Management of Soil Salinity and Improvement of Nutrient Use Efficiency of Salt-Affected Farmland

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Introduction

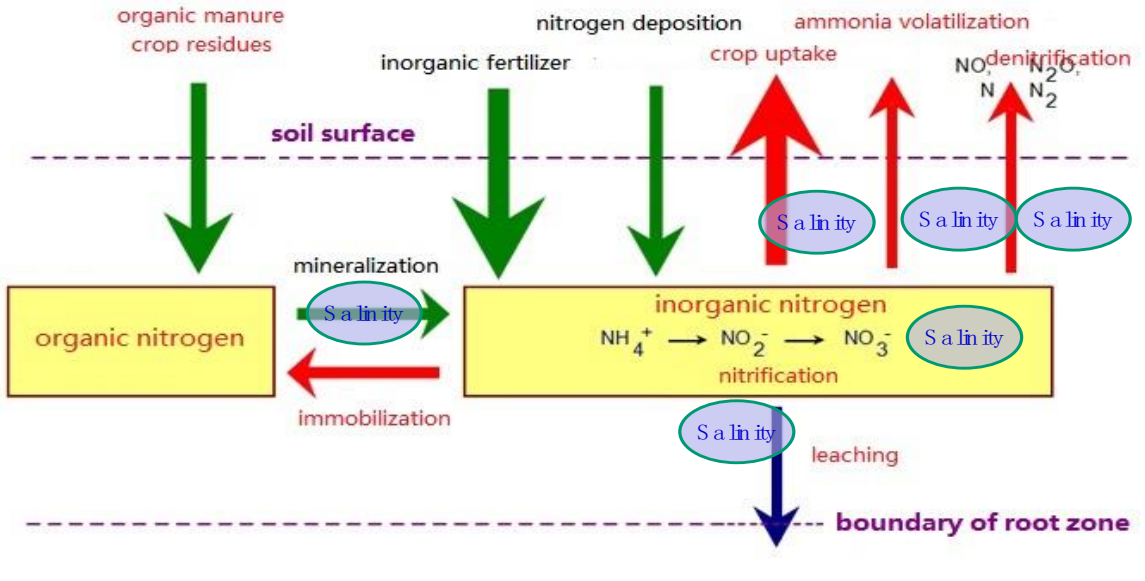
- Salt-affected land spreads widely in China with many types, large area and various degree, which has seriously affected soil quality and land productivity.




Introduction

- According to our previous study, more nutrient losses by volatilization and leaching are often observed in saline farmland than salinity free land.

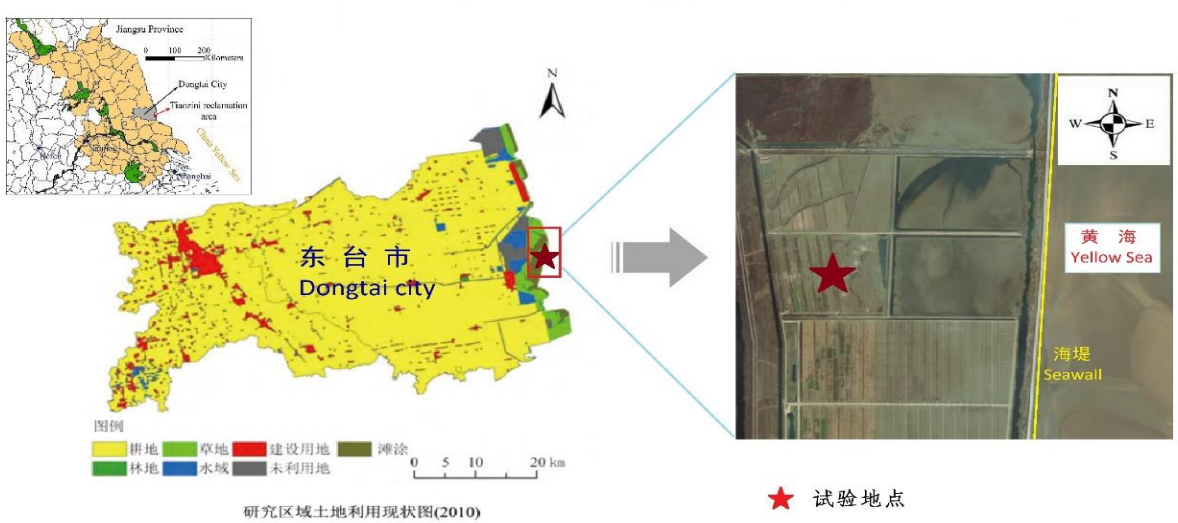
- As nutrient use efficiency is reduced by salinity, salinization not only aggravate salinity hazard to crop production, but also induce waste of agricultural resources and fertilizer pollution to the environment.



