Responses of Soil Water Potential and Plant Physiological Status to Pulsed Rainfall Events in Arid Northwestern China: Implications for Disclosing the Water-use Strategies of Desert Plants

Yuanyuan Ma[a, b, c], Hu Liu[a, b*], Wenzhi Zhao[a, b], Li Guo[d, e], Qiyue Yang[a, b], Yulong Li[f], Jintao Liu[g], Omer Yetemen[h]

[a] *Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, Lanzhou, 730000, China*

[b] *Linze Inland River Basin Research Station, Chinese Ecosystem Research Network, Lanzhou 730000, China*

[c] *University of Chinese Academy of Sciences, Beijing 100029, China*

[d] *Department of Ecosystem Science and Management, The Pennsylvania State University, University Park, PA 16802, U.S.A.*

[e] *State Key Laboratory of Hydraulics and Mountain River Engineering, Sichuan University, Chengdu, 610000, China*

[f] *Hebei Key Laboratory of Geological Resources and Environment Monitoring and Protection, Shijiazhuang, 050021, China*

[g] *State Key Laboratory of Hydrology-Water Resources and Hydraulic Engineering, Hohai University, Nanjing 210098, China*

[h] *Eurasia Institute of Earth Sciences, Istanbul Technical University, Maslak, Istanbul 34469, Turkey*

[*] Corresponding author: Hu Liu (lhayz@lzb.ac.cn), Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, 320# Dong Gang Road, Lanzhou, 730000, China

Fig. S1 (a) Location of the experimental station in the Heihe River Basin; (b) location of the experimental site in the Linze Inland River Basin; (c) aerial photograph of the rainfall intercept-guide devices (-10%, +10%, -20%, +20%, -30%, and +30%) and control group (CK); (d) photograph of the rainfall intercept-guide device (-30%)

Fig. S2 Daily rainfall and corresponding daily soil water potential (SWP) changes at five soil depths (20, 40, 60, 80, and 100 cm) under different rainfall interception treatments (-30%, -20%, -10%, CK, +10%, +20%, and +30%) from May 1 to October 31, 2016 to 2018. The gray dotted line indicates the minimum SWP for *Haloxylon ammodendron* (HA) growth according to Yang et al. (2014)

Fig. S3 Correlation coefficients of influencing factors (Ts, soil temperature; E*, net radiation; RH, relative humidity; T, atmospheric temperature; VP, vapor pressure) of SWP in shallow soil (a, b: 20 cm; c, d: 40 cm) of study period (from May 1 to October 31, 2016 to 2018) under different treatments (a, c: -30%; b, d: +30%)

Fig. S4 Correlation between soil temperature and SWP under different rainfall interception treatments (a~f are -10%, -20%, -30%, +10%, +20%, and +30%, respectively) in response to continuous rainfall events (28.2 mm) starting on August 31, 2018

Fig. S5 SWP under different rainfall treatments (a, -10%; b, -20%; c, -30%; d, +10%; e, +20%; f, +30%) in response to continuous rainfall events (28.2 mm) starting on August 31, 2018. The circles in the figure indicate the maximum SWP change per unit time. The black dotted lines indicate the minimum SWP for *Haloxylon ammodendron* (HA) growth according to Yang et al. (2014)

Fig. S6 Physiological response of *Haloxylon ammodendron* (HA) to various rainfall events (0-

2, 2-5, 5-10 mm) under different treatments (-10%, -20%, -30%, +10%, +20%, and +30%, respectively) from May 1 to October 31, 2016 to 2018. a) leaf water potential (Ψ_l), b) photosynthetic rate (P_r), c) stomatal conductance (g_s), d) transpiration rate (T_r), and e) water use efficiency (WUE) (average ± standard error)

