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Grass Litter Decomposition Rate and Water-Holding Capacity in Dry-Hot Valley of Jinshajiang River

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Abstract: The decomposition rate and the water-holding capacity of 6 kinds of grass litters were studied in the Jinshajiang river dry-hot valley. The results showed that the dry weight remains reduced with time but did not have a direct correlation with time. The decomposition litters were affected by climate, character of litter, animalcule and soil animal. The climate factors of temperature and humidity were important especially. The water-holding capacity was in the sequence of *N. wightii* (336%), *P. notatum* Flugge (248%), *H. contortus* (L.) Beauv (209%), *B. pertusa* (L.) A. Camus(206%), *I. endecaphylla* Jacq (174%), *D. annulatum* (Forsk.) Stapf (168%). After 24 months decomposition the remaining dry weight of the litter was in the sequence as follows: 15.12% for *N. wightii*, 26.38% for *I. endecaphylla* Jacq, 27.23% for *B. pertusa* (L.) A. Camus, 30.78% for *P. notatum* Flugge, 39.72% for *H. contortus* (L.) Beauv and 39.76% for *D. annulatum* (Forsk.) Stapf. The decomposition rate and water-holding capacity of *N. wightii* are at the highest level. It is important for the development, improvement and conservation of the grassland soil.

Key words: grass litter; dry-hot river valley; decomposition rate; water- holding capacity

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0 Introduction

The formation of litter in the Jinshajiang River is an important part of the grassland ecosystem[1]. This is not only because the litter plays an important role in soil development and improvement, but also because the loose structure of the litter could adsorb and keep a lot of the natural rainfall[2-4]. Therefore, the litter has a great effect on soil and water conservation. On the one hand, the litter could directly alleviate the spatter power of the raindrop and slowdown the wash power of runoff[5]; the interception of the natural rainfall could keep the infiltration slow and improve the soil water moisture[6] and as a result the ecological environment is changed[7,8]. At the same time, the litter could increase the soil fertility and prompt the normal succession of the plant community[9,10].

A dry-hot valley is a comparative fragile ecological environment area and the grass vegetation is the precondition of restoration and improvement of the ecological environment basis. The metabolism and multiplication rate of grass vegetation could accelerate the ecological environment construction step and the litter of the grass vegetation could also play a certain role in the construction. This paper mainly studied the decomposition rate and water-holding capacity of some common species of grass litters from the enclosed grassland and artificial grassland in the Jinshajiang hot-dry valley by periodic measurement. The law of material circulation of the natural grass ecosystem was investigated. This research could provide a theory basis for the increment of the productivity of the

enclosed grassland and artificial grassland and for the improvement of the ecological environment.

The area in study is located in the dry-hot area of the Yuanmou county, Yunnan province and is also the Houshan research base of the Institute of Tropical Eco-Agriculture, Yunnan Academy of Agriculture Science. The location ranges from 25°50′46″N-25°51′41″N, 101°41′18″E-101°49′42″E. This area is of the typical southern subtropical monsoon dry-hot valley climate. Its photothermal resource is abundant, it is clearly in dry and humid season; its rainfall is rare and the temperature is high. The mean annual temperature is 21.9 ℃ so that this area is called a natural greenhouse[11]. The average rainfall and evaporation of 13 years from 1990 to 2002 are respectively 702.65 mm and 2 589.48 mm; the rainfall is mainly distributed from April to October, and June to August is the flooding season.

1 Materials and Methods

1.1 Materials

The litters were collect from the test base of the enclosed grassland and artificial grassland in Jan. 2003. All the stems and leaves of the litters were collected and 100 g of each species of grass were gathered with the badge plate on it. The species of the grass included *Neonotonia wightii* cv.spp, *Indigofera endecaphylla* Jacq, *Paspalum notatum* Flugge, *Heteropogon contortus*(L.) Beauv, *Bothriochloa pertusa* (L.) A.Camus, *Dichanthium annulatum* (Forsk.) Stapf.

