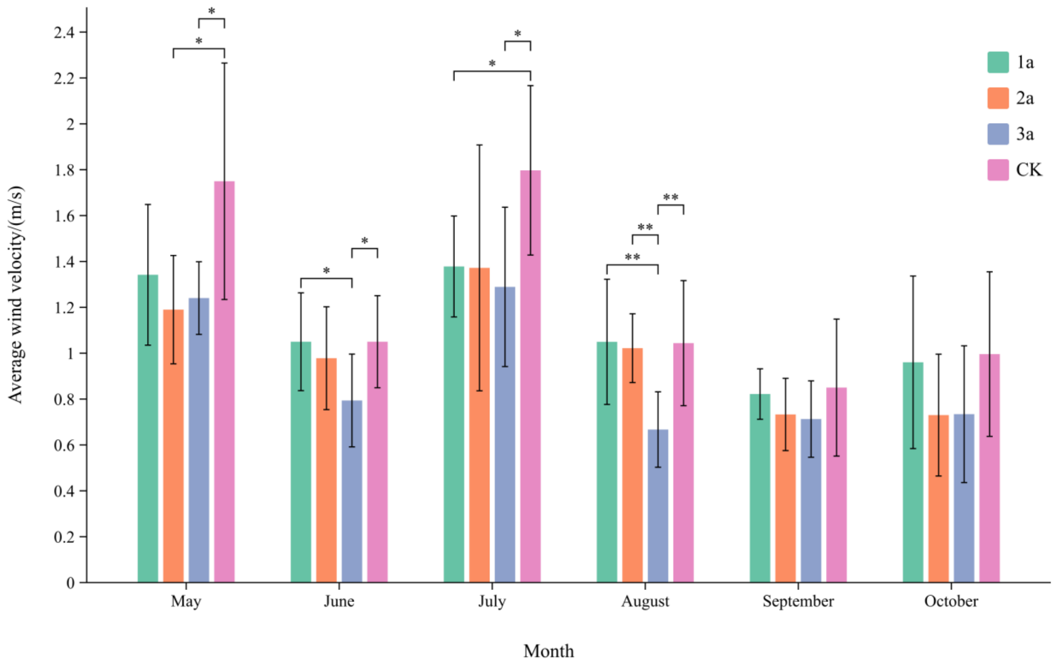


***Figure 6.** Monthly variation chart of average wind speed*

The changes in the average humidity under the forest are shown in *Figure 7*. It can be seen from the figure that there are no significant differences among the groups, and the change trends of each group are basically the same, which indicates that the humidity under the forest is less affected by the growth status of *S. psammophila*. Generally speaking, except in October, the humidity in the *S. psammophila* sample plots of the 3a group remains at a high level.

The changes in the average air temperature of the four different treatment groups in different months are shown in *Figure 8*. In June, there were extremely significant differences between the 3a group and the 1a, 2a and CK groups, and the temperature of the 3a group was significantly lower than that of the other groups. In June, the average air temperature of the CK group reached the highest, about 30.5°C. There were no significant differences among the groups in other months. Generally speaking, the average temperatures of the 1a and CK groups were higher than those of the other two groups, indicating that the growth status of *S. psammophila* had no significant impact on the temperature at a height of 20 cm under the forest.


