**Precipitation is the main factor affecting the variation of foliar nitrogen isotope composition in two leguminous shrub species of northwestern China**

**Fei Ma****1,2,\*, Ting-Ting Xu3, Ming Li1,2,, Ji-Li Liu1,2,, Zhao-Jun Sun1,2,**

1*Institute of Environmental Engineering, Ningxia University, Yinchuan 750021, PR China*

2*Ningxia (China-Arab) Key Laboratory of Resource Assessment and Environmental Regulation in the Arid Region, Ningxia University, Yinchuan 750021, PR China*

3*School of Life Science, Ningxia University, Yinchuan 750021, PR China*

\* Author for correspondence (mafei05@163.com)

Table S1. Coordinates and climatic factors of each sampling location

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Species | Code | SY | Lat (o) | Long (o) | Alt (m) | MAP (mm) | MAT (°C) | DTR(°C) | RH(%) | SH(%) | WR(km/h) | MAI | PM(mm/d) | MTCM(°C) | MTWM(°C) | N(mg / g) | C(mg / g) | C:N | 15N ± SD(‰) |
| *C. korshinskii* | CK1 | 2015 | 40.95  | 110.03  | 1440  | 270.1  | 4.7  | 12.8 | 53.9  | 69.1  | 2.7 | 0.1 | 2.8 | -13.1 | 20.5 | 37.34 | 448.62 | 12.0 | 1.57 ± 0.25 |
| *C. korshinskii* | CK2 | 2015 | 39.77  | 112.20  | 1325  | 434.4  | 4.4  | 12.3 | 54.8  | 64.8  | 2.5 | 0.2 | 2.6 | -12.4 | 19.0 | 35.87 | 426.15 | 11.9 | 0.89 ± 0.17 |
| *C. korshinskii* | CK3 | 2015 | 38.02  | 107.38  | 1323  | 234.3  | 8.3  | 13.5 | 56.7  | 62.8  | 2.0 | 0.1 | 2.9 | -7.9 | 22.6 | 33.48 | 439.02 | 13.1 | 1.68 ± 0.18 |
| *C. korshinskii* | CK4 | 2015 | 37.82  | 107.45  | 1431  | 258.6  | 8.2  | 13.3 | 56.9  | 62.0  | 2.0 | 0.1 | 2.8 | -7.7 | 22.4 | 34.76 | 433.87 | 12.5 | 1.22 ± 0.07 |
| *C. korshinskii* | CK5 | 2015 | 36.86  | 105.98  | 1568  | 278.1  | 8.2  | 11.9 | 58.4  | 57.9  | 1.6 | 0.1 | 2.6 | -6.3 | 21.1 | 42.01 | 457.36 | 10.9 | 0.69 ± 0.22 |
| *C. korshinskii* | CK6 | 2015 | 38.88  | 111.87  | 1520  | 555.1  | 1.7  | 11.0 | 54.6  | 63.2  | 2.8 | 0.3 | 2.4 | -13.9 | 15.6 | 33.64 | 438.04 | 13.0 | 0.46 ± 0.16 |
| *C. korshinskii* | CK7 | 2015 | 39.87  | 111.48  | 1211  | 407.1  | 5.8  | 12.6 | 54.9  | 65.3  | 2.4 | 0.2 | 2.7 | -11.6 | 20.7 | 37.83 | 436.39 | 11.6 | 0.95 ± 0.35 |
| *C. korshinskii* | CK8 | 2015 | 39.83  | 108.68  | 1412  | 249.9  | 6.3  | 13.0 | 54.3  | 67.7  | 2.5 | 0.1 | 2.9 | -10.9 | 21.5 | 30.40 | 435.59 | 14.3 | 2.21 ± 0.59 |
