Soil Properties and Plant Growth Response to Litter in a Prolonged Enclosed Grassland of Loess Plateau, China

Yunwu Xiong, Bing Yu, Mengting Bai, Xueyang Zhang, Guanhua Huang, Alex Furman

1. College of Water Resources & Civil Engineering, China Agricultural University, Beijing 100083, China
2. Chinese-Israeli International Center for Research and Training in Agriculture, China Agricultural University, Beijing 100083, China
3. Civil and Environmental Engineering, Technion-Israel Institute of Technology, Haifa 32000, Israel

ABSTRACT: The enclosure and ungrazing practices for grassland management result in accumulation of plant litter on soil surface thus affecting the available soil water and nutrients for plant production. We experimentally investigated the effects of litter on soil properties and plant growth in a prolonged enclosure grassland of Loess Plateau, China. Three different litter manipulations were conducted including removal of all litter, an untreated in-situ control with original litter levels, and a double litter treatment. Litter treatment experiments demonstrated that plant litter affected the superficial soil water. Soil water content in plots with in-situ or double litter is generally higher than that with litter removal. The depletion of soil water up to five days post rainfall is fastest in litter removal plots for the top soil, but no evident difference for the deep ones. Different litter treatments have no significant impact on soil total carbon, nitrogen as well as carbon/nitrogen ratio for consecutive two years experiments. Both above- and below-ground biomasses in plots of litter removal were less than those in the plots of in-situ and double litter treatment. Litter affects plant production mainly through the mechanical barrier regulating root zone soil moisture. Therefore, prolonged litter manipulation experiments are desirable to understand the long-term response of plant growth on litter from nutrient aspect.

KEY WORDS: soil moisture, ungrazed grassland, Stripa bungeana, litter manipulation.

0 INTRODUCTION

In the Loess Plateau of China, soil erosion is serious and ecosystem is vulnerable due to the specific soil properties, topography, climate and heavy human activities. In order to restore the ecosystem and conserve soil and water resources, various strategies and practices (e.g., the Grain for Green Program) have been carried out in the last few decades including afforestation and ungrazing (Chen et al., 2015; Fu et al., 2011). The implementation of these practices has affected the micro-environment of different ecosystems. The Yunwu Mountain Grassland in the Loess Plateau has been enclosed and ungrazed for more than 30 years (since 1982). Resulting from prolonged reservation and ungrazing, a large amount of plant litter has accumulated on soil surface. The presence of litter may affect the available soil water and nutrients for plant growth, thus ameliorate the micro-environments and interactions with hydrological and biogeochemical cycle (Bansal et al., 2014; Wang et al., 2011; Weber and Gokhale, 2011). Thus, understanding the impact of litter on soil properties and hydrological state as well as on plant growth is important for managing hydrologic function and plant production in grassland ecosystem.

Plant litter may affect the exchange of water between soil and atmosphere and regulate soil water dynamics. Litter can change the surface structure and intercept precipitation (Facelli and Pickett, 1991a). The intercepted precipitation is held above soil surface and finally evaporates, and is generally unavailable to plant root (Horton et al., 1994). Water holding capacity of litter differs among plant species, litter architecture, and level of decomposition (Naeth et al., 1991). Litter accumulation in ungrazed grasslands has been found increasing infiltration and decreasing runoff (Dormaar et al., 1997). In Mediterranean semi-arid shrub-land, litter addition has been found to significantly decrease the runoff regardless of the location and amount of litter application (Boeken and Orenstein, 2001). On the other hand, plant litter can reduce evaporation from soil by creating a barrier to water vapor diffusion (Sakaguchi and Zeng, 2009; Horton et al., 1994). Thus, the net effect of litter on soil water is mostly the balance among its impact on interception, infiltration and evaporation.

The presence of litter could alter the micro-environmental conditions of the top soil. The litter layer regulates soil micro-
climate by forming a buffering interface between soil surface and the atmosphere. Litter intercepts light and solar radiation thus changing the transfer of heat between soil and atmosphere (Facelli and Pickett, 1991b). Change in micro-environmental conditions (e.g., soil temperature) caused by litter may directly affect plant growth.