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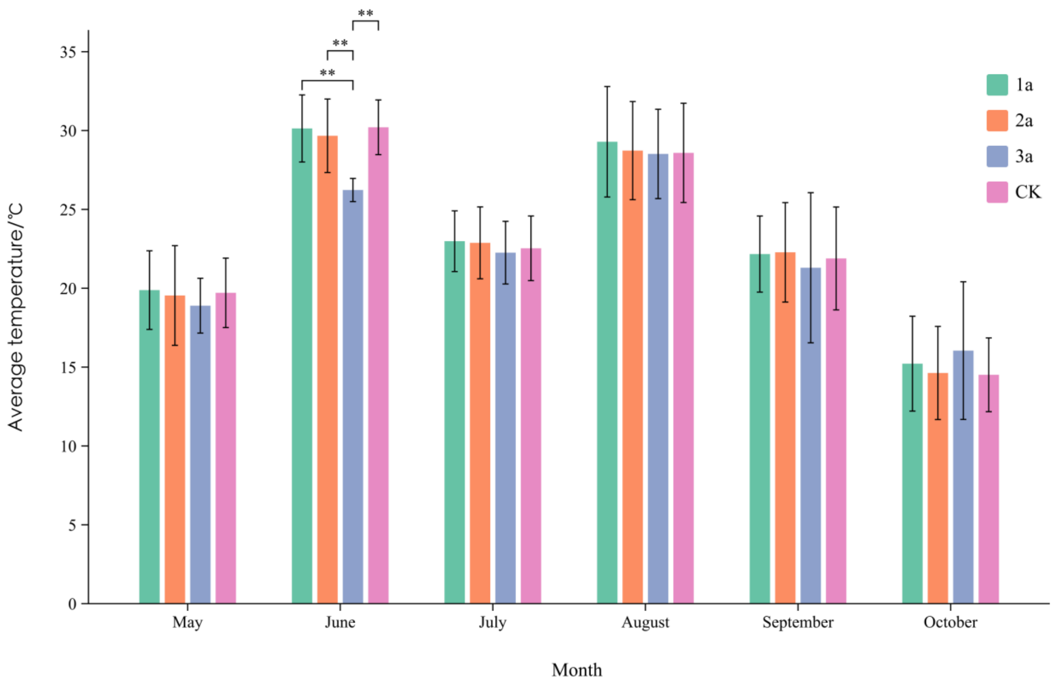


***Figure 8.*** *Monthly variation chart of average temperature*

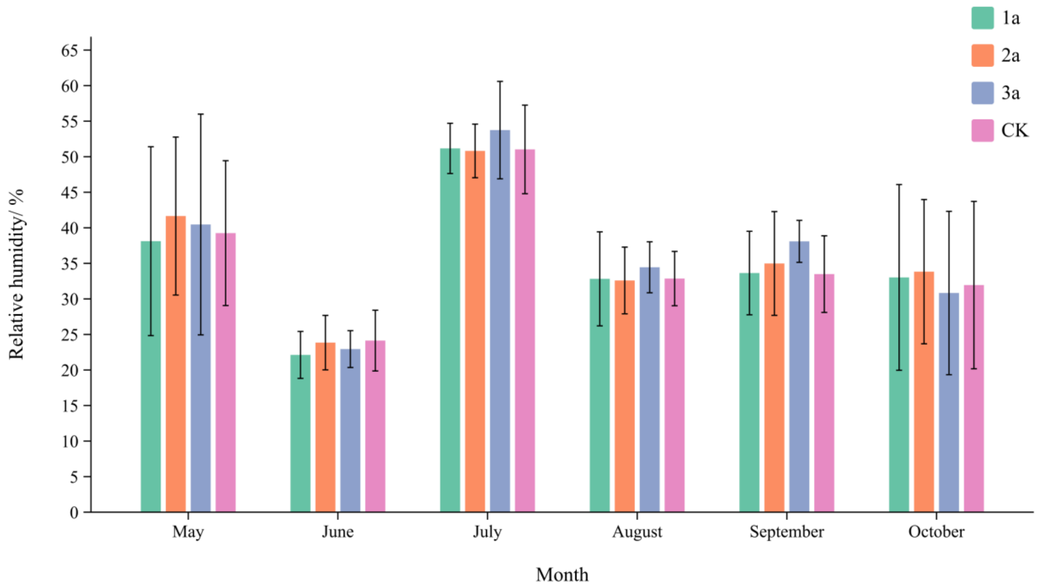


***Figure 7.*** *Monthly variation chart of humidity*

The wind erosion amount can be divided into deflation and wind accumulation. According to the monitoring data of the wind erosion amount in *Figure 9,* the phenomenon of wind accumulation occurred in all months in the four sample plots of the treatments. The wind erosion amount of the CK group was the highest in most months, especially reaching the extreme values in May and July, which was extremely significantly higher than that of other groups. The overall change was consistent with the change of the wind speed. However, the 3a group was generally at a low level,


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especially between June and October. This indicates that *S. psammophila* that has grown for 3 years provides better protection for the surface soil. As the growth period of *S. psammophila* in the CK group is relatively long, there are more dead branches, resulting in a decrease in the protection ability of the surface soil.

