北京市農林科学院
Beijing Academy of Agriculture and Forestry Sciences

我院林果院研究人员参加第六届全国稳定同位素生态学学术研讨会并获奖励

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9月22-25日，第六届全国稳定同位素生态学学术研讨会在湖北宜昌举行，会议由中国生态学会稳定同位素生态专业委员会和三峡大学主办。院林果院林业生态研究室鲁绍伟研究员、李少宁副研究员等一行5人参加了本次会议。

此次会议邀请了相关学科领域来自海内外的知名专家、学者和技术人员200余人，就稳定同位素技术在生态学研究中的前沿热点领域进行了充分的交流和探讨。徐晓天助理研究员提交了题为“Rainfall addition for 8 years promoted the growth of non-lignified roots in clay and shrub forming nabkhas”的墙报，利用^{13}C、^{15}N揭示了固沙植物唐古特白刺不同层次根系对长期人工模拟增雨响应过程与适应策略，为研究未来气候变化情景下植物复杂地下过程的响应提供了科学依据，并获得墙报优秀奖。

通过此次会议的交流和学习，使我院林果院林业生态研究团队的青年科研工作者开阔了视野，加深了对稳定同位素技术的认识，有助于更好地将其作为重要技术手段应用到京津冀生态建设研究中去。


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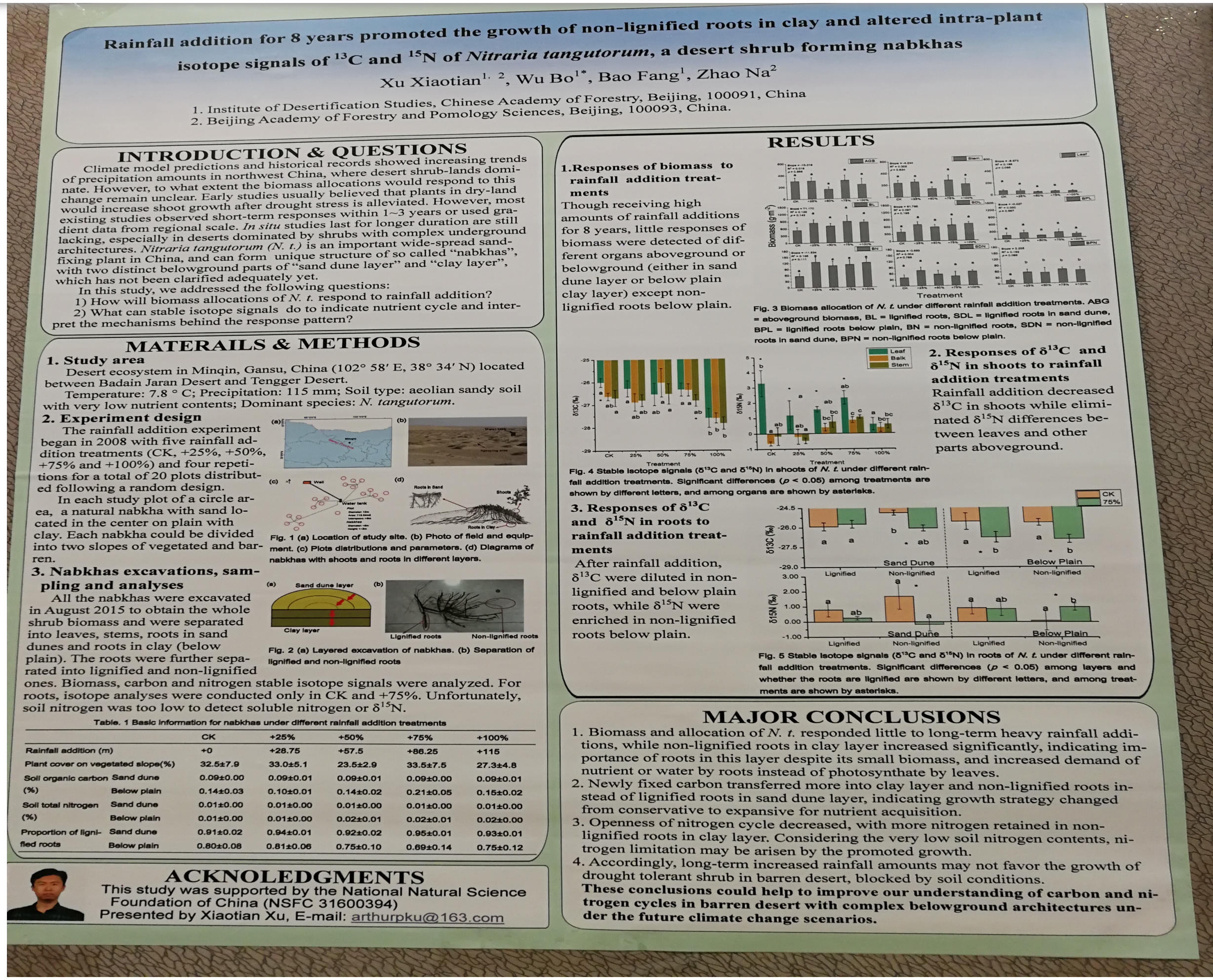

Rainfall addition for 8 years promoted the growth of non-lignified roots in clay and altered intra-plant isotope signals of ^{13}C and ^{15}N of *Nitraria tangutorum*, a desert shrub forming nabkhas

Xu Xiaotian[1, 2], Wu Bo[1*], Bao Fang[1], Zhao Na[2]

1. Institute of Desertification Studies, Chinese Academy of Forestry, Beijing, 100091, China
2. Beijing Academy of Forestry and Pomology Sciences, Beijing, 100093, China.

