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C, N, P Contents Dynamics of *Calamogrostis Angustifola* Under Different Water Gradients

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Abstract

C, N, P contents dynamics of *Calamogrostis angustifola* growing on different water zonations,under variable water regime,were studied by field studying. Results showed that TC contents changed with the time and were higher in the zonations inundated all the year. TN, TP contents decreased as the water increasing and time passing. C, N, P contents of leaves were higher than that of stems and vaginas. C/N had different changing patterns in zonations with different inundation time, and C/P presented an increasing trend through the growing process and also as water increasing. N/P increased with the increasing water level, and took on a wave -like changing across the growing season. Quality of *Calamogrostis angustifola* decreased as water increasing, and the growth was constraint by N under all gradients at the beginning, but constraint by P at zonations inundated all the year while that at other zonations still constraint by N during the following growth stages.

Key words: Water gradients; Module; Nutrient elements; C/N, C/P, N/P

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INTRODUCTION

The formation and evolvement of wetlands are controlled by hydrological processes and the biotic, physical and chemical characteristics of wetlands are affected by hydrological regimes. Wetland hydrology is the most important factor determining the types, structure, and functions of wetlands (Miller &Zedler, 2003; Pezeshki, 2001; Sun&Liu, 2000; Sun, 2006; Guesewell &Koerselman, 2002). C, N, P contents dynamics of plants is one of the important step of wetland biogeochemical cycle(Jos&Francisco, 1999; Margaret&Anne, 1999; Xie *et al*., 2004). So, it is important to study the relevant relationship between the wetland hydrological situation and the wetland vegetation, which has important economical and social effects to the optimal management, and to the improvement of the amount of production of the wetland.

Sanjiang Plain (129°11′ - 135°05 ′N,43°49′ - 48°27′E), the largest area in China, where fresh water swamp and wetland are distributed concentrated, is representative and typical. There are albic soil, meadow soil, turfy soil and mud soil in this area, of which 40% of the total area is albic soil, and the thickness of black soil layer is 8 to 18 cm. The poor soil aeration and permeability are represented by the obvious characteristics - easy drought and easy waterlogged. *Calamogrostis angustifola* (Rhizomatous herbaceous perennial gramineous) is one of the most extensive wetland plants in the district which is suitable for adequate soil moisture, saturated or oversaturated. C, N, P contents dynamics of *Calamogrostis angustifola* growing on different water zonations, under variable water regime, were studied by field studying in order to provide a theoretical basis for the formulation and implementation of policies in wetland protection and utilization.

1. METHODOLOGY

The proving ground (47°35′,133°29′) located in the typical dish depression of Sanjiang Plain wetland ecosystem experiment station of CAS. Three transects, which is 100 meter, were seted by the depression the periphery to the center at May of 2006. Every transect includes 5 quadrat (1m*1m), and the quadrat spacing is 15~25meter. Plant community is GX, XYZ, XT, TC and TC from outside to inside (Yi *et al*.,1988). Different community represents different water zonations. GX: Surface soil moisture is 73.75~98.15%; XYZ : Surface soil moisture is more than 93.5%; XT: Perennial hydrocephalus is 5~15cm; TC: Perennial hydrocephalus is 8~20cm; ZZ: Perennial hydrocephalus is 10~45cm.

Calamogrostis angustifola was collected on June1, July2, July30 of 2006 from different transects. Plants were separated to leaves, stems and vaginas, and then determine TC, TN, TP contents after drying. The different parts respesent different growing season: initial stage, strong stage, summit stage. Meanwhile, soil organic carbon content of upper 20cm was determined according to the method of Li (Li, 1983).

Soil pH was determined by American Spectrum IQ150 pH instrument, Eh and T was determined by FJA-16 ORP instrument. Soil depth was divided into 0~15cm and 16~30cm. Data analysis completed through SPSS 13.0 and Origin7.5.