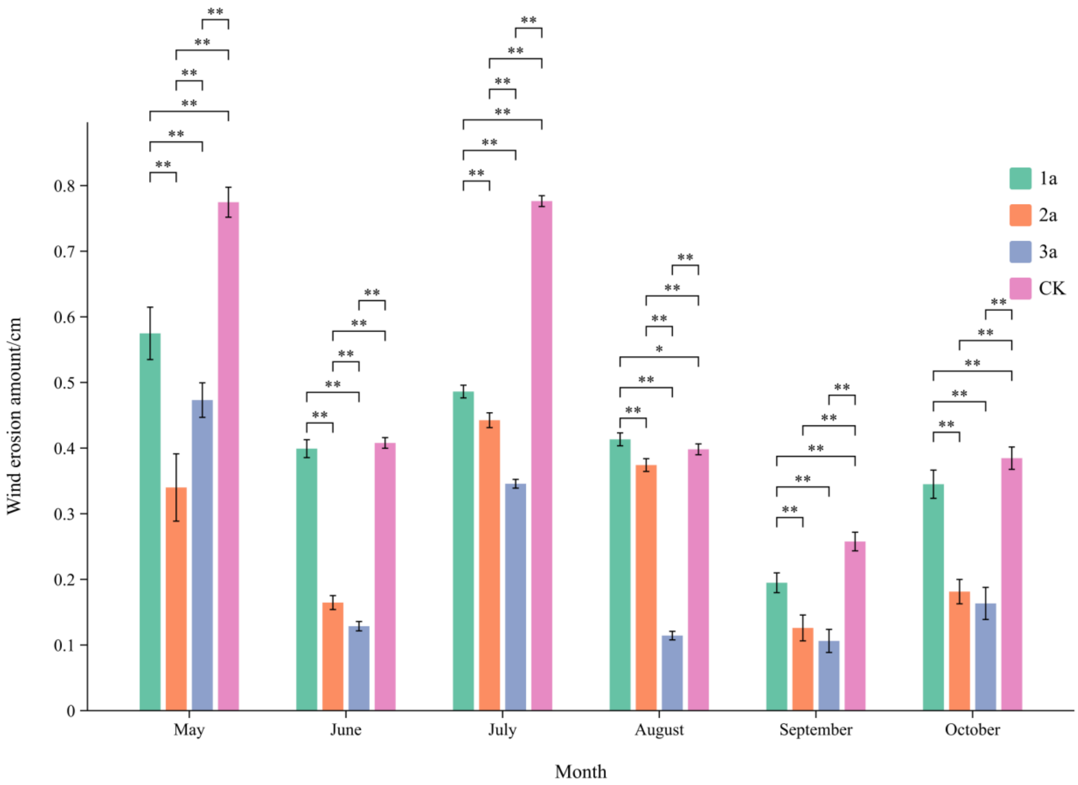


***Figure 9.*** *Monthly variation diagram of wind erosion amount*

*Correlation between the microclimate of the habitat and the forage value of the branches and leaves of S. psammophila*

In terms of soil and environmental variables, as shown in *Figure 10,* the relative humidity has an extremely significant negative correlation with the average basal diameter, crude protein and crude fat ($P < 0.01$), and has a significant negative correlation with the plant height ($P < 0.05$). The results indicate that a lower humidity is conducive to the accumulation of the contents of crude protein and crude fat in the branches and leaves of *S. psammophila*. The height growth of *S. psammophila* and the growth of the basal diameter of its branches can effectively reduce the humidity of the environment under the forest. The average temperature has an extremely significant negative correlation with the humidity ($P < 0.01$), has a significant negative correlation with the acid detergent fiber (ADF) and neutral detergent fiber (NDF) ($P < 0.05$), and has a significant positive correlation with the crude fat ($P < 0.05$). This shows that when the temperature in the sample plot is high, it is conducive to the increase of the crude fat content in the branches and leaves of *S. psammophila*, and can also reduce the contents of ADF and NDF in the branches and leaves at the same time. The average wind speed at a height of 20 cm above the ground has a significant positive correlation with the plant height, crown width, basal diameter, crude protein content and crude fat content of


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*S. psammophila* ($P < 0.05$), and has a significant negative correlation with the environmental humidity ($P < 0.05$).

This may mean that the excessive growth of the plants will reduce the wind protection effect at the ground surface. The wind erosion amount is significantly correlated with the average plant height and environmental humidity ($P < 0.05$), indicating that the higher the plant height, the greater the wind erosion amount at the ground surface, and at the same time, the drier the environment, the more serious the wind erosion. Therefore, through the stumping treatment, reducing the height and width of the *S. psammophila* shrubs can reduce the environmental humidity and achieve a better effect of wind prevention and sand fixation.