Plant litter decomposition is one of the important components of carbon and nutrient cycling. Decomposition of litter is the conversion of photosynthetic products to inorganic forms and represents a fundamental source of nutrients for plants (Ball et al., 2014; Carrillo et al., 2012; Wickings et al., 2012; Borgen et al., 2011; Carrera and Bertiller, 2010). The decay of plant litter adds nutrients to soil and improves soil structure (Guretzky et al., 2014). Large amount of litter inputs to soil could cause substantial cascading effects on underground biogeochemical cycling (Ball et al., 2014; Freschet et al., 2013). Changes in litter inputs were observed in various manipulation experiments in different ecosystems (Liu et al., 2014; Baer and Blair, 2008). Leff et al. (2012) found that litter manipulations had only small effects on soil organic carbon chemistry in a tropical rain forest. Knapp and Seastedt (1986) have detected that the elimination of litter in grasslands increase nutrient availability. While in the Hulunbeier Grassland of China, Li et al. (2017) found that soil available nitrogen is significantly increased after eight years of enclosure. Despite extensive study, the effects of litter inputs on soil carbon and nutrient turnover and transform are still uncertain. Meta-analysis has indicated that increasing/decreasing litter inputs could accelerate/reduce the decomposition and accumulation of carbon and nutrients, but the response magnitude varied greatly among different ecosystems (Xu et al., 2013).

The presence of litter regulated the micro-environment and biogeochemical processes of the grassland, and hence affected the plant growth. Willsms et al. (1993) found that removing litter for more than one successive year had no impact on herbage production, but affects plant height, tiller weight of some plant species in the mixed prairie. In grassland with dense litter accumulation, plants have been found growing more slowly and flowering more sparsely (Sayer, 2006). Deutsch et al. (2010) reported that both litter removal and double litter reduce total growing season production in comparison to original levels at the naturalized native site, and conversely litter removal improves overall production at the same grassland.

Litter manipulation in typical steppe of Inner Mongolia of China demonstrated that removing litter causes a reduction in the amount of grass production, but the impacts of litter addition are not consistent among years (Wang et al., 2011). Meta-analysis of the short-term influence of litter on vegetation indicated that plant litter mostly had a negative effect on vegetation, but the magnitude varies with the biotic and abiotic factors (Xiong and Nilsson, 1999).

Given the fact that the effect of litter on grassland varies with location, climate, soil properties and plant community, site-specific investigation is required for optimizing the positive effects of litter on soil and associated plant production. The purpose of this paper is to investigate the effects of litter on soil micro-environment and plant growth in the prolonged enclosed grassland of Loess Plateau, China. The litter in present study consists of all dead plant material standing or lying on soil surface including standing stems, fallen stems and leaf material, and partially decomposed material.

1 MATERIAL AND METHODS

1.1 Study Site Description

The experimental study focuses on Yunwu Mountain (Mt.) Grassland in the Loess Plateau of China (between 106°21’ and 106°27’ eastern longitude and 36°10’ and 36°17’ northern latitude, Fig. 1). The elevation of the grassland varies from 1 800 to 2 200 m above sea level. The area of Yunwu Mt. Grassland is 6 660 ha which is composed of three areas: core area (1 700 ha), buffer area (1 400 ha) and external transition area (3 560 ha). The core area of the grassland has been enclosed and ungrazed for over 30 years (since 1982) which results in large amount of litter lying or standing on soil surface. The Yunwu Mt. Grassland has been promoted to the state-level nature reserve in China since 2013.

Climate at Yunwu Mt. Grassland is temperate semi-arid with a mean annual precipitation of 424 mm (mean values from 1980 to 2009). Precipitation shows a marked seasonality with 65%–75% rainfall occurring in the vegetation period. The drought index varies from 1.5 to 2.0. Mean annual temperature is 4–6 °C with the warmest month averaging 22–25 °C. The

![Figure 1. Location of Yunwu Mountain Grassland.](https://example.com/image1.png)
annual cumulative temperature above 10 °C is 2 100–3 200 ºC. The mean annual day-length is approximate 2 500 h. Meteorological data, including air temperature, relative humidity, rainfall, sunshine duration were measured by an automatic weather station. Table 1 shows monthly meteorological data at the growing season in 2013 and 2014.