1.2 Methods

1.2.1 Measurement of the decomposition rate of grass litter in dry-hot valley of Jinshajiang River

The badge plate and the 100 g litter sized 30×60 cm^2 were put in a 1 mm mesh nylon net bag**,** which was sealed by a nylon line. Each species of the grass litter was put in 3 sample bags, which were put in the original sampling place on the surface of the soil keeping the same natural condition with the same species of the litter. All the bags of the litters were weighed every month. When the sample bag was taken, first the soil and foreign substance should be shaken off, the sample bag should be weighed and put into the oven under 65 ℃ to dry to the constant weight and weighed. The sample bag should be put back to the original place after water content and the dry weight residual are measured.

1.2.2 Measurement of the grass litter water-holding capacity

The process of measuring the saturated water content is to prepare the sample and weigh the nylon net bag first. The sample is the air-dried litter of 100 g kept with integrity (including stems and leaves). The second step is to put the sample into the nylon net bag and then put the bag in water for 48 h. The last step is to draw out the bag and to weigh the bag and the sample together after the leakage of the water for 3 min. The natural water content is to put the sample into the oven at 75 ℃ for 22-24 h.

2 Results

2.1 Decomposition Dynamics of the Grass Litter in Dry-Hot Valley of Jinshajiang River

Measurement of the decomposition rates of *Neonotonia wightii* cv.spp, *Indigofera endecaphylla* Jacq, *Paspalum notatum* Flugge, *Heteropogon contortus* (L.) Beauv*, Bothriochloa pertusa* (L.) A.Camus and *Dichanthium annulatum*(Forsk.) Stapf, showed that the litter residual decreased with time. From March to June in that year, along with the increase of the temperature and rainfall, there was a significant downward trend of the dry weight residual. Especially from Fig.1, it was found that grass litter amount depends on time length elapsed. The decomposition speed began to accelerate from the third month and after the sixth month *Neonotonia wightii* cv.spp and *Indigofera endecaphylla* Jacq especially significantly decomposed 61.38% and 53.9%, respectively. The decomposition rates of other litters were slow. The average temperature, the precipitation and the evaporation increased in March and the litter decomposed quickly. *Neonotonia wightii* cv.spp and *Indigofera endecaphylla* Jacq decomposed more than a half after July and the litter residuals began to decrease slowly. The other grass

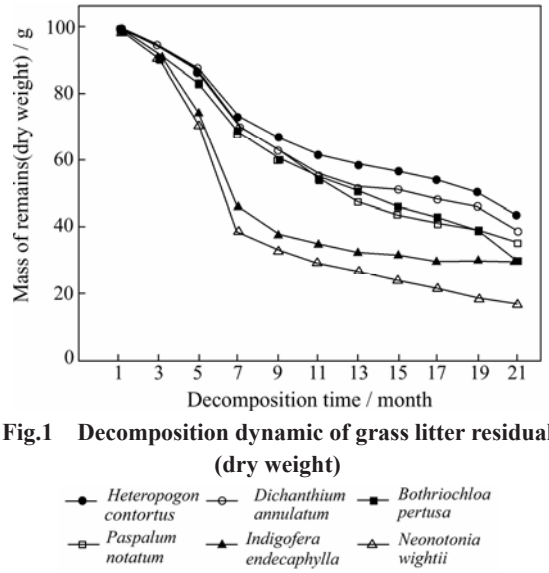

Fig.1 Decomposition dynamic of grass litter residual (dry weight)

litter residuals began to decrease greatly in July. When the temperature and the rainfall decreased greatly from October to March in the next years, the decomposition rate decreased gradually. Humidity also could have a direct influence on decomposition rate.