Fig. S1

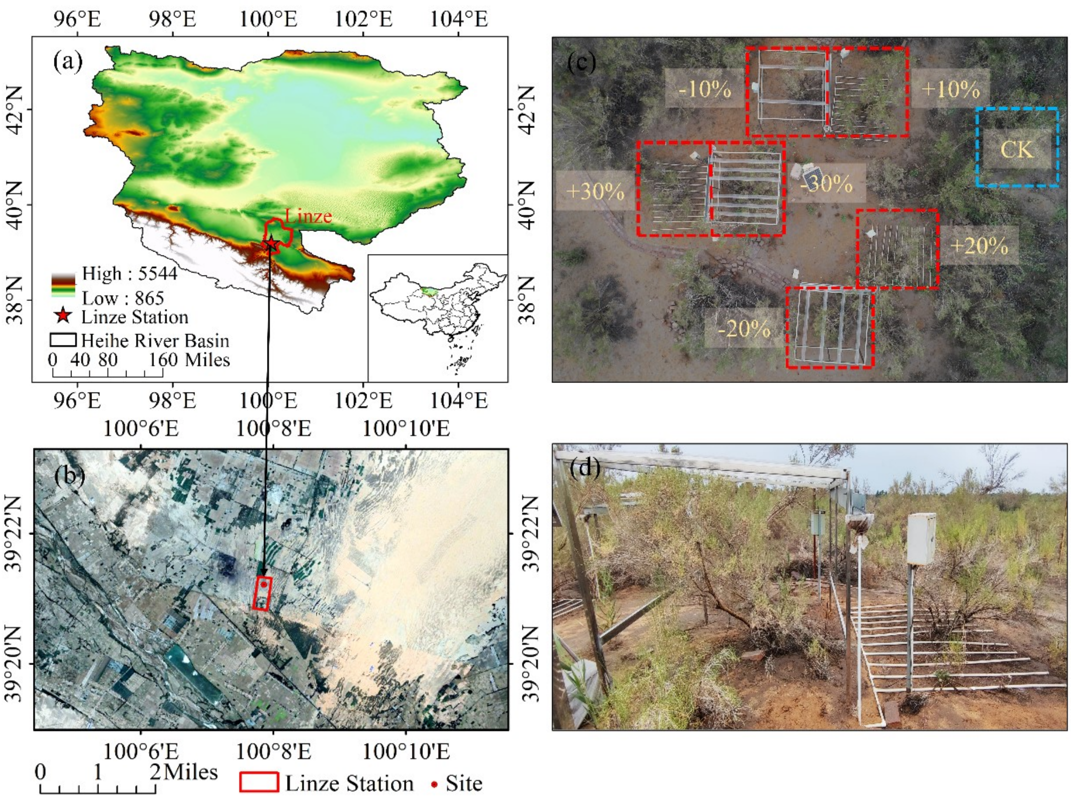
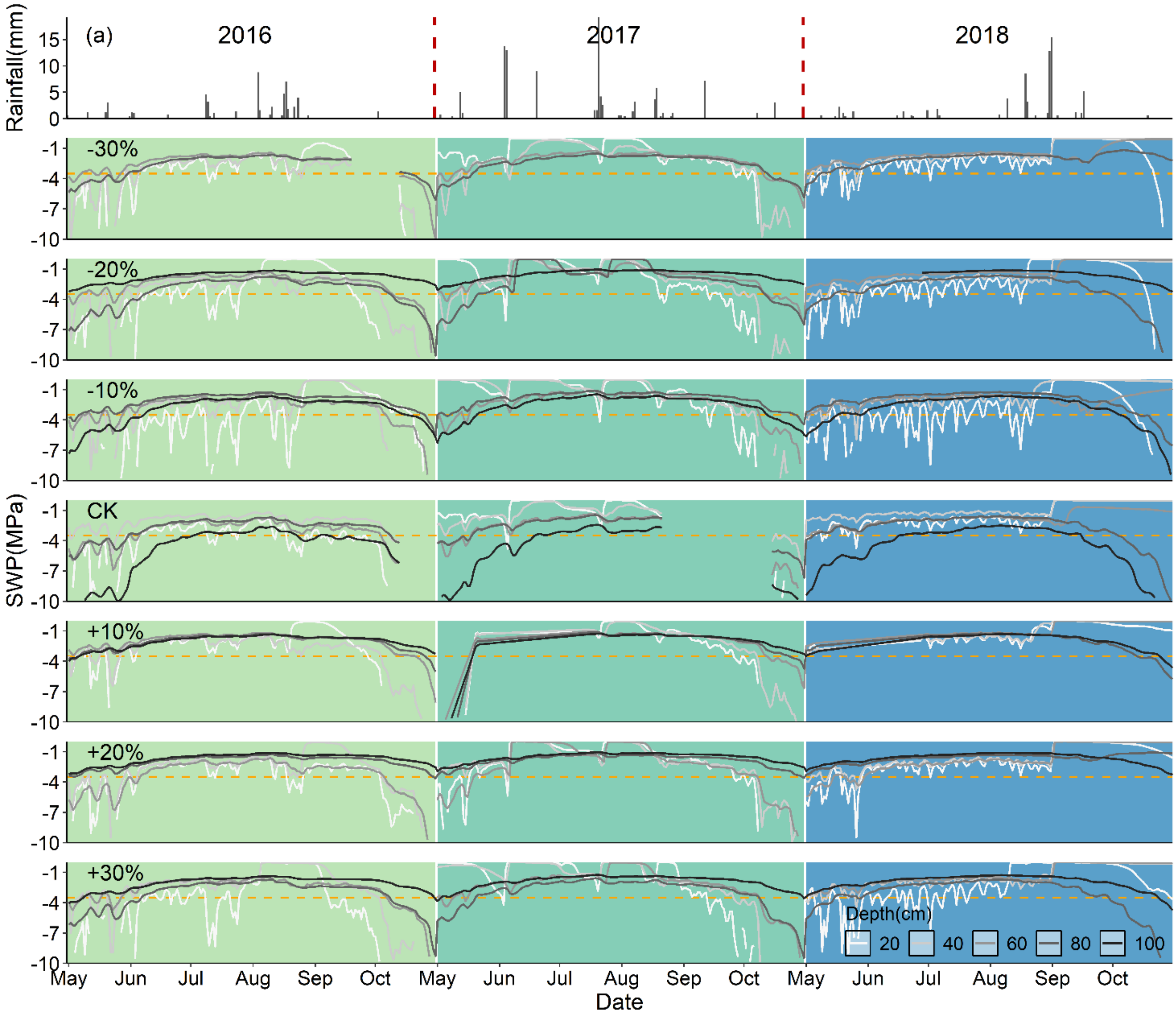