2. RESULTS

2.1 Modules TC, TN, TP Contents Dynamics of *Calamogrostis Angustifola* under Different Water Gradients

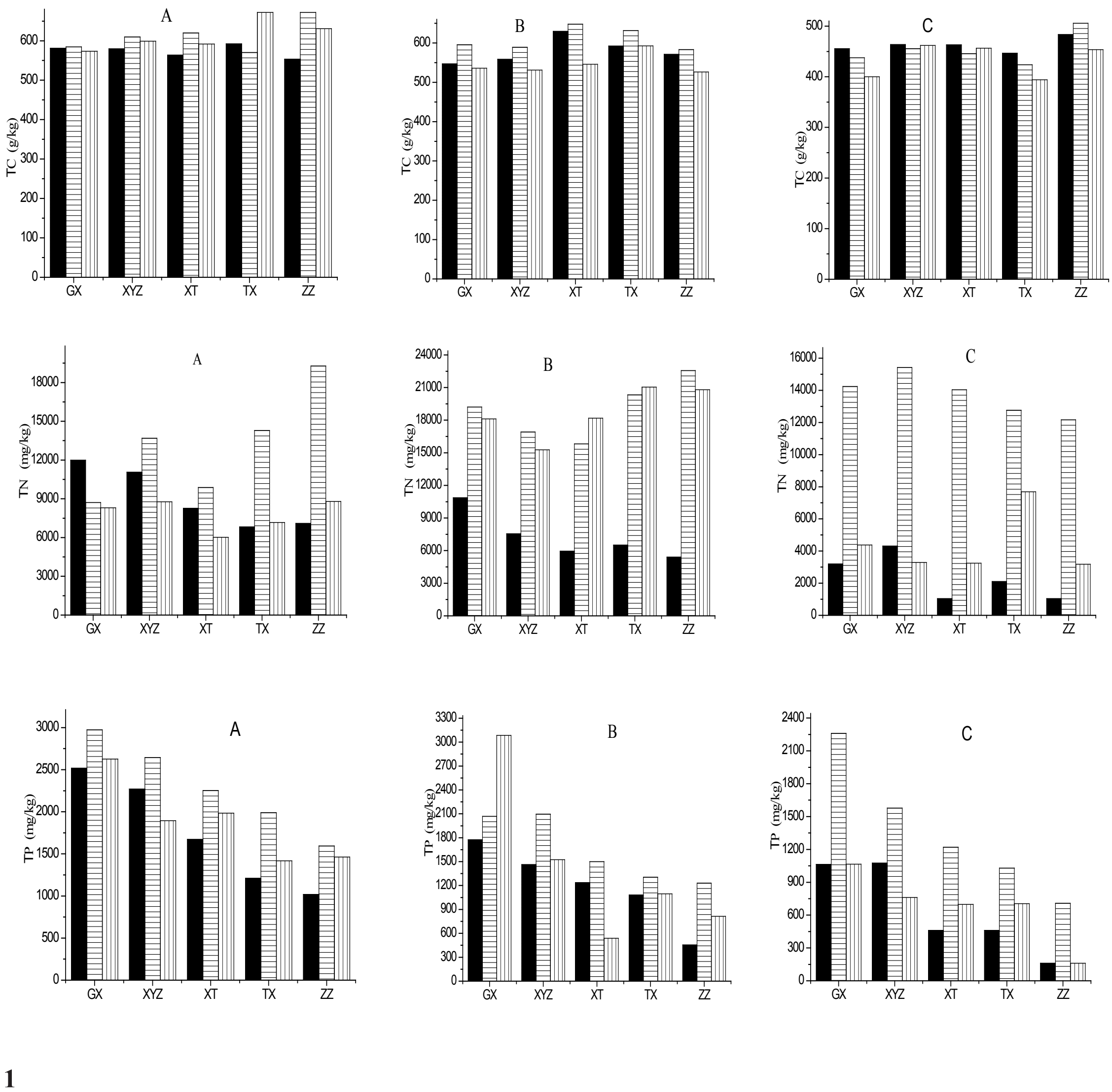

Figure 1
Modules TC, TN, TP Contents Dynamics of *Calamogrostis Angustifola* under Different Water Gradients
stern leave vagina. A, B, C, represent initial stage, strong stage, summit stage; GX, XYZ, XT, TX, ZZ represent different water zonations, the same below.

TC content of *Calamogrostis angustifola* from XT, TX, ZZ was higher than GX and XYZ (figure 1); TC content of leaves and vaginas was higher than stems in the beginning. TC content of stems increase as time change, and TC content of leaves and vaginas decrease. To medium-term, TC content of stems and leaves was higher than vaginas, while to late –term, the difference of TC content of stems, leaves and vaginas was insignificant.