During the experiment (2003-2004), the climate factors (Table 1) including temperature, humidity, precipitation, and evaporation were all analyzed. In the two years, the temperature began to increase in March, and reached its maximum in August of 27.1 ℃ and 25.4 ℃, respectively. The relative humidity and precipitation also reached their maximum in June or July of 73% or 76% and 168.8 mm or 163.7 mm. However, the maximum evaporation happened in March or April. The evaporation could soften the litter and could embrittle the hard portion of the litter like stems and leaves, which have fully reflected the climate characteristics of the dry-hot valley in Yuanmou. According to the decomposition rate and the climate factors, it could be found that the high temperature and humidity season was from March to September, when the litters decomposed fast. *Neonotonia wightii* cv.spp litter decomposed fast at the beginning (March to July). As time went on, the decomposition amount reached the most 24 months later while the rate was 83.8%. *Indigofera endecaphylla* Jacq decomposed 73.6%. The decomposition rate of both *Neonotonia wightii* cv.spp and *Indigofera endecaphylla* Jacq is high in the earlier stage and then becomes lower. As for legume, it has a large proportion of the leaves and the fuzz on the surface of the leaves could absorb water in the environment, which is good for the decomposition. *Heteropogon contortus* (L.) Beauv, *Bothriochloa pertusa* (L.) A.Camus and *Dichanthium annulatum* (Forsk.) Stapf belong to gramineae, which has hard and rough stems and leaves. The stems and leaves of gramineae are not easy to separate, so that the grass litters of gramineae decomposed slowly and the decomposition rates of the 3 kinds of litters above were 60.3%, 67.8% and 67.2%, respectively.

Table 1 Climate factors of grassplot from 2003 to 2004 in dry-hot valley of Jinshajiang River

Months	Average temperature /℃		Relative humidity / %		Rainfall / mm		Evaporation / mm	
	2003	2004	2003	2004	2003	2004	2003	2004
1	13.6	14.8	57	49	8.9	3.8	106.3	116.3
2	17.3	17.5	42	41	6.0	0.2	149.1	140.1
3	21.4	23.4	35	30	0.0	0.1	218.5	211.4
4	25.7	21.5	34	58	3.4	62.9	265.6	147.5
5	26.1	25.0	50	55	89.3	93.9	219.1	186.3
6	24.7	24.3	73	75	168.8	99.0	137.5	113.5
7	26.3	24.7	67	76	60.9	163.7	165.2	131.9
8	27.1	25.4	67	74	31.4	105.6	165.4	137.3
9	24.3	23.5	68	75	88.5	89.0	123.7	98.6
10	23.1	21.1	64	66	28.2	75.6	126.0	119.1
11	17.5	16.8	62	66	2.0	3.1	112.4	87.2
12	14.9	13.7	62	61	11.9	1.8	92.1	79.6
Average	21.8	20.9	56.8	60.5	—	—	—	—
Total	—	—	—	—	499.3	698.7	1 880.9	1 568.8

2.2 Relation between Decomposition of Grass Litter and Water-Holding Capacity

The water condition of the litter had an important effect on the decomposition. Sufficient water and high temperature could be helpful to decomposition. The water content of the litter had a direct relation to self-character and environment condition including grass density, soil type, temperature and humidity, etc. The litter of local grass such as *Heteropogon contortus* (L.) Beauv and *Bothriochloa pertusa* (L.) A.Camus had high natural water content of 4.36% and 3.95%, and need more time to decompose. The reason was that their litters have a high proportion of hard stems and leaves with high fiber composition. *Paspalum notatum* Flugge also had high natural water content of 4.25%, but its litters were almost leaves, which were easy to adsorb moisture in soil and air. The test of the saturated water content of the litters (Fig.2) showed that the litters of *Neonotonia wightii* cv.spp and *Paspalum notatum* Flugge, had the highest saturated water content of 336% and 248% and the litters

of *Bothriochloa pertusa* (L.) A.Camus had the lowest saturated water content of 168%. The water-holding capacity (including natural water and saturated water content) was directly related to the decomposition rate. In a certain time, the stronger the water-holding capacity, the higher the decomposition rate. The grass litters not only had high natural water content and saturated water content but also played an important role in soil and water conservation, the soil water infiltration and the soil water balance of the grassland, etc. At the same time, the water-holding capacity of the litters also reflected the precipitation interception capacity of the litters[12,13].