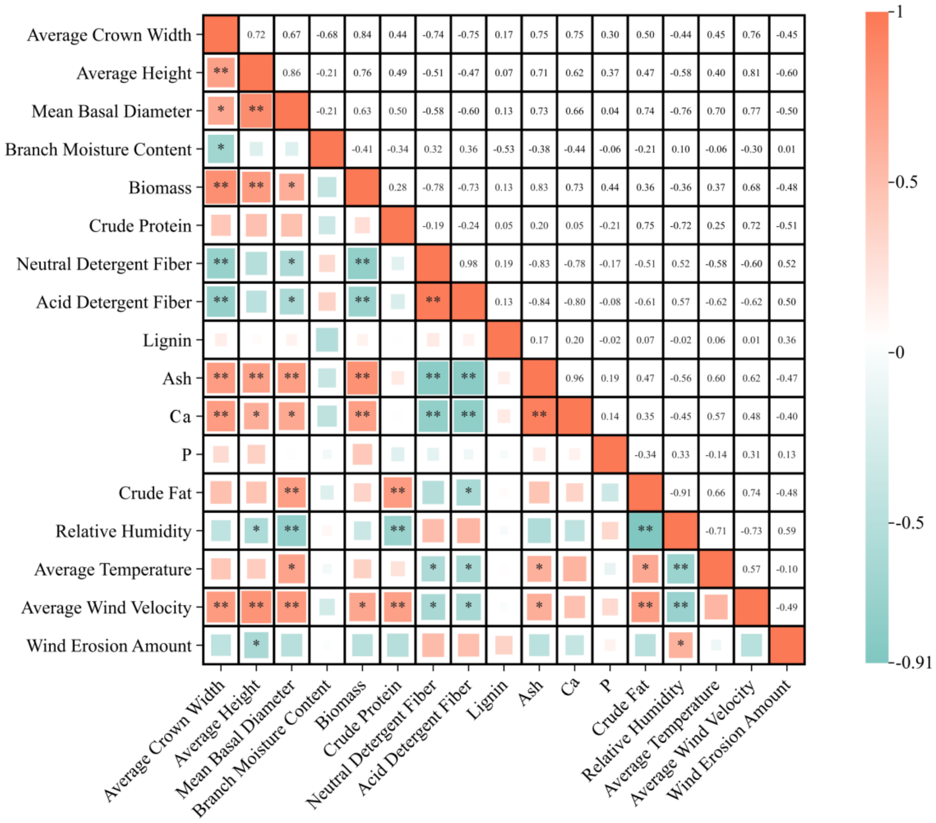


***Figure 10.*** *The correlation between habitat microclimate and the feeding value of S. psammophila branches and leaves*

## Discussion

### *Influence of stumping intervals on the nutritional components of the branches and leaves of S. psammophila*

Research findings indicate that *S. psammophila* exhibits high nutritional value as forage, yet monthly variations in nutrient indices during the growing season lack consistent patterns. Harvesting decisions should integrate dynamic changes in branch/leaf nutrients to determine the optimal harvest period. Generally, higher crude protein (CP) and crude fat (EE) combined with lower crude fiber content enhance forage quality. From May–July during vigorous growth, EE and CP reached peak levels, corroborating Guo Yanjun's conclusion (Guo, 2000) that mid-season harvest provides

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superior nutritional forage for livestock. From August–October, as growth transitions to dormancy, CP/EE levels decline while Ash, NDF, ADF, Lig, and Ca contents increase.

Nutritional performance varied across stumping intervals. CP contenta critical feed quality indicator (Li et al., 2023) first increased then decreased, aligning with Caragana studies on the Ordos Plateau (Gao, 2006). Uniquely, 3a-stumped *S. psammophila* maintained highest CP levels in most months, possibly due to species-specific traits or differing climatic conditions (Yun et al., 2010). Crude fat, which can partially substitute protein for energy (Li et al., 2018), followed a similar trajectory with 3a groups peaking in May, consistent with Wu Xiujuan's report of higher EE in 2–3a Caragana korshinskii (Wu et al., 2014). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) key fiber quality metrics (Jung, 1997) reached nadir values in June–July, with 2a groups demonstrating optimal suitability. Elevated lignin content negatively impacts forage value (Li et al., 2010), though 1a/2a groups showed lower levels in June, making new shoots preferable. Calcium/phosphorus levels remained stable across treatments, with 2a/3a groups generally higher. Relative Forage Value (RFV) calculations (Jia et al., 2017) identified June, September, and October as peak periods for 2a/3a groups. Comprehensive analysis of nutritional and forage value, May–July harvest combined with 2–3a stumping intervals is recommended to optimize both nutritional quality and ecological sustainability.