TN content of *Calamogrostis angustifola* also changed with different water zonations. TN content of XYZ was higher than GX in initial stage, GX was higher than XYZ in strong stage and XYZ was higher than GX in the summit stage of non-perennial water area. In perennial water area, TN content increased with increasing moisture and difference gradually reduced, then in summit stage, TN content decreased with increasing moisture. During the experiment, TN content of leaves increased and then decreased which was higher than content of stems and vaginas. TN content of vaginas also increased and then decreased, while TN content of stem decreased during the experiment (figure 1).

TP content of *Calamogrostis angustifola* decreased with increasing moisture; TP content of leaves was higher than stems and vegans during the whole experiment. And TP content was highest in initial stage, and decreased with time goes (figure 1).

2.2 Modules C/N, C/P, N/P Seasonal Dynamics of *Calamogrostis Angustifola* under Different Water Gradients

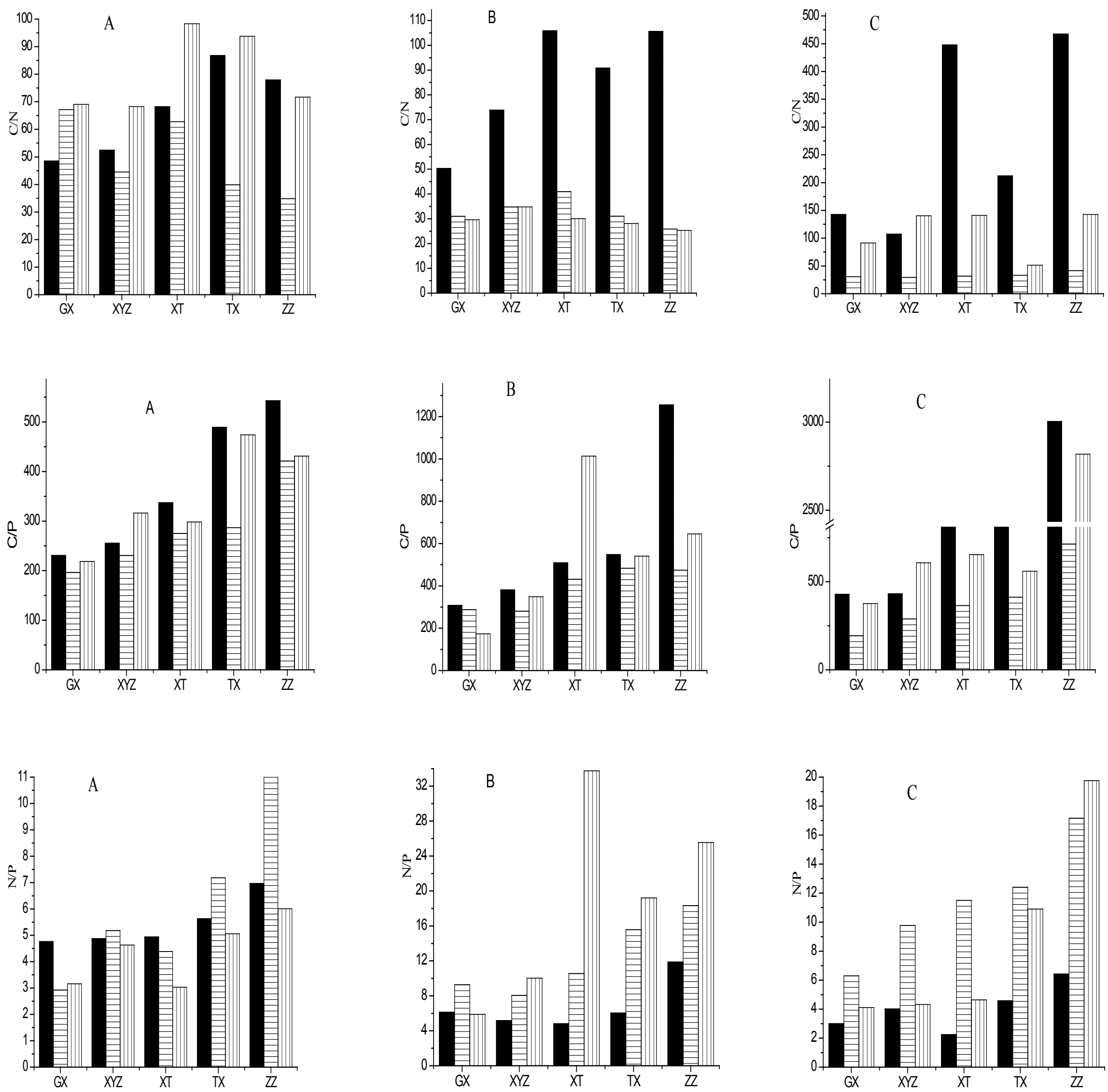

Figure 2
Modules C/N, C/P, N/P Seasonal Dynamics of *Calamogrostis Angustifola* under Different Water Gradients

C/N of *Calamogrostis angustifola* in perennial water area was higher than non- perennial water area, and increased with increasing moisture. C/N of stems and vaginas decreased with increasing moisture in perennial water area, and the difference gradually reduced. While in non-perennial water area, C/N of XYZ was higher than GX in initial and summit stage, and reversed in strong stage. C/N of stems gradually increased, C/N of leaves gradually decreased and vaginas decreased and then increased with time goes (Fig.2). C/P of *Calamogrostis angustifola* increased with increasing moisture, and C/P of stem was the highest one. N/P of *Calamogrostis angustifola* increased with increasing moisture, and it was highest in strong stage. N/P of vaginas changed significantly, and N/P of leaves and vaginas was higher than stems throughout the whole experiment.

3. DISCUSSIONS

The formation and evolvement of wetlands are controlled by hydrological processes and the biotic, physical and chemical characteristics of wetlands are affected by hydrological regimes (Grieve *et al*., 1995; Keddy, 2000). Representation environmental characteristics by plant nutrients content was more contentious topic in recent years (Guesewell &Koerselman, 2002) .

3.1 Analysis of Plant Element Characteristics in Different Moisture Gradients