INTRODUCTION & QUESTIONS

Climate model predictions and historical records showed increasing trends of precipitation amounts in northwest China, where desert shrub-lands dominate. However, to what extent the biomass allocations would respond to this change remain unclear. Early studies usually believed that plants in dry-land would increase shoot growth after drought stress is alleviated. However, most existing studies observed short-term responses within 1~3 years or used gradient data from regional scale. *In situ* studies last for longer duration are still lacking, especially in deserts dominated by shrubs with complex underground architectures. *Nitraria tangutorum (N. t.)* is an important wide-spread sand-fixing plant in China, and can form unique structure of so called "nabkhas", with two distinct belowground parts of "sand dune layer" and "clay layer", which has not been clarified adequately yet.

In this study, we addressed the following questions:

1) How will biomass allocations of *N. t.* respond to rainfall addition?
2) What can stable isotope signals do to indicate nutrient cycle and interpret the mechanisms behind the response pattern?

MATERAILS & METHODS

1. Study area

Desert ecosystem in Minqin, Gansu, China (102° 58′ E, 38° 34′ N) located between Badain Jaran Desert and Tengger Desert.

Temperature: 7.8 ° C; Precipitation: 115 mm; Soil type: aeolian sandy soil with very low nutrient contents; Dominant species: *N. tangutorum*.

2. Experiment design

The rainfall addition experiment began in 2008 with five rainfall addition treatments (CK, +25%, +50%, +75% and +100%) and four repetitions for a total of 20 plots distributed following a random design.

In each study plot of a circle area, a natural nabkha with sand located in the center on plain with clay. Each nabkha could be divided into two slopes of vegetated and barren.

Fig. 1 (a) Location of study site. (b) Photo of field and equipment. (c) Plots distributions and parameters. (d) Diagrams of nabkhas with shoots and roots in different layers.

3. Nabkhas excavations, sampling and analyses

All the nabkhas were excavated in August 2015 to obtain the whole shrub biomass and were separated into leaves, stems, roots in sand dunes and roots in clay (below plain). The roots were further separated into lignified and non-lignified ones. Biomass, carbon and nitrogen stable isotope signals were analyzed. For roots, isotope analyses were conducted only in CK and +75%. Unfortunately, soil nitrogen was too low to detect soluble nitrogen or $\delta^{15}N$.

Fig. 2 (a) Layered excavation of nabkhas. (b) Separation of lignified and non-lignified roots

Table. 1 Basic information for nabkhas under different rainfall addition treatments

		CK	+25%	+50%	+75%	+100%
Rainfall addition (m)		+0	+28.75	+57.5	+86.25	+115
Plant cover on vegetated slope(%)		32.5±7.9	33.0±5.1	23.5±2.9	33.5±7.5	27.3±4.8
Soil organic carbon (%)	Sand dune	0.09±0.00	0.09±0.01	0.09±0.01	0.09±0.00	0.09±0.01
	Below plain	0.14±0.03	0.10±0.01	0.14±0.02	0.21±0.05	0.15±0.02
Soil total nitrogen (%)	Sand dune	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00	0.01±0.00
	Below plain	0.01±0.00	0.01±0.00	0.02±0.01	0.02±0.01	0.02±0.00
Proportion of lignified roots	Sand dune	0.91±0.02	0.94±0.01	0.92±0.02	0.95±0.01	0.93±0.01
	Below plain	0.80±0.08	0.81±0.06	0.75±0.10	0.69±0.14	0.75±0.12

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Presented by Xiaotian Xu, E-mail: arthurpku@163.com

RESULTS

1. Responses of biomass to rainfall addition treatments

Though receiving high amounts of rainfall additions for 8 years, little responses of biomass were detected of different organs aboveground or belowground (either in sand dune layer or below plain clay layer) except non-lignified roots below plain.

Fig. 3 Biomass allocation of *N. t.* under different rainfall addition treatments. ABG = aboveground biomass, BL = lignified roots, SDL = lignified roots in sand dune, BPL = lignified roots below plain, BN = non-lignified roots, SDN = non-lignified roots in sand dune, BPN = non-lignified roots below plain.

