Water-saving potential of different agricultural management practices in an arid river basin

Wang Zhang[1,2], Yong Tian[2], Yu Feng[2], Jie Liu[1*], Chunmiao Zheng[1, 2]

[1]Institute of Water Sciences, College of Engineering, Peking University, Beijing, China

[2]State Environmental Protection Key Laboratory of Integrated Surface Water-Groundwater Pollution Control, School of Environmental Science and Engineering, Southern University of Science and Technology, Shenzhen, China

Supplementary Material

A. Estimation of soil hydraulic parameters

Three soil hydraulic parameters (θ_s, θ_{fc}, θ_{wp}) in each simulated unit were calculated as follows [1,2]:

$$\theta_s = -0.00126F_{sand} + 0.489 \quad (1)$$

$$\psi_s = -7.74e^{-0.0302F_{sand}} \quad (2)$$

$$\mathrm{b} = 0.159F_{clay} + 2.91 \quad (3)$$

$$\theta_{fc} = \theta_s \left(\psi_{fc} / \psi_s\right)^{-1/b} \quad (4)$$

$$\theta_{wp} = \theta_s \left(\psi_{wp} / \psi_s\right)^{-1/b} \quad (5)$$

where F_{sand} and F_{clay} are the percentages of soil sand and clay (%), ψ_s, ψ_{fc}, and ψ_{wp} represent the soil matric potential at saturation, field capacity and permanent wilting points, respectively (kPa), and b is the Campbell slope. *Ks* was estimated by the ROSETTA program, and *the curve number (CN)* was determined by the saturated conductivity of the topsoil.

References

1. Campbell, G.S. A simple method for determining unsaturated conductivity from moisture retention data. *Soil science* **1974**, *117*, 311-314.
2. Koren, V.; Smith, M.; Duan, Q. Use of a priori parameter estimates in the derivation of spatially. *Calibration of watershed models* **2003**, 239.

Figure S1. Comparison between the observed and simulated (a) soil water content, (b) crop canopy cover, (c) aboveground biomass and (d) yield at the three experimental stations during the validation period.

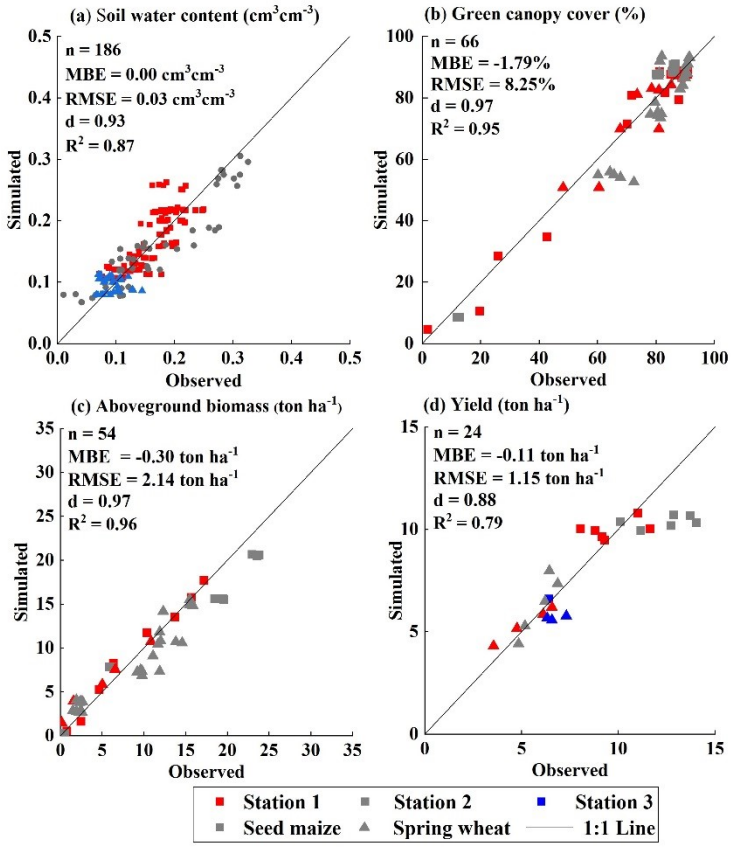

Table S1. Full list of calibrated crop parameters at three experimental stations.