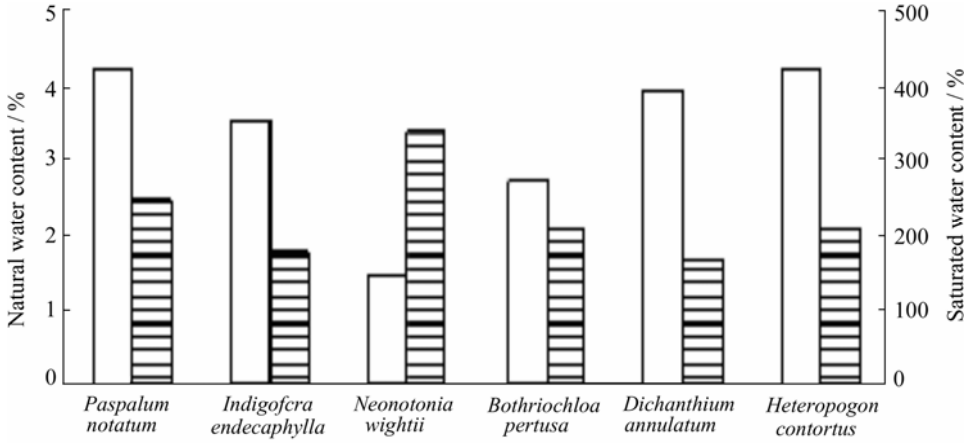

Fig.2 Natural and saturated water content of grass litters

3 Conclusion

The decomposition rate and water-holding capacity test of the grass litters in the dry-hot valley of Jinshajiang River showed that different grasses had different decomposition rates and water-holding capacities. The decomposition of the litters was a complex process. The Olson degradation model[14] could calculate the half-time decomposition of the grass litters, which were 1.67 a for *Heteropogon contortus* (L.) Beauv, 1.33 a for *Dichanthium annulatum* (Forsk.) Stapf, 1.17 a for *Bothriochloa pertusa*(L.) A. Camus, 1 a for *Paspalum notatum* Flugge, 0.58 a for *Indigofera endecaphylla* Jacq and 0.5 a for *Nenotonia wightii* cv.spp. The saturated water content of the grass litters were 336% for *Neonotonia wightii* cv.spp, 248% for *Paspalum notatum* Flugge, 209% for *Heteropogon contortus* (L.) Beauv, 206% for *Bothriochloa pertusa* (L.) A.Camus, 174% for *Indigofera endecaphylla* Jacq and 168% for *Dichanthium annulatum* (Forsk.) Stapf. The higher the saturated water content, the higher the interception and utilization rate of the precipitation and such situations were helpful for optimizing circulation of land surface water, temperature and humidity as well as for accelerating litter decomposition.

The decomposition rate of the litters depended not only on their characteristics, but also on the interactions of temperature, rainfall, humidity, microorganism, etc. This result was the same to what the other researches showed[10, 15-16]. The litters of *Neonotonia wightii* cv.spp and *Indigofera endecaphylla* Jacq decomposed fast especially in the early stage, but would slow down later. The main reason was that in the early stage the litters had washed off the soluble organics and the labile carbohydrates, and in the later stage the substances such as cellulose and tannin that were difficult to decompose accumulated in litters. The effects of temperature, humidity, rainfall, evaporation, etc., on the decomposition of the litters were direct and the natural water content and saturated water content of the litters had a proportional relation with composition rate. In the process of litter decomposition there were a lot of white mycelium and soil brought by termites on the combination part of the net bag and soil surface. This promoted the decomposition of the litters on one hand and made the weigh error on the other hand. The actual productivity of the litters and the test result showed that the natural thickness of the litters could reach 8-10 cm each year and a lot of new litters were produced. As for the litter of *Neonotonia wightii* cv.spp, it had the highest decomposition rate and saturated water content, so it had a significant meaning for soil development and improvement of the grassland and play an important role in soil and water conservation.

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