96°E
98°E
100°E
102°E
104°E
(a)
42°N
40°N
38°N
Linze
High : 5544
Low : 865
Linze Station
Heihe River Basin
0 40 80 160 Miles
100°6'E
100°8'E
100°10'E
(b)
39°22'N
39°20'N
0 1 2Miles
Linze Station
Site
(c)
-10%
+10%
CK
+30%
-30%
+20%
-20%
(d)

Fig. S2



(a)
2016
2017
2018
Rainfall(mm)
15
10
5
0
-30%
-20%
-10%
CK
+10%
+20%
+30%
-1
-4
-7
-10
SWP(MPa)
Depth(cm)
20
40
60
80
100
May
Jun
Jul
Aug
Sep
Oct
Date

Fig. S3

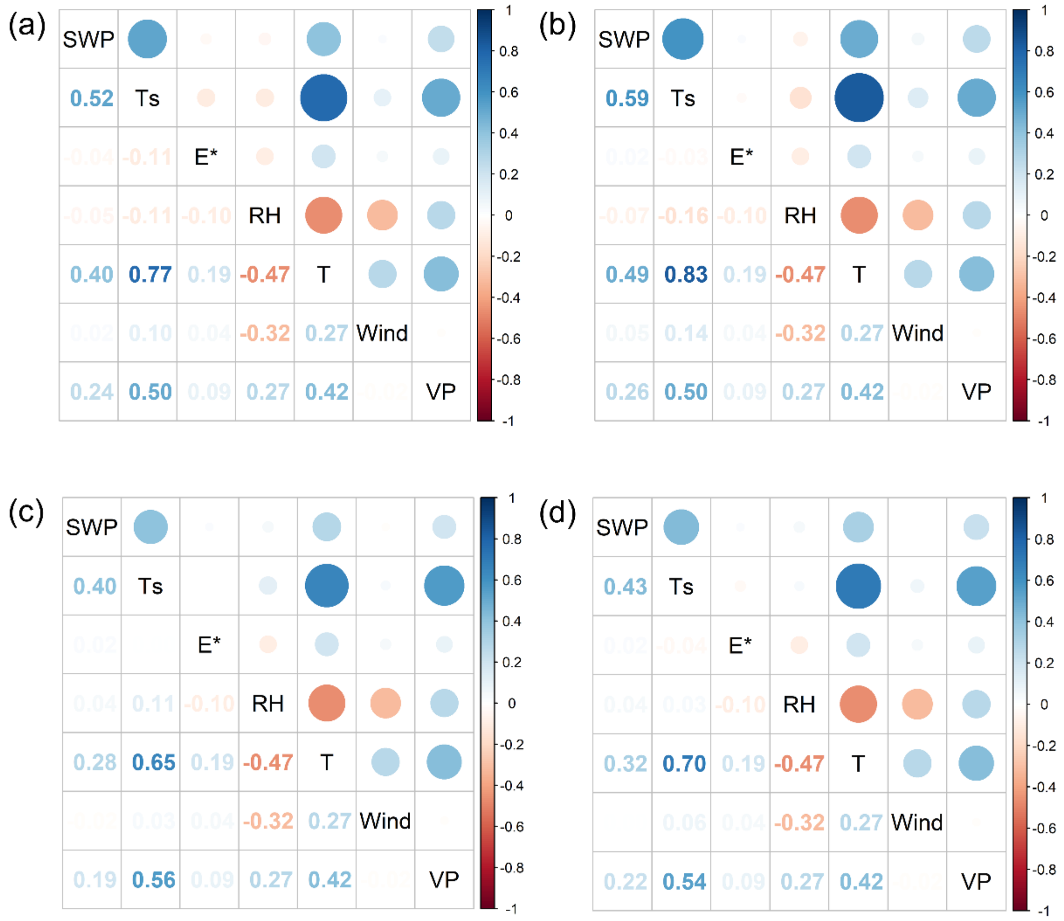

(a)
SWP
Ts
E*
RH
T
Wind
VP
0.52
-0.11
-0.11
-0.10
0.40
0.77
0.19
-0.47
0.10
-0.32
0.27
0.24
0.50
0.09
0.27
0.42
(b)
0.59
-0.16
-0.10
0.49
0.83
0.19
-0.47
0.14
-0.32
0.27
0.26
0.50
0.09
0.27
0.42
(c)
0.40
0.11
-0.10
0.28
0.65
0.19
-0.47
-0.32
0.27
0.19
0.56
0.09
0.27
0.42
(d)
0.43
-0.10
0.32
0.70
0.19
-0.47
0.06
-0.32
0.27
0.22
0.54
0.09
0.27
0.42
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1