Introduction

- Therefore, besides technologies for salinity control and management, it is also necessary to develop comprehensive measures for controlling nutrient loss and increasing nutrient use efficiency in salt-affected farmland, so that we can better manage salinity, improve soil quality and land productivity.

Methods



- **Measurement items:** Soil salinity, pH, organic matter, ammonium nitrogen, nitrate nitrogen, bulk density and water stable aggregate content, crop yield, straw amount, nitrogen content of grain and straw, etc.

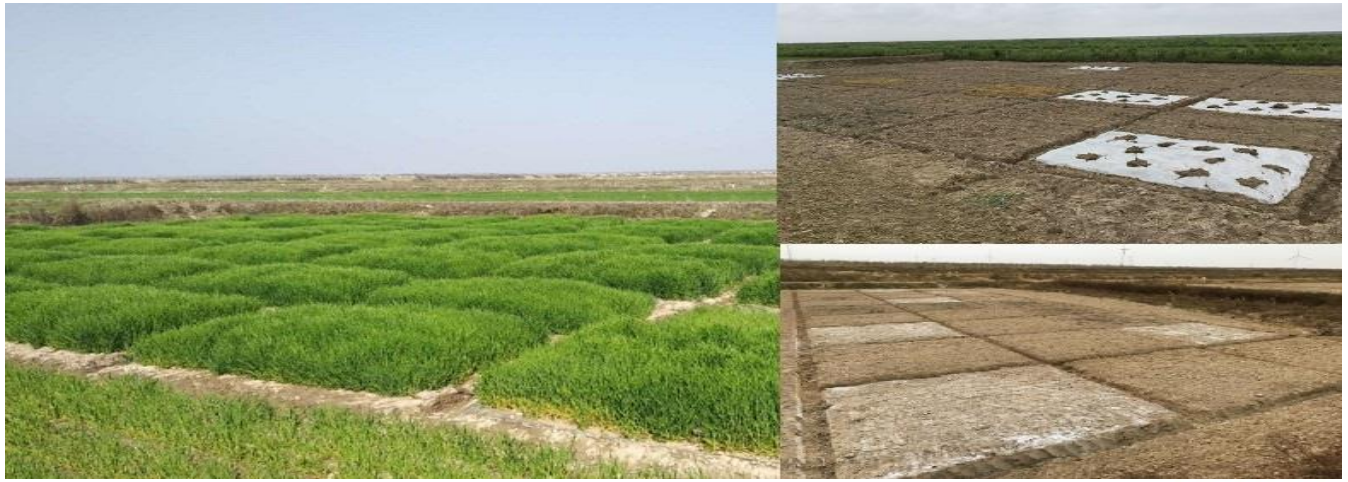
- Two years of plot experiments were carried out in a typical coastal salt-affected farmland of Dongtai City, Jiangsu Province, China.
- Three groups of experiments were carried out.
- Mainly focused on N use efficiency
- Soil salinity is in moderate degree, The planting system is double cropping a year of Wheat-Maize with rain fed.

Methods

1. Organic-inorganic fertilizer application: Different proportion of organic and inorganic fertilizer. (OM1), (OM3/4), (OM1/2), (OM1/4), pure chemical Fertilizer(CK) and no fertilizer (CK0).

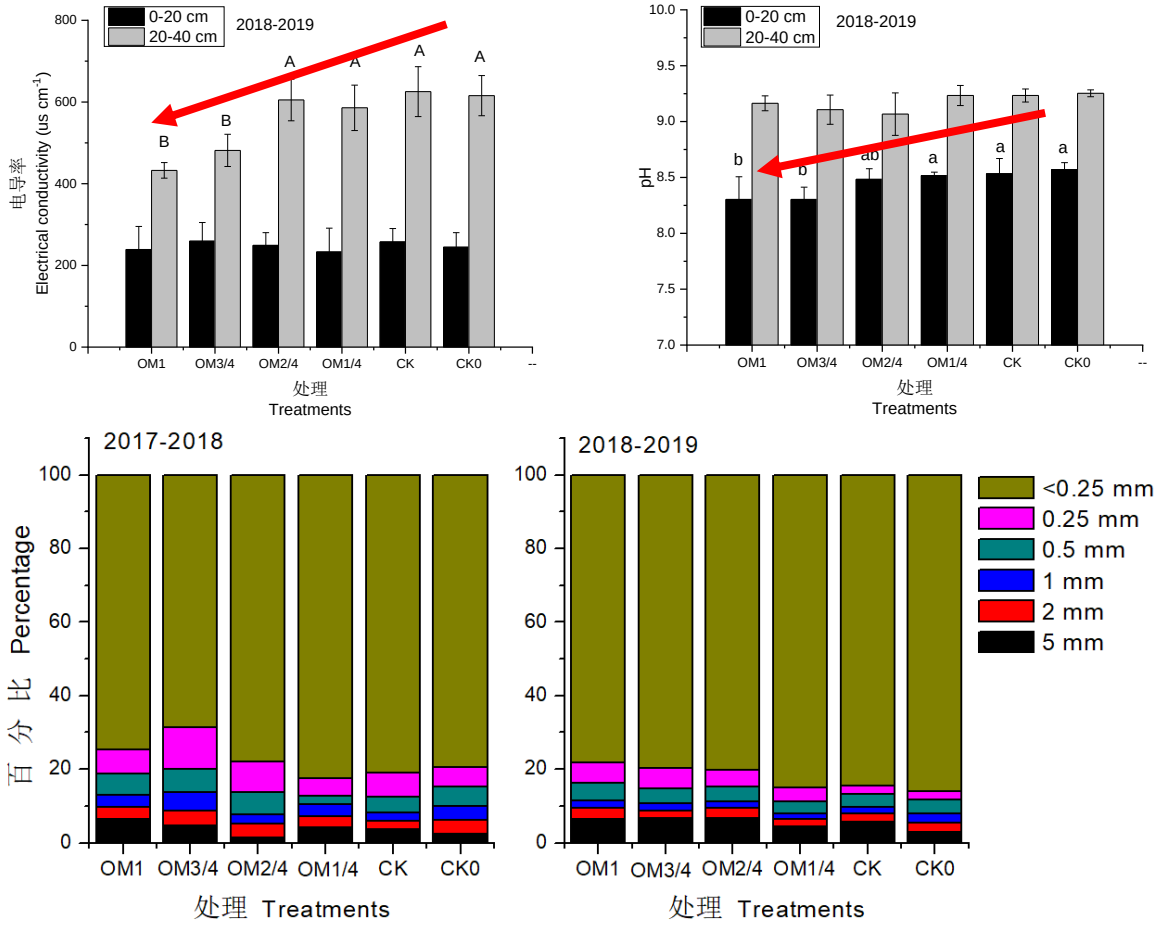
2. Mulching and straw interlayer: Different mulching material and straw interlayer. film mulching (FM), straw mulching (SM), straw interlayer (SB), film mulching and straw interlayer (FM + SB), pure chemical fertilizer (CK) and no fertilization (CK0).

3. Modifier application: Different types of modifier. biochar (BC), gypsum (SG), fulvic acid (FA), microbial agent (EM), pure chemical fertilizer (CK) and no fertilizer (CK0)



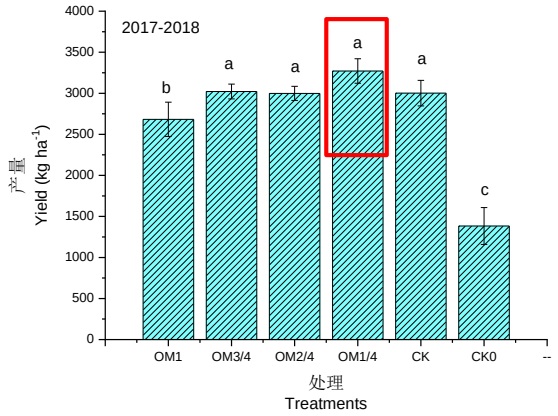
- Nitrogen application rate were all the same for all treatments.

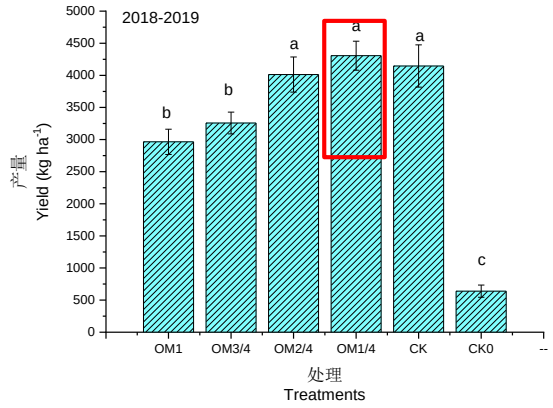
Results: 1. Effects of organic-inorganic fertilizers application on control of salinity and nutrient loss ---- EC, pH and macro-aggregates

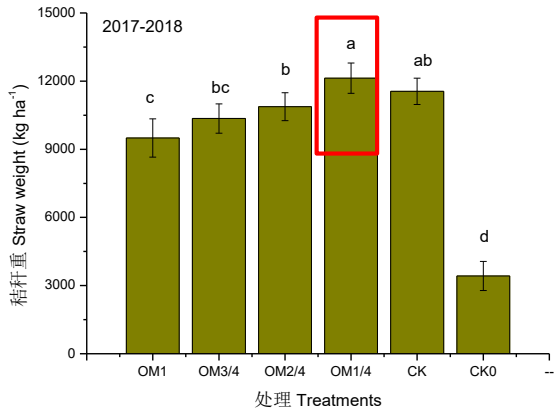


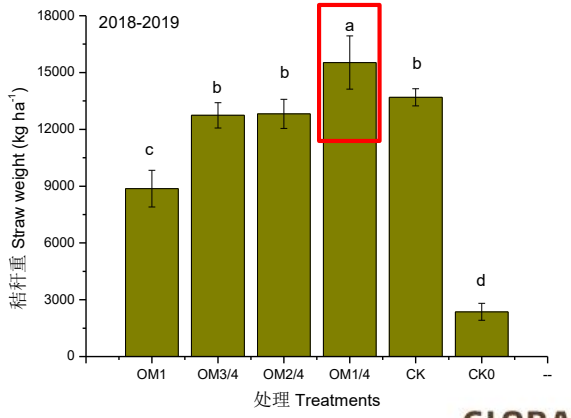
- Organic-inorganic fertilizers application decreased soil salinity and pH.
- Higher proportion of organic fertilizer makes more significant reduction of salinity and pH.
- Content of soil macro-aggregates increased with higher proportion of organic fertilizer.

Results: 1. Effects of organic-inorganic fertilizers application on control of salinity and nutrient loss ----Yield and straw weight









- When the proportion of organic fertilizer is too high, crop yield and straw amount is relatively low.
- Barley yield gets the highest for treatment of 1 / 4 organic fertilizer and 3 / 4 chemical fertilizer.

Results: 1. Effects of organic-inorganic fertilizers application on control of salinity and nutrient loss ----Nitrogen use efficiency

Nitrogen balance of coastal salinized farmland under different treatments

Treatments	N input (kg ha^{-1})			N output (kg ha^{-1})		
	N rate	Initial N	Net mineralization	Crop uptake	Residual N	Apparent loss rate
OM1	225	62.18	35.53	91.50	30.83	200.4
OM3/4	225	88.81	35.53	116.09	30.67	202.6
OM2/4	225	79.29	35.53	137.11	37.32	165.4
OM1/4	225	88.93	35.53	167.71	36.84	144.9
CK	225	82.87	35.53	156.44	36.96	145.0
CK0	0	16.33	35.53	21.86	30.00	0.00

- Apparent nitrogen loss was the smallest for treatment of 1 / 4 organic fertilizer + 3 / 4 chemical fertilizer.

Barley yield, nitrogen content and N uptake of different treatments