| *C. korshinskii* | CK9 | 2015 | 39.12  | 108.03  | 1400  | 223.2  | 6.9  | 13.6 | 54.7  | 66.6  | 2.3 | 0.1 | 2.9 | -10.1 | 22.0 | 30.94 | 437.66 | 14.4 | 1.82 ± 0.28 |
| *C. korshinskii* | CK10 | 2015 | 38.01  | 107.22  | 1224  | 234.3  | 8.3  | 13.5 | 56.7  | 62.8  | 2.0 | 0.1 | 2.9 | -7.9 | 22.6 | 26.98 | 402.29 | 15.0 | 1.15 ± 0.04 |
| *C. korshinskii* | CK11 | 2015 | 37.20  | 108.02  | 1456  | 341.7  | 7.3  | 12.6 | 57.5  | 60.8  | 2.1 | 0.2 | 2.7 | -8.1 | 21.1 | 36.30 | 441.37 | 12.2 | 1.52 ± 0.16 |
| *C. korshinskii* | CK12 | 2015 | 40.13  | 106.88  | 1180  | 103.5  | 8.4  | 13.9 | 54.0  | 68.6  | 2.4 | 0.0 | 3.1 | -9.7 | 24.3 | 25.78 | 422.17 | 17.0 | 1.96 ± 0.37 |
| *C. korshinskii* | CK13 | 2015 | 40.67  | 106.30  | 1039  | 87.2  | 7.8  | 13.6 | 53.4  | 69.5  | 2.6 | 0.0 | 3.2 | -10.4 | 24.0 | 30.74 | 429.54 | 14.2 | 2.78 ± 0.21 |
| *C. korshinskii* | CK14 | 2015 | 40.95  | 112.22  | 1276  | 351.6  | 4.1  | 12.7 | 54.8  | 67.5  | 2.6 | 0.2 | 2.7 | -13.4 | 19.5 | 34.61 | 432.90 | 12.5 | 0.29 ± 0.16 |
| *C. korshinskii* | CK15 | 2015 | 39.50  | 110.22  | 1353  | 385.3  | 8.0  | 13.2 | 56.6  | 63.5  | 2.2 | 0.2 | 2.9 | -9.3 | 22.8 | 40.22 | 445.98 | 11.1 | 1.00 ± 0.58 |
| *C. liouana*. | CL1 | 2015 | 37.82  | 107.45  | 1431  | 258.6  | 8.2  | 13.3 | 56.9  | 62.0  | 2.0 | 0.1 | 2.8 | -7.7 | 22.4 | 37.39 | 437.82 | 11.7 | 0.95 ± 0.20 |
| *C. liouana*. | CL2 | 2015 | 38.18  | 107.68  | 1342  | 249.5  | 7.9  | 13.5 | 56.5  | 63.5  | 2.1 | 0.1 | 2.8 | -8.3 | 22.3 | 35.54 | 441.59 | 12.4 | 0.67 ± 0.26 |
| *C. liouana*. | CL3 | 2015 | 38.60  | 108.75  | 1330  | 292.2  | 7.3  | 13.3 | 55.8  | 65.0  | 2.3 | 0.1 | 2.9 | -9.4 | 22.0 | 37.91 | 444.80 | 11.7 | 1.06 ± 0.55 |
| *C. liouana*. | CL4 | 2015 | 39.42  | 110.47  | 1169  | 395.0  | 6.9  | 12.6 | 55.2  | 65.2  | 2.3 | 0.2 | 2.8 | -10.4 | 21.7 | 38.53 | 449.41 | 11.7 | 0.28 ± 0.19 |
| *C. liouana*. | CL5 | 2015 | 39.22  | 110.15  | 1257  | 379.9  | 7.2  | 12.6 | 55.4  | 65.2  | 2.3 | 0.2 | 2.9 | -10.0 | 22.1 | 40.90 | 447.18 | 11.0 | 0.16 ± 0.09 |
| *C. liouana*. | CL6 | 2015 | 37.20  | 108.02  | 1456  | 341.7  | 7.3  | 12.6 | 57.5  | 60.8  | 2.1 | 0.2 | 2.7 | -8.1 | 21.1 | 35.83 | 445.30 | 12.4 | 1.81 ± 0.36 |
| *C. liouana*. | CL7 | 2015 | 37.52  | 108.60  | 1531  | 387.8  | 6.7  | 12.4 | 57.6  | 60.7  | 2.2 | 0.2 | 2.7 | -8.7 | 20.4 | 42.11 | 441.86 | 10.5 | -0.37 ± 0.11 |