Fig. S4

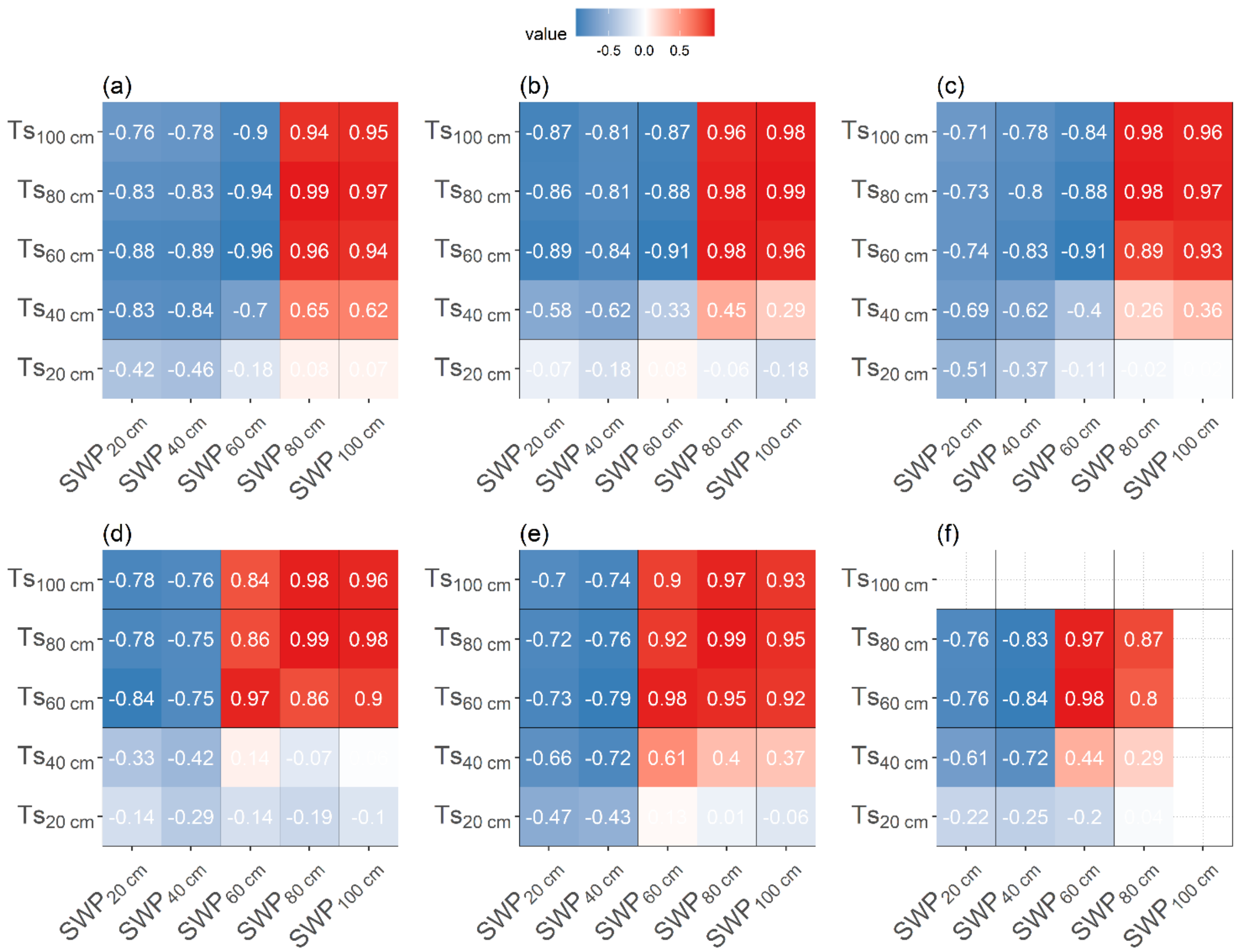
