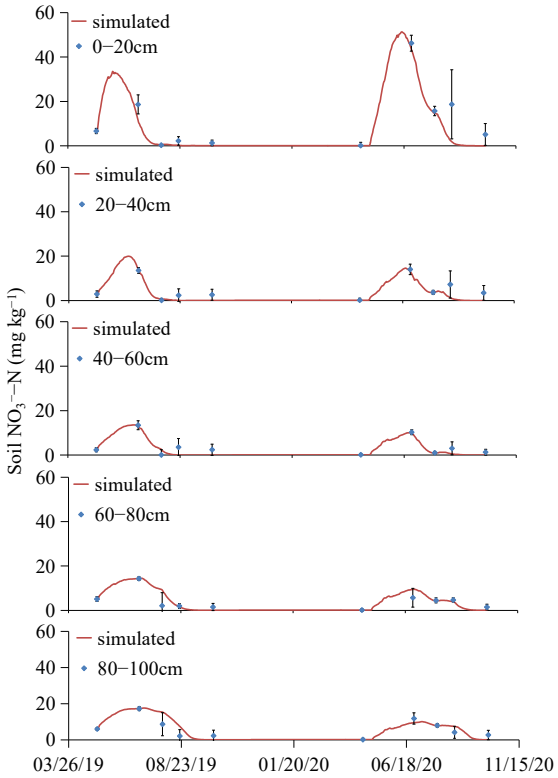

Figure S1. Comparison of simulated and measured soil nitrate N concentration at different depths under U+NBPT treatment on CT modes from 2019 to 2020.

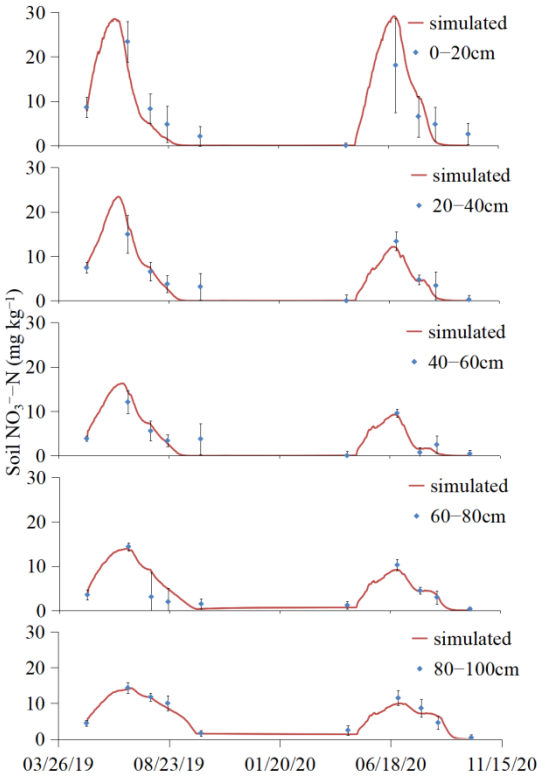

Figure S2. Comparison of simulated and measured soil nitrate N concentration at different depths under U+DMPP treatment on CT modes from 2019 to 2020.

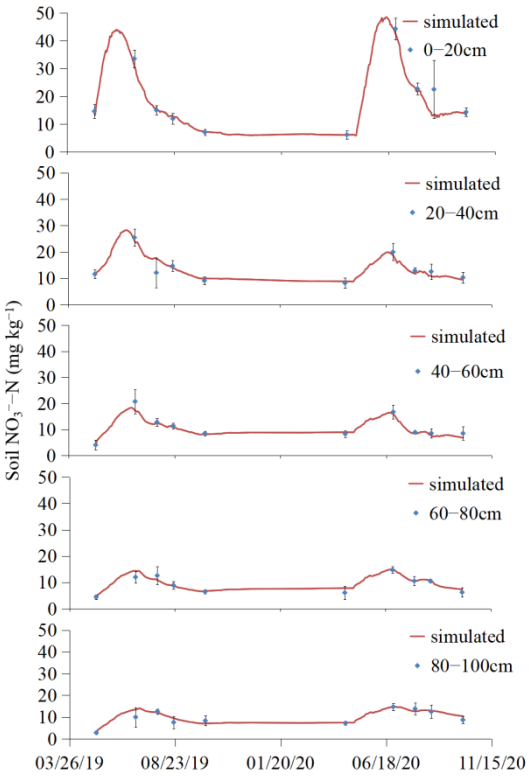

Figure S3. Comparison of simulated and measured soil nitrate N concentration at different depths under U treatment on ST modes from 2019 to 2020.