Soil is classified as a Cal-Orthic Aridisol according to Chinese Soil Classification and Terminology (Qiu et al., 2012). Soil organic carbon content at a depth of 0–100 cm is around 20.5 kg·m$^{-2}$ in the grassland (Chang et al., 2017). Texture analysis of root zone soil (0–60 cm) yields a sand content of 31.8%, a silt content of 56.5% and a clay content of 11.7%. Soil is classified as silt loam according to the U.S. textural classification triangle. The average saturated water content and field capacity of the top 100 cm are 0.52±0.02 and 0.43±0.02 cm$^3$·cm$^{-3}$, respectively. Detailed soil physical properties are shown in Table 2.

The preponderant vegetation species is Stipa bungeana. The main growing period is from June to September, which is general consistent with precipitation. Plant roots were mainly concentrated at a depth of 0–30 cm.

1.2 Litter Manipulation Experiments

Litter manipulations were conducted to assess the effects of litter on soil properties and plant growth. Three litter treatments were carried out including removal of all standing and lying litter, an untreated in-situ control with original litter levels, and a double litter treatment where the removed litter from the first treatment was added to the plot. The added litter was evenly spread over the plot to provide double litter treatments similar to the treatment conducted by Deutsch et al. (2010) and Villalobos-Vega et al. (2011). The plot size of each treatment is 114 m$^2$ (6 m×19 m), and each manipulation has three repetitions.

Soil water in the root zone (0–60 cm) was measured weekly (May–September) in 2013 and 2014 using a neutron probe and a TRIME moisture probe. The neutron and TRIME pipes were set in the center of each plot at 5, 10 and 15 m location along the length. Consecutive five-day soil water content was measured following a relative heavy rain in August to investigate the effects of litter on depletion of soil water. Soil in root zone was sampled monthly to measure total carbon and nitrogen. Soil at depth of 0–100 cm was sampled using an auger, and placed in plastic bags and transported to the laboratory for detailed analysis. Total carbon and nitrogen content in soil were examined by the element analyzer (Elementar vario MACRO cube).

Plant characteristics were measured on the dominant species of Stipa bungeana. The heights of ten plants (twenty tillers per plant) from the soil surface to the top of the longest leaf were measured in each plot during growing periods in 2013 and 2014. Aboveground biomass was sampled in the size of 0.25 m$^2$ (0.5 m×0.5 m). The sampled plants were first dried at 105 °C for one hour to de-enzyme and then dried at 60 °C to constant weight. Root biomass was sampled using a root-core with volume 785 cm$^3$ (10 cm diameter by 10 cm depth) to a depth of 50 cm with interval of 10 cm. The roots were separated from the soil by washing over a sieve of 0.5 mm mesh and were dried at 60 °C to constant weight.

Data were statistically analyzed by a one-way analysis of variance (ANOVA) using the software of SPSS 21.0 software (SPSS Inc., Chicago, IL, USA). Statistical differences between treatments were determined by the Duncan test with significance at $P=0.05$.

2 RESULTS

2.1 Soil Properties Response to Litter Manipulation

Soil moisture was affected by the manipulation of plant litter in the semi-arid grassland. Table 3 shows the average soil

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>Rainfall (mm)</td>
<td>61.9</td>
<td>78.7</td>
<td>164.3</td>
<td>199.1</td>
<td>96.9</td>
<td>25.5</td>
</tr>
<tr>
<td></td>
<td>$T_{\text{mean}}$ (°C)</td>
<td>15.3</td>
<td>18.5</td>
<td>19.0</td>
<td>19.6</td>
<td>13.8</td>
<td>9.2</td>
</tr>
<tr>
<td></td>
<td>Mean wind speed (m/s)</td>
<td>2.6</td>
<td>2.7</td>
<td>2.2</td>
<td>2.3</td>
<td>2.0</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Sunshine duration (h)</td>
<td>7.6</td>
<td>7.5</td>
<td>5.4</td>
<td>9.2</td>
<td>5.6</td>
<td>7.1</td>
</tr>
<tr>
<td>2014</td>
<td>Rainfall (mm)</td>
<td>8.4</td>
<td>94.6</td>
<td>78.3</td>
<td>93.0</td>
<td>150.0</td>
<td>46.9</td>
</tr>
<tr>
<td></td>
<td>$T_{\text{mean}}$ (°C)</td>
<td>14.7</td>
<td>18.4</td>
<td>20.1</td>
<td>17.9</td>
<td>14.2</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>Mean wind speed (m/s)</td>
<td>2.7</td>
<td>2.2</td>
<td>2.1</td>
<td>2.3</td>
<td>2.2</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Sunshine duration (h)</td>
<td>9.8</td>
<td>7.8</td>
<td>8.7</td>
<td>8.0</td>
<td>5.2</td>
<td>6.2</td>
</tr>
</tbody>
</table>