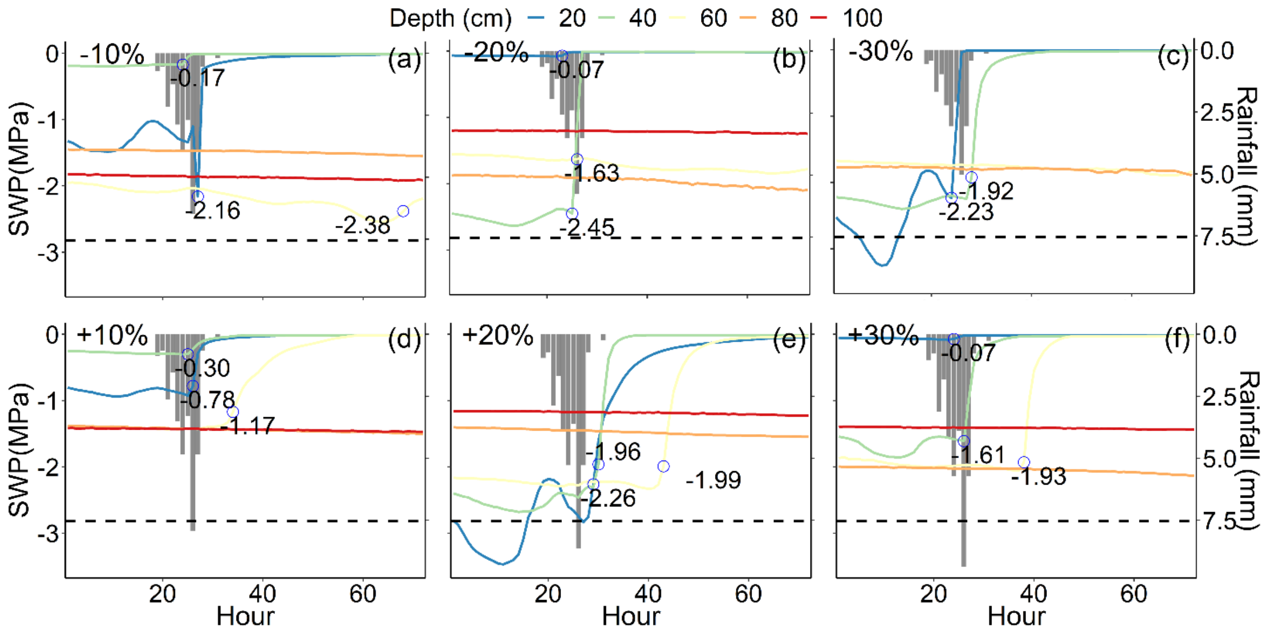
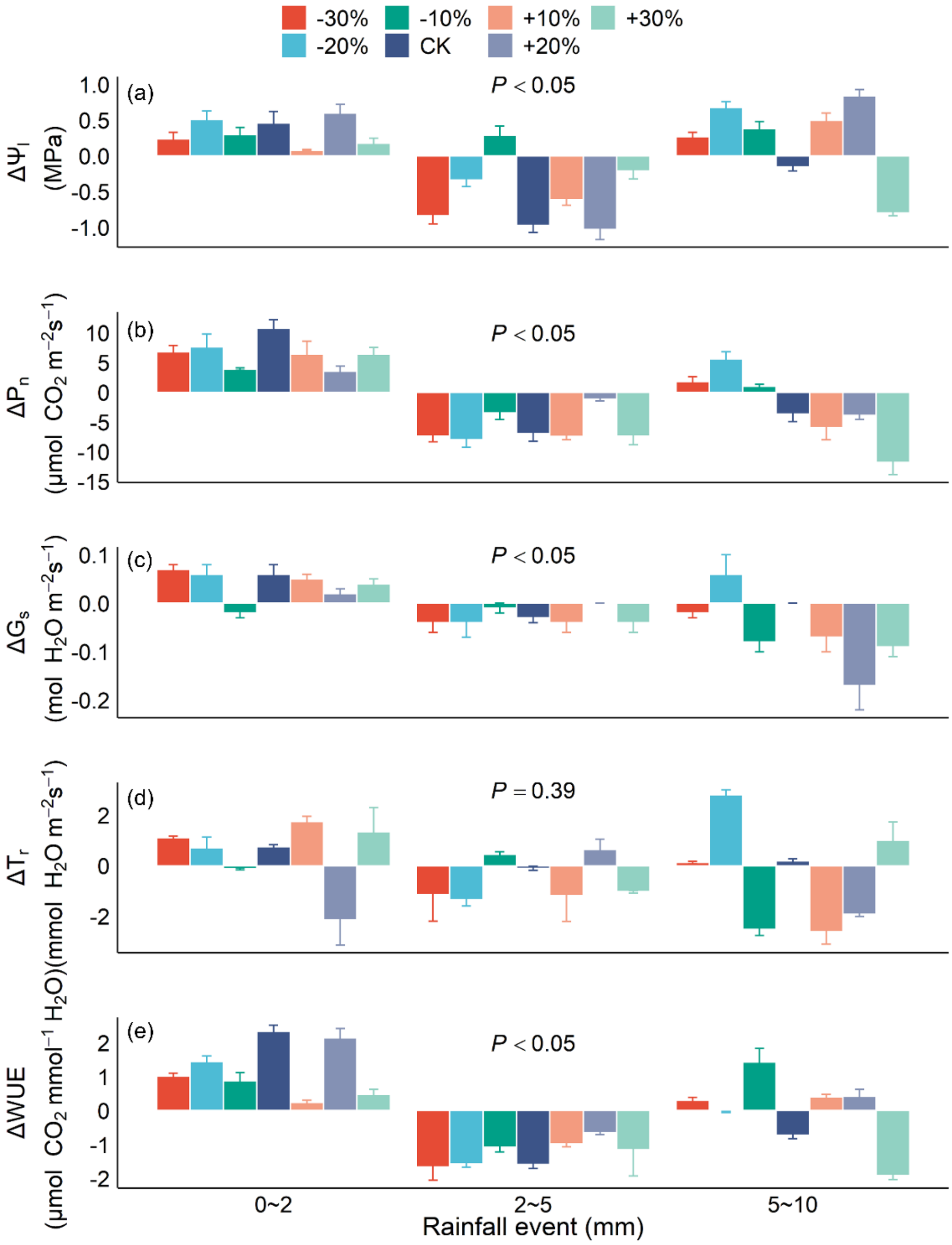