Studies suggest that the low water levels may reduce the ability of plants to absorb nutrients and organic matter accumulation by Walbrigde etc. The paper showed that TC and TN content of *Calamogrostis angustifola* in perennial water area was higher than non- perennial water area, and the contents increased with increasing moisture. Then, the difference of TC was non-significant in summit stage, TN and TP content decreased with increasing moisture. TC, TN and TP content of *Calamogrostis angustifola* had significant temporal changes because dilution effect based on plants at different growth stages on the needs of the various elements and the accumulation of photosynthetic products(Li &ang, 2002; Gifford *et al*., 2000; Sun *et al*., 2000; Willby *et al*., 2001).

Consistent with the findings by SUN (Sun *et al*., 2000; Sun *et al*.,2006) where leaves were the major nutrients, production and storage of organs although *Calamogrostis angustifola was* Rhizomatous herbaceous perennial gramineous. Leaf nutrients compositon was the key indicator of the scale conversion from leaves to the community and even regional or global bio-geographic formations (Zheng &hangguan, 2006; Wright &Sun *et al*., 2004). *Calamogrostis angustifola*, as one of the typical wetland plants, TC, TN, TP content of leaves was 55.8%, 1.6%, 0.18%, which was lower than other plants (Elser *et al*., 2000; Han *et al*., 2005). To some extent, it showed that the wetland plants had higher productivity (Mitsch &Gosselink, 2000) and low N, P absorption capacity.

C/N and C/P can be used to indicate the quality of plant production (Guo &Gao, 2003), and then affected the post-decomposition of litter(Liu *et al*., 2005; Yang *et al*., 2006). C/N and C/P of *Calamogrostis angustifola* increased with increasing moisture, which showed that carbohydrate content was higher than the nutrients content. N/P represented the elements which restricted plant growth. Koerselman etc. showed that when N/P was lower than 14, N element was the restricted element; when N/P was higher than 16, P element was the restricted one; when N/P was between 14 and 16, N and P were the restricted elements (Koerselman &Meuleman, 1996) . The following studies determined the restricted element according it (Sun *et al*.,2000; Sun *et al*., 2006; Zheng &Shangguan, 2006) . The existing studies suggested that N was the restricted element for terrestrial ecosystem and P for aquatic ecosystem (McGroddy *et al*.,2004). According to SUN (Sun *et al*.,2006)studies, N was the restricted element for *Calamogrostis angustifola* in Sanjiang Plain. The paper showed that N/P increased with increasing moisture and N/P was 5.39±2.24 in initial stage, N was the restricted element; N/P was 12.68±8.41 in strong stage and 8.08±5.32 in summit stage. And N/P in perennial water area was significantly higher than non-perennial water area. In non-perennial water area, N/P was lower than 14 and N was the restricted element; in perennial water area, N/P of XT and ZZ was higher than 16 and P was the restricted one.