| *C. liouana*. | CL8 | 2015 | 37.83  | 109.26  | 1057  | 370.1  | 8.1  | 13.2 | 57.3  | 61.9  | 2.2 | 0.2 | 2.8 | -8.2 | 22.3 | 44.73 | 438.30 | 9.8 | 0.91 ± 0.22 |
| *C. liouana*. | CL9 | 2015 | 38.77  | 110.23  | 1220  | 385.8  | 7.4  | 12.9 | 55.8  | 64.4  | 2.3 | 0.2 | 2.9 | -9.9 | 22.2 | 37.84 | 438.15 | 11.6 | 0.83 ± 0.21 |
| *C. liouana*. | CL10 | 2015 | 38.85  | 107.67  | 1344  | 225.2  | 7.4  | 13.6 | 55.5  | 65.2  | 2.2 | 0.1 | 2.9 | -9.2 | 22.2 | 39.27 | 450.45 | 11.5 | 2.86 ± 0.12 |
|  *C. liouana*. | CL11 | 2015 | 39.22  | 110.15  | 1324  | 379.9  | 7.2  | 12.6 | 55.4  | 65.2  | 2.3 | 0.2 | 2.9 | -10.0 | 22.1 | 41.27 | 451.40 | 10.9 | 0.42 ± 0.36 |
| *C. liouana*. | CL12 | 2015 | 38.88  | 108.35  | 1369  | 262.9  | 7.0  | 13.4 | 55.4  | 65.6  | 2.3 | 0.1 | 2.9 | -9.7 | 21.9 | 37.85 | 454.70 | 12.0 | 1.80 ± 0.44 |
| *C. liouana*. | CL13 | 2015 | 39.20  | 110.28  | 1285  | 382.5  | 7.3  | 12.6 | 55.3  | 65.4  | 2.3 | 0.2 | 2.9 | -10.0 | 22.3 | 44.26 | 449.79 | 10.2 | 0.29 ± 0.21 |
| *C. liouana*. | CL14 | 2015 | 39.35  | 111.18  | 893  | 393.7  | 7.9  | 13.2 | 55.7  | 63.9  | 2.2 | 0.2 | 2.9 | -9.8 | 23.0 | 37.12 | 452.31 | 12.2 | 0.29 ± 0.59 |
| *C. liouana*. | CL15 | 2015 | 37.56  | 107.39  | 1352  | 293.1  | 7.5  | 12.7 | 57.6  | 60.9  | 2.0 | 0.1 | 2.7 | -7.8 | 21.3 | 41.36 | 449.08 | 10.9 | 1.69 ± 0.21 |

SY, sampling year; Lat, latitude; Long, longitude; Alt, altitude; MAP, mean annual precipitation; MAT, mean annual temperature (MAT); DTR, daily temperature range; RH, relative humidity; SH, sunshine hours; WR, wind run; MAI, moisture availability index; PM, Penman-Montieth; MTWM, mean temperature of warmest month; MTCM, mean temperature of coldest month. Leaf properties: δ15N, nitrogen isotope composition; N, foliar nitrogen concentration; C, foliar carbon concentration; C:N, the ratio of leaf carbon to nitrogen. SD, standard deviation.

 

Figure S1. Locations of the sampling sites of two *Caragana* species in arid and semi-arid regions of northwestern China

Figure S2. Variation in foliar nitrogen isotope composition (δ15N) across populations for each *Caragana* species (a, *C. korshinskii*, CK1-CK15; b, *C. liouana*, CL1-CL15)

Figure S3. Box plots showing the difference in foliar nitrogen isotope composition (δ15N) between the two species.