Fig. S5



Depth (cm) 20 40 60 80 100
-10%
(a)
-0.17
-2.16
-2.38
-20%
(b)
-0.07
-1.63
-2.45
-30%
(c)
-1.92
-2.23
+10%
(d)
-0.30
-0.78
-1.17
+20%
(e)
-1.96
-2.26
-1.99
+30%
(f)
-0.07
-1.61
-1.93
SWP(MPa)
0
-1
-2
-3
Rainfall (mm)
0.0
2.5
5.0
7.5
20
40
60
Hour

Fig. S6



-30%
-10%
+10%
+30%
-20%
CK
+20%
(a)
$P < 0.05$
$\Delta\Psi_l$ (MPa)
(b)
$P < 0.05$
ΔP_n (μmol CO_2 $m^{-2}s^{-1}$)
(c)
$P < 0.05$
ΔG_s (mol H_2O $m^{-2}s^{-1}$)
(d)
$P = 0.39$
ΔT_r (mmol H_2O $m^{-2}s^{-1}$)
(e)
$P < 0.05$
ΔWUE (μmol CO_2 $mmol^{-1}$ H_2O)
0~2
2~5
5~10
Rainfall event (mm)

References

Yang W, Feng W, Jia Z, Zhu Y, Guo J (2014b) Soil water threshold for the growth of *Haloxylon ammodendron* in the Ulan Buh desert in arid northwest China. S Afr J Bot 92:53-58. doi: 10.1016/j.sajb.2014.02.001