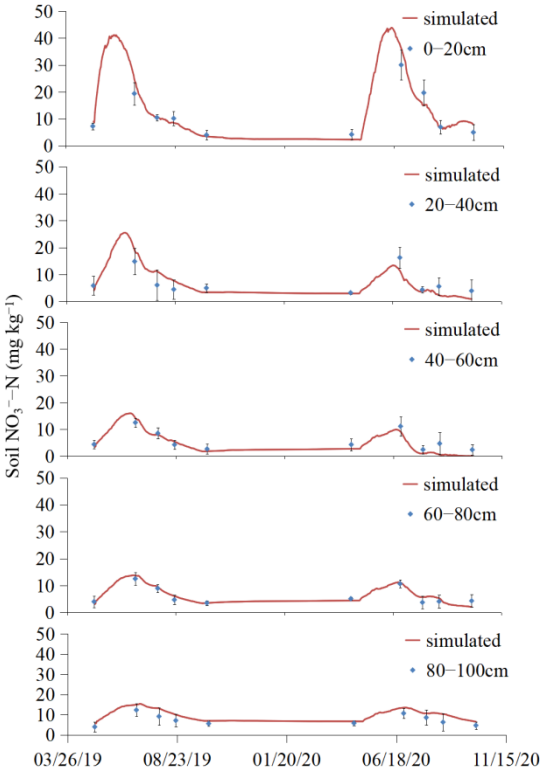

Figure S4. Comparison of simulated and measured soil nitrate N concentration at different depths under U+NBPT treatment on ST modes from 2019 to 2020.

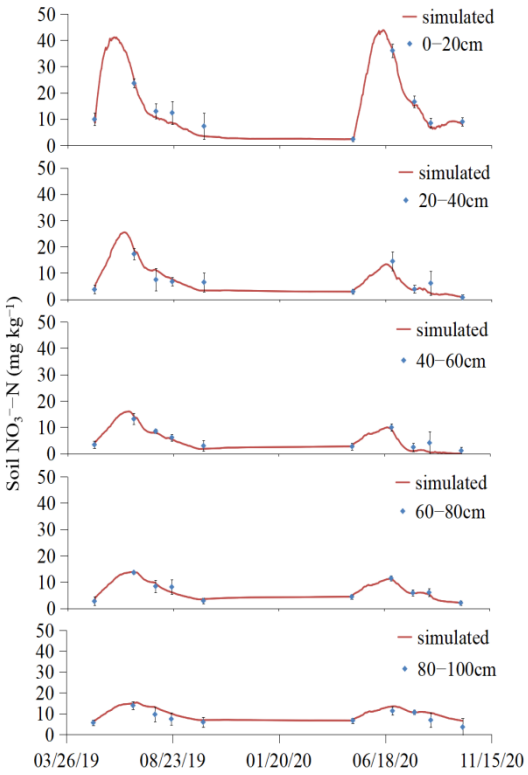

Figure S5. Comparison of simulated and measured soil nitrate N concentration at different depths under U+DMPP treatment on ST modes from 2019 to 2020.