Table 2 Physical properties of root zone soil in the litter manipulation site

<table>
<thead>
<tr>
<th>Soil depths (cm)</th>
<th>Soil particle fraction (%)</th>
<th>Soil texture</th>
<th>Bulk density (g cm$^{-3}$)</th>
<th>Saturated wetness (cm$^3$·cm$^{-3}$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–10</td>
<td>8.3</td>
<td>Silt (0.05–0.002 mm)</td>
<td>42.1</td>
<td>Loam</td>
</tr>
<tr>
<td>10–20</td>
<td>11.7</td>
<td>Clay (&lt;0.002 mm)</td>
<td>49.6</td>
<td>Silt loam</td>
</tr>
<tr>
<td>20–40</td>
<td>10.2</td>
<td>Silt (0.05–0.002 mm)</td>
<td>59.1</td>
<td>Silt loam</td>
</tr>
<tr>
<td>40–60</td>
<td>9.1</td>
<td>Sand (&gt;0.05 mm)</td>
<td>43.9</td>
<td>Loam</td>
</tr>
</tbody>
</table>
Table 3 Mean monthly soil water content at a depth of 0–10 cm for the different litter manipulations during growing season (values within columns followed by different letters are statistically significant at the 0.05 level)

<table>
<thead>
<tr>
<th>Year</th>
<th>Month</th>
<th>Removal</th>
<th>In-situ</th>
<th>Double</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>Jun.</td>
<td>0.22±0.03 a</td>
<td>0.28±0.05 b</td>
<td>0.29±0.02 b</td>
</tr>
<tr>
<td></td>
<td>Jul.</td>
<td>0.30±0.05 a</td>
<td>0.31±0.04 a</td>
<td>0.32±0.04 a</td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>0.26±0.08 a</td>
<td>0.27±0.07 a</td>
<td>0.29±0.06 a</td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>0.20±0.04 a</td>
<td>0.18±0.05 b</td>
<td>0.19±0.04 b</td>
</tr>
<tr>
<td>2014</td>
<td>May</td>
<td>0.23±0.07 a</td>
<td>0.26±0.04 b</td>
<td>0.29±0.05 b</td>
</tr>
<tr>
<td></td>
<td>Jun.</td>
<td>0.22±0.07 a</td>
<td>0.25±0.06 b</td>
<td>0.26±0.05 b</td>
</tr>
<tr>
<td></td>
<td>Jul.</td>
<td>0.23±0.05 a</td>
<td>0.30±0.13 b</td>
<td>0.29±0.06 b</td>
</tr>
<tr>
<td></td>
<td>Aug.</td>
<td>0.24±0.09 a</td>
<td>0.24±0.07 a</td>
<td>0.24±0.08 a</td>
</tr>
<tr>
<td></td>
<td>Sept.</td>
<td>0.26±0.08 a</td>
<td>0.27±0.07 ab</td>
<td>0.29±0.06 b</td>
</tr>
</tbody>
</table>

Water content at a depth of 0–10 cm under different litter manipulations. Monthly average soil water content in the superficial layer varied in the range of 0.20–0.35 cm³·cm⁻³ during the growing periods. In the earlier (May) and late (September) growing period, soil water content in plots without litter was significantly (P<0.05) lower than that in plots in the presence of litter. But there was no significant difference (P>0.05) for the plots of in-situ and double litter manipulations. In contrast, litter manipulation has no significant (P>0.05) effect on monthly average soil water content in high growing periods in both experimental years.