2. Responses of $\delta^{13}C$ and $\delta^{15}N$ in shoots to rainfall addition treatments

Rainfall addition decreased $\delta^{13}C$ in shoots while eliminated $\delta^{15}N$ differences between leaves and other parts aboveground.

Fig. 4 Stable isotope signals ($\delta^{13}C$ and $\delta^{15}N$) in shoots of *N. t.* under different rainfall addition treatments. Significant differences ($p < 0.05$) among treatments are shown by different letters, and among organs are shown by asterisks.

3. Responses of $\delta^{13}C$ and $\delta^{15}N$ in roots to rainfall addition treatments

After rainfall addition, $\delta^{13}C$ were diluted in non-lignified and below plain roots, while $\delta^{15}N$ were enriched in non-lignified roots below plain.

Fig. 5 Stable isotope signals ($\delta^{13}C$ and $\delta^{15}N$) in roots of *N. t.* under different rainfall addition treatments. Significant differences ($p < 0.05$) among layers and whether the roots are lignified are shown by different letters, and among treatments are shown by asterisks.

MAJOR CONCLUSIONS

1. Biomass and allocation of *N. t.* responded little to long-term heavy rainfall additions, while non-lignified roots in clay layer increased significantly, indicating importance of roots in this layer despite its small biomass, and increased demand of nutrient or water by roots instead of photosynthate by leaves.
2. Newly fixed carbon transferred more into clay layer and non-lignified roots instead of lignified roots in sand dune layer, indicating growth strategy changed from conservative to expansive for nutrient acquisition.
3. Openness of nitrogen cycle decreased, with more nitrogen retained in non-lignified roots in clay layer. Considering the very low soil nitrogen contents, nitrogen limitation may be arisen by the promoted growth.
4. Accordingly, long-term increased rainfall amounts may not favor the growth of drought tolerant shrub in barren desert, blocked by soil conditions.

These conclusions could help to improve our understanding of carbon and nitrogen cycles in barren desert with complex belowground architectures under the future climate change scenarios.


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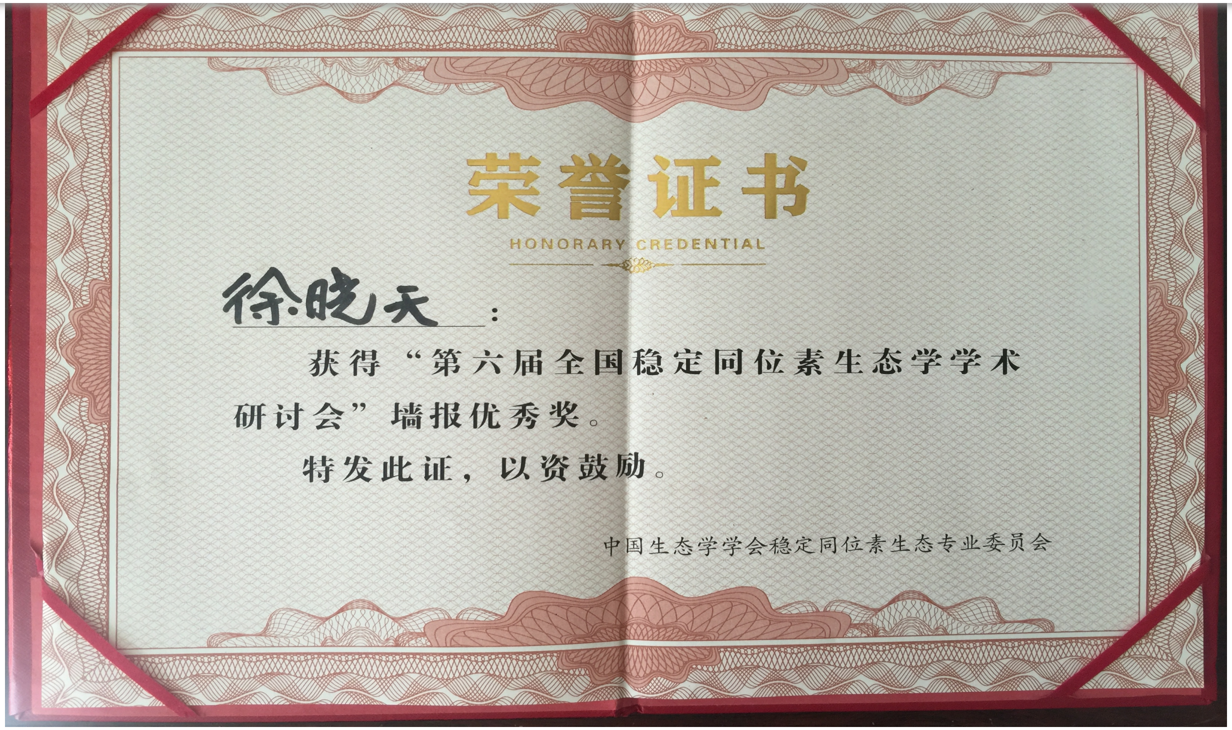
荣誉证书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