3.2 Analysis of Soil Characteristics in Different Moisture Gradients

PH, Eh, T and SOC of wetland soil were affected by different water zonations (Baird &Wilby, 2002), and directly impacted on the oxygen content in the soil and the effectiveness of nutritional elements(Reddy &Patrick,1974; Urban *et al*.,2000), which was one of the most important factor of plants distribution patterns and plants physiological and ecological characteristics formation (Miller &Zedler, 2003; Pezeshki, 2001).

Results showed that *Calamogrostis angustifola* modules nutrient contents had higher correlation with pH, Eh and SOC, while lower correlation with T through pearson correlation analysis of soil characters and plants modules nutrient contents (table1). At the 0.05 significant level, there was significant positive correlation between TP content of stems and leaves and soil Eh; significant positive correlation between TN content of leaves and soil upper layer pH, significant negative correlation between TN content of leaves and SOC; significant positive correlation between TN content and C/N of vaginas and soil upper layer pH. In addition, there was negative correlation between C/N, N/P, C/P of stems and leaves and soil Eh. This phenomenon may be due to different water zonations and banded or zonal distribution pattern of natural wetland (Mitsch &Gosselink, 2000). At present, there are more controversial on soil characters changes and its affect to plants in different water zonations which need further studies (Wang *et al*., 2003; Baird & Wilby, 2002).

Table 1
Correlation Analysis of *Calamogrostis Angustifola* Modules Nutrient Contents with Soil Characters

	Surface layer			Deep layer			SOC
	pH	Eh	T	pH	Eh	T	0—20cm
stem N	.274	.769	.197	.688	.820	.559	-.498
P	.130	.934*	-.037	.508	.942*	.205	-.750
C	-.802	-.221	.360	-.358	-.135	.256	.132
C/N	-.569	-.634	-.187	-.600	-.679	-.427	.340
N/P	.071	-.647	.812	-.184	-.481	.668	.803
C/P	-.371	-.758	.466	-.583	-.661	.149	.683
leave N	-.154	.937*	-.378	.670	.867	.101	-.895*
P	.055	.878	-.071	.116	.886*	-.125	-.757
C	-.670	-.320	.518	-.364	-.202	.379	.288
C/N	-.263	-.785	.550	-.625	-.671	.167	.748
N/P	-.198	-.858	.274	-.276	-.816	.206	.765
C/P	-.252	-.835	.412	-.419	-.757	.221	.766
vagina N	.963*	-.398	.063	.101	-.403	-.026	.537
P	.346	.750	-.356	.288	.684	-.288	-.670
C	-.797	.112	-.190	.229	.072	.193	-.276
C/N	-.933*	.222	-.114	.018	.208	.101	-.387
N/P	-.051	-.844	.626	-.483	-.718	.313	.870
C/P	-.451	-.617	.570	-.504	-.494	.305	.586

Note: Correlation is significant at the 0.05 level (2-tailed).

CONCLUSION

1) TC contents changed with the time and were higher in the zonations inundated all the year. TN, TP contents decreased as the water increasing and time passing. C, N, P contents of leaves were higher than that of stems and vaginas.

2) C/N had different changing patterns in zonations with different inundation time, and C/P presented an increasing trend through the growing process and also as water increasing. N/P increased with the increasing water level, and took on a wave -like changing across the growing season.

3) Quality of *Calamogrostis angustifola* decreased as water increasing, and the growth was constraint by N under all gradients at the beginning, but constraint by Pat zonations inundated all the year while that at other zonations still constraint by N during the following growth stages.

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