Figure 2 illustrates the depletion patterns of soil water up to 5 days post rainfall under different litter manipulations. The depletion pattern of soil water varied with soil depth. Soil water content in plots of litter removal subsequent to a rain was evidently higher than that in plots in the presence of litter for the upper root zone, which suggested that litter has an impact on rainfall interception. The fastest soil water depletion took place in the plots of litter removal which demonstrated the barrier effects of litter on soil evaporation. In contrast, there was no significant difference (P>0.05) of soil water content in the deeper root zone (20–40 cm), so that the depletion patterns were almost identical for the different litter treatments.

Soil carbon, nitrogen as well as their ratio at a depth of 0–50 cm are presented in Fig. 3 for different litter treatments. Soil total carbon monotonically decreases from surface downward to deeper root zone at different growing periods. The total carbon of soil at a depth of 0–10 cm was around 40 g·kg⁻¹, and varied around 26 g·kg⁻¹ in deep root zone (40–60 cm). The variation of soil carbon in different layers was not significant (P>0.05) for different plant litter treatments.

The distribution of soil nitrogen in root zone was similar to that of soil carbon (Fig. 3). Total nitrogen was around 3.0 g·kg⁻¹ for different growing periods at a depth of 0–10 cm and gradually reduced to around 1.7 g·kg⁻¹ in deep root zone (40–60 cm). Variations of total soil nitrogen in different depth were not significant (P>0.05) for litter treatment as well. Two-year consecutive litter manipulation did not show evidently change of the total soil nitrogen.

The carbon-to-nitrogen ratio shows the degradation rate of organic matter. The carbon-to-nitrogen ratio was approximately 13 for superficial soil at different growing periods. In the vertical profile, the ratio of carbon to nitrogen slightly increased with soil depth.

2.2 Plant Growth Response to Litter Manipulation

Plant height at different growing periods for different litter treatments is presented in Fig. 4. In general, the dominant species of Stipa bungeana in plots with litter removed was significantly shorter (P<0.05) than those in plots of in-situ and double litter treatments. In contrast, the height of plants in plots with in-situ and double litter treatments varied in different growing periods. In the first experimental year, there was no significant difference (P>0.05) between the double and in-situ litter treatments. In mid and high growing periods (June to August) of the second year, plants in double litter plots were significantly (P<0.05) shorter than those in in-situ plots. However, in earlier and late of growing periods, there was no significant difference.
Figure 3. Mean (±SD) soil total carbon and nitrogen distribution profiles as well as carbon-to-nitrogen ratio for different litter manipulations (a) 2013-6, (b) 2013-8 and (c) 2013-9.

Figure 4. Plant heights at different growing periods for different litter treatments.

Figure 5. Mean (±standard deviation) tiller weight for different litter treatments.

for plant in double and in-situ litter plots.

Figure 5 shows the dry biomass of tillers in plots with different litter treatments. The effect of plant litter on tiller weight varied with different growing periods. In the late of first and earlier of second experimental year, addition and removal of litter did not significantly influence ($P>0.05$) the tiller weight. However, the tiller weight was significantly ($P<0.05$) influenced by litter in the high growing periods of second experimental year. The presence of litter significantly ($P<0.05$) promoted the tiller weight.

Root weight for different litter treatments is presented in Fig. 6. More than 70% of root weight concentrated in the upper root zone (0–20 cm) for all litter treatments. Root at a depth of 0–10 cm account for approximate or more than 50% of total root mass. The effects of litter manipulation on root weight varied with growing period. In the first experimental year, litter manipulation did not show significant difference for the root mass and distribution in the vertical profile (Fig. 6a). In the early growing period of second experimental year, litter addition or removal increased root biomass. However, the highest root biomass obtained in plots with in-situ litter level in the high growing periods. The large standard deviation of root weight may be attributed to spatial heterogeneity of grass growth in the plots.
3 DISCUSSION

Litter present on soil surface may affect soil and plant through two different mechanisms, sort of a mechanical barrier affecting the micro-environment (such as soil water and temperature) and influence of soil nutrients in the root zone. Soil water in the root zone influenced by litter is critical for plant growth in the semi-arid region. Monthly averaging soil water content in upper root zone (a depth of 0–10 cm) of plots with litter was generally larger than that in plots without litter (Table 3). However, soil moisture is affected by many factors such as physical properties of soil, root uptake and mechanical barrier of litter on infiltration and evaporation. In this study, litter treatments were in the same area so that soil heterogeneity of physical properties such as porosity can be ignored. The difference of soil moisture was mainly due to the barrier effect of plant litter and root uptake. The barrier effects of plant litter included interception rainfall, impact on infiltration and runoff, and reduce evaporation (Deutsch et al., 2010). The higher soil water content in plots with litter after one day of rainfall demonstrated the interception effects, while the relatively slow depletion of soil moisture in plots with litter up to five days post rainfall indicated the water holding and evaporation regulation effects (Fig. 2). Soil water content in plots of litter removal was evidently higher than that in plots in the presence of litter for the upper root zone. Thus, the net effect of litter on soil water is mostly the balance among its impact on interception, infiltration and evaporation.

Soil water availability in arid and semi-arid grassland is a key influence regulating plant production. Tiller and root biomass variations in the different periods were generally corresponding to variations of soil water content. In fact, in addition to the effects of litter, the tiller of *Stipa bungeana* impacts on the hydrological processes as well. The tiller of *Stipa bungeana* was lodged in the high growing periods due to plant height (more than 40 cm) and wind. The lodged tiller increases the surface coverage and plays a role of barrier similar to litter. This may be the cause that there was no significant difference in soil water in high growing periods.

The influence of litter on soil nutrient relates to litter decomposition. Soil carbon and nitrogen as well as their ratio in the root zone did not significantly vary in the two successive experimental years (Fig. 3). This is consistent with most short-term manipulation experiments which have shown no significant decreases in soil nitrogen concentration (Sayer, 2006). Even though the presence of litter on soil nutrient was not significant in short period, existing studies have indicated that addition of litter improved soil organic matter and available nitrogen. Li et al. (2017) found that soil available nitrogen significantly increased after eight years of enclosure in the Hulunbeier Grassland of China. In Yunwu Mt. Grassland, regional sampling analysis indicated that soil organic matter at a depth of 0–10 cm was around 27 g·kg\(^{-1}\) in the core area (unpublished data) which was more than five-fold of that in the surrounding farmland (5 g·kg\(^{-1}\)). Total nitrogen content was 3.3 g·kg\(^{-1}\) in the core area, which was much higher than that in the farmland nearby (0.6 g·kg\(^{-1}\)) (Liu et al., 2014; Gao and Cheng, 2013; Wei et al., 2011). The increasing of soil organic matter and nitrogen suggested that the impact of soil nutrient takes place in the long-term reservation. Therefore, prolonged litter manipulation experiments are desirable to better understanding the response of plant growth on litter from nutrient aspect.

4 CONCLUSIONS

The enclosure and ungrazing practices for grassland management result in accumulation of plant litter on soil surface. The presence of litter may ameliorate the micro-environments and interactions with hydrological and biogeochemical cycle thus the available soil water and nutrients for plant production. We experimentally investigated the influence of litter presented on soil surface on the physical and chemical environment and plant growth in a prolonged enclosed grassland in the Loess Plateau. Three different litter manipulations were conducted.
including litter removal, untreated in-situ control with original litter level, and double litter treatments. Soil water, carbon and nitrogen as well as plants (Stipa bungeana) in plots of different litter levels were measured.

Soil water at superficial layer was influenced by litter manipulation. Soil water content in plots with litter was generally higher than that in litter removal plots. Soil water depletion was fastest in litter removal plots for top soil, while no evident difference for deep soil. Different litter treatments have no evidently impact on soil carbon, nitrogen as well as carbon/nitrogen ratio for two-year litter treatments. The effects of litter addition and removal on tiller and root biomass productivity varied in different growing periods. The mechanical barrier of plant litter is the main influence mechanism in the relative short-period experiments. The prolonged litter manipulation experiments are desirable to better understanding the response of plant production on litter from nutrient aspect.

ACKNOWLEDGMENTS

This research was partially supported by the National Natural Science Foundation of China (No. 41201037) and the Fundamental Research Funds for the Central Universities (No. 2014XJ024). The final publication is available at Springer via https://doi.org/10.1007/s12583-019-1017-3.

REFERENCES CITED