### *Influence of different stumping methods on the regenerative performance of S. psammophila*

Monthly regeneration rates of *S. psammophila* showed significant differences across stump heights, with faster growth in June, September, and October likely related to low and uneven precipitation that year. Statistical analysis revealed no significant effects of stump height on regeneration rate or sprout number, consistent with Zhou Jingjing's findings on Caragana korshinskii (Zhou et al., 2017). The 5 cm stump height produced the largest average basal diameter, supporting its rationality from a growth perspective, corroborating Liu Tao's recommendations (Liu et al., 2022) that 5 cm stumps optimize sprouting capacity. Discrepancies with Liu Qirong's results (Liu, 2022) may stem from differences in planting ages.

Ground-level stumping across intervals showed no significant regeneration rate differences, though 1a, 2a, and 3a groups had significantly more sprouts than CK, indicating stumping promotes sprouting with declining effectiveness over longer intervals. Considering growth and ecological function, a 3–5a stumping cycle is recommended, aligning with Duan Guangdong's research (Duan et al., 2019) on *S. psammophila* windbreak decline after 4a in the Mu Us Sandy Land. Wen Xuefei's (Wen, 2021) Logistic growth function analysis of Caragana shrubbery further validated this interval by demonstrating optimal 3–4a stumping cycles for Caragana, indirectly supporting our findings.

### *Changes in the microclimate under the forest and the soil wind erosion amount under the treatments of different stumping intervals*

As a critical environmental factor influencing biological growth, microclimate varies significantly across plant communities, which in turn shape distinct biotic assemblages (Zhang et al., 2002). *S. psammophila* plantations play vital roles in windbreak and sand fixation in northwestern deserts, yet older stands exhibit increasing dead branches and even whole-plant mortality.


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Research data indicate that wind speed, temperature, and humidity in CK plots were generally higher than other groups, suggesting that while plant height increases with age, microclimate regulation capacity declines. This aligns with Wang Ying's findings (Wang et al., 2001) on poplar-crop intercropping systems, where mid-aged and mature forests showed weaker microclimate regulation compared to young stands due to rapid growth and dynamic height changes in younger populations. Soil wind erosion followed the pattern CK > 1a > 2a > 3a, most pronounced in May and July, consistent with wind speed trends in 1a and CK plots. Seasonal wind variations contributed to erosion dynamics (Chen, 2014), though 2a/3a groups showed significant erosion changes despite stable wind speeds, implying additional influences from vegetation coverage (Li et al., 2021), soil moisture, and organic matter (Chen et al., 2021). Studies demonstrate soil organic matter stabilizes micro-aggregates through metal cation (Ca2+, Na+) bridging and hydrogen bonding, enhancing soil particle cohesion and stability (Edgar et al., 2021).

### *The correlation between the microclimate and the forage value of the branches and leaves of S. psammophila*

Data analysis revealed extremely significant negative correlations between relative humidity and average basal diameter, crude protein, and crude fat, as well as a significant negative correlation with plant height. This indicates lower humidity conditions promote accumulation of crude protein and fat in *S. psammophila* foliage. Additionally, height and basal diameter growth effectively regulate understory humidity, driving its reduction.

Studies also indicate significant correlations between wind erosion and environmental humidity drier conditions exacerbate erosion. Appropriate reduction of shrub height and canopy width through stumping can effectively reduce surface humidity, enhancing windbreak and sand fixation performance, aligning with Wang Bin et al.'s wind tunnel experiments. Their research found synchronous acceleration of air-drying processes and erosion on wet sand surfaces, suggesting a coupling relationship where erosion occurs once humidity drops below a critical threshold. Erosion further accelerates air-drying, causing rapid humidity decline. In this process, moisture acts as a key control factor: water bonds loose sand particles into aggregates of varying sizes, effectively inhibiting wind erosion (Wang et al., 2024).

## Conclusions

Considering the forage nutritional components and the regeneration of *S. psammophila*, the optimal stumping time for the artificial forest of *S. psammophila* in Hanggin Banner, Ordos City is around May. The appropriate stumping height is about 5-10 cm, and the stumping interval should be about 3 years. At the same time, calcium can be applied to promote the growth of *S. psammophila* and increase the forage value of its branches and leaves.

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