No	Name	Description	Spring wheat				Seed maize			
			Initial value	GZ	LZ	GT	Initial value	GZ	LZ	GT
1	Tbase	Base temperature	0	0	0	0	8	8	8	8
2	Tupper	Upper temperature	26	26	26	26	30	30	30	30
3	pexu	Soil water depletion threshold for canopy expansion - Upper threshold	0.2	0.2	0.2	0.2	0.14	0.14	0.14	0.14
4	pexl	Soil water depletion threshold for canopy expansion - Lower threshold	0.65	0.65	0.65	0.65	0.72	0.72	0.72	0.72
5	pexshp	Shape factor for Water stress coefficient for canopy expansion	5	5	5	5	2.9	2.9	2.9	2.9
6	psto	Soil water depletion threshold for stomatal control – Upper threshold	0.65	0.65	0.65	0.65	0.69	0.69	0.69	0.69
7	pstoshp	Shape factor for Water stress coefficient for stomatal control	2.5	2.5	2.5	2.5	6	6	6	6
8	psen	Soil water depletion threshold for canopy senescence –Upper threshold	0.7	0.7	0.7	0.7	0.69	0.69	0.69	0.69
9	psenshp	Shape factor for Water stress coefficient for canopy senescence	2.5	2.5	2.5	2.5	2.7	2.7	2.7	2.7
10	ppol	Soil water depletion threshold for failure of pollination –Upper threshold	0.85	0.85	0.85	0.85	0.8	0.8	0.8	0.8
11	anaer	Vol% at anaerobiotic point	5	5	5	5	5	5	5	5
12	poln	Minimum air temperature below which pollination starts to fail (cold stress)	5	5	5	5	10	10	10	10
13	polx	Maximum air temperature above which pollination starts to fail (heat stress)	35	35	35	35	40	40	40	40

14	stbio	Minimum growing degrees required for full biomass production	13.0-15.0	14	14	14	12	12	12	12
15	ecen	Electrical conductivity of the saturated soil-paste extract: lower threshold	6	6	6	6	1	1	1	1
16	ecex	Electrical conductivity of the saturated soil-paste extract: upper threshold	20.1	20	20	20	10	10	10	10
17	Kctrx	Crop coefficient when canopy is complete but prior to senescence	1.1	1.1	1.1	1.1	1.05	1.05	1	1.05
18	fage	Decline of crop coefficient	0.15	0.15	0.15	0.15	0.3	0.15	0.3	0.3
19	Zn	Minimum effective rooting depth	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
20	Zx	Maximum effective rooting depth	Up to 2.4	1.34	1.5	1.4	1.6	1.6	1.6	1.6
21	Rtshp	Shape factor describing root zone expansion	15	15	15	15	13	13	13	13
22	Sxtop	Maximum root water extraction in top quarter of root zone	0.044	0.044	0.044	0.044	0.015	0.015	0.015	0.015
23	Sxbot	Maximum root water extraction in bottom quarter of root zone	0.012	0.012	0.012	0.012	0.004	0.004	0.004	0.004
24	evladc	Effect of canopy cover in reducing soil evaporation in late season stage	50	50	50	50	50	50	50	50
25	cco	Canopy size of the average seedling at 90% emergence	1.5	1.5	1.5	1.5	6.5	6.5	6.5	6.5
26	den	Number of plants per hectare	200000-70000000	5450000	6000000	6000000	50000-100000	75000	98000	75000
27	CGC	Canopy growth coefficient	5%-7%	8.50%	8%	8%	12-13%	12%	12%	12%
28	CCx	Maximum canopy cover	80-99%	96%	98%	95%	97%	94%	93%	89%
29	CDC	Canopy decline coefficient	4%	4%	4.50%	4%	10%	10%	10%	10%
30	eme	Time from sowing to emergence	14	20	9	20	21	21	21	21
31	root	Time from sowing to maximum rooting depth	85	80	75	85	134	130	139	145
32	sen	Time from sowing to start senescence	100	100	90	98	134	128	134	135
33	mat	Time from sowing to maturity	121	121	116	124	149	149	150	154
34	flo	Time from sowing to flowering or to the start of yield	81	83	66	80	97	88	94	95

35	flolen	Length of the flowering stage	5	14	5	8	10	8	8	8
36	exc	Excess of potential fruits	100	100	100	100	50	50	50	50
37	hilen	Building up of harvest index starting at flowering	38	31	23	30	75	30	40	30
38	wp*	Water productivity normalized for ET_o and CO^2	15	16.5	20	17.5	33.7	33.7	33.7	33.7
39	Hio	Reference harvest index	45-50	50	45	48	48-52	44	41	43
40	hiflo	Possible increase (%) of HI due to water stress before flowering	5	5	4	5	0	0	0	0
41	hipi	Coefficient describing positive impact of restricted vegetative growth during yield formation on HI	10	10	10	4	10	10	10	10
42	hini	Coefficient describing negative impact of stomatal closure during yield formation on HI	5	5	5	7	3	3	3	3
43	hia	Allowable maximum increase (%) of specified HI	15	15	15	15	15	15	15	15

Note: GZ, LZ and GT represent experimental sites at Ganzhou, Linze and Gaotai County, respectively. wp* is the normalized water productivity.

Table S2. Uncertainty analysis results of simulated crop yields.

Station	Seed maize		Spring wheat	
	SD	CV	SD	CV
Station 1	1.91	0.26	1.86	0.22
Station 2	1.51	0.21	1.49	0.17
Station 3	1.01	0.12	1.27	0.15

Note: SD (ton ha^{-1}) and CV represent the standard deviation and coefficient of variation of the simulated crop yields.