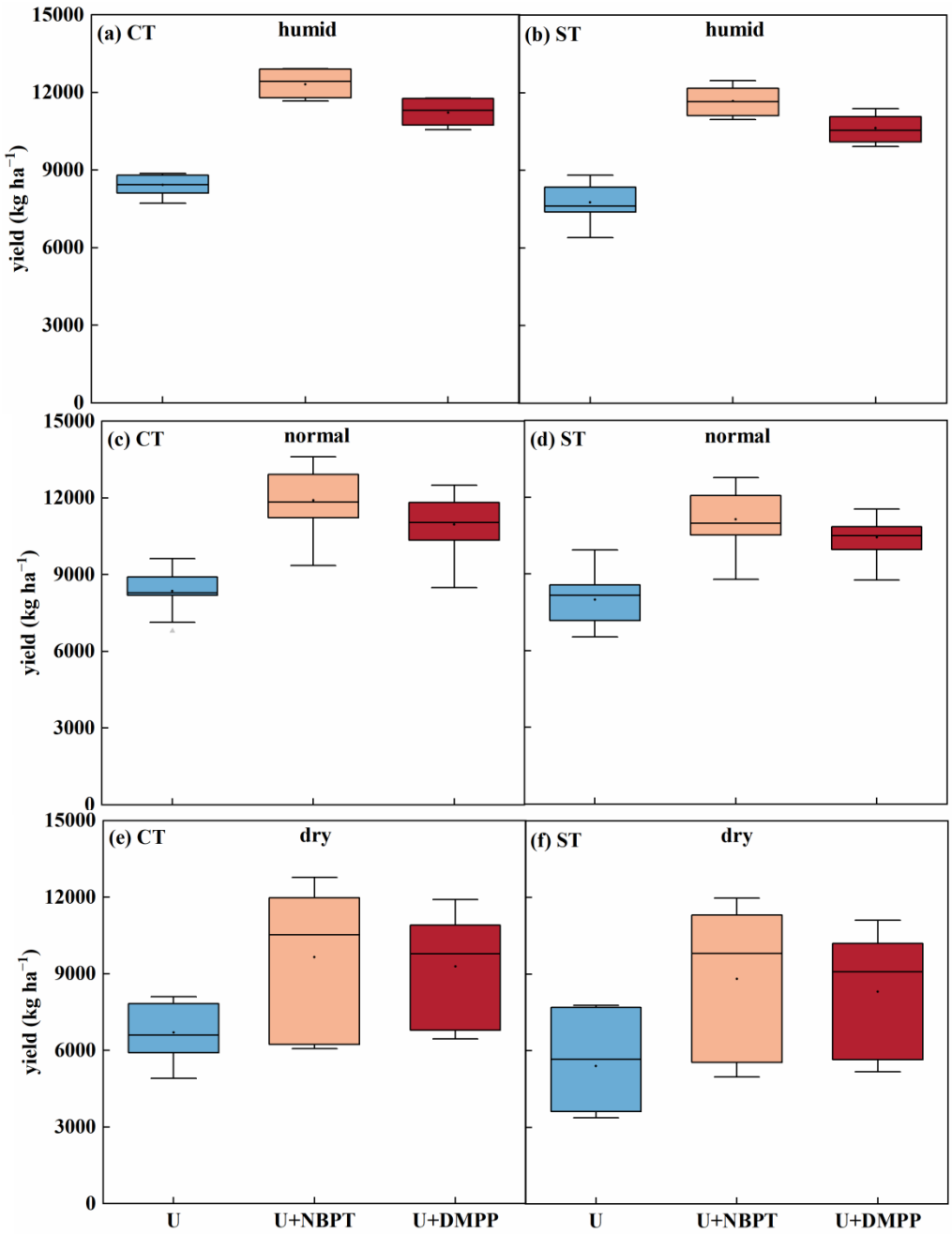

Figure S6. Simulated maize yield under different N fertilizer application treatments in different rainfall years in the growing season from 1991 to 2020. (a)and (b) are in humid years; (c) and (d) are in normal years; (e) and (f) are in dry years.The box is the interquartile range (IQR), the upper, middle and lower three black solid lines inside the box represent the 75%, 50%, and 25% quartile respectively; the two vertical lines outside the box represent the 1.5IQR that extends upward and downward. The black point inside the box is the mean value. The gray dots outside the box are outliers.

Table S1. Parameters for soil organic matter transformations.

Parameter	Value	Unit
Decomposition rate of SOM1	2.70×10^{-6}	d^{-1}
Decomposition rate of SOM2	1.40×10^{-4}	d^{-1}
Decay rate of SMB1	1.85×10^{-4}	d^{-1}
Decay rate of SMB2	1.00×10^{-2}	d^{-1}
Decomposition rate of plant material –AOM1	1.20×10^{-2}	
Decomposition rate of plant material –AOM2	5.00×10^{-2}	d^{-1}
Maintenance respiration coefficient of SMB1	1.8×10^{-3}	d^{-1}
Maintenance respiration coefficient of SMB2	1.00×10^{-2}	d^{-1}
Substrate (SMB) utilization efficiency	0.6	
Substrate (SOM1) utilization efficiency	0.4	
Substrate (SOM2) utilization efficiency	0.5	
Substrate (Plant material – AOM1)utilization efficiency	0.13	
Substrate (Plant material – AOM2)utilization efficiency	0.69	
Partitioning coefficient, SOM2 to SOM1	0.1	
Partitioning coefficient, SMB1 to SOM2	0.6	
Partitioning coefficient, SMB2 to SOM2	0.6	
Partitioning coefficient, AOM1 to SMB1	0.5	
Partitioning coefficient, AOM1 to SMB2	0.5	
C/N ratio of SOM1 (depending on soil-SOM)	10	
C/N ratio of SOM2 (depending on soil-SOM)	12	
C/N ratio of SMB (SMB1 and SMB2)	6.7	
C/N ratio of AOM1 (depending on input material)	100	
C/N ratio of AOM2 (depending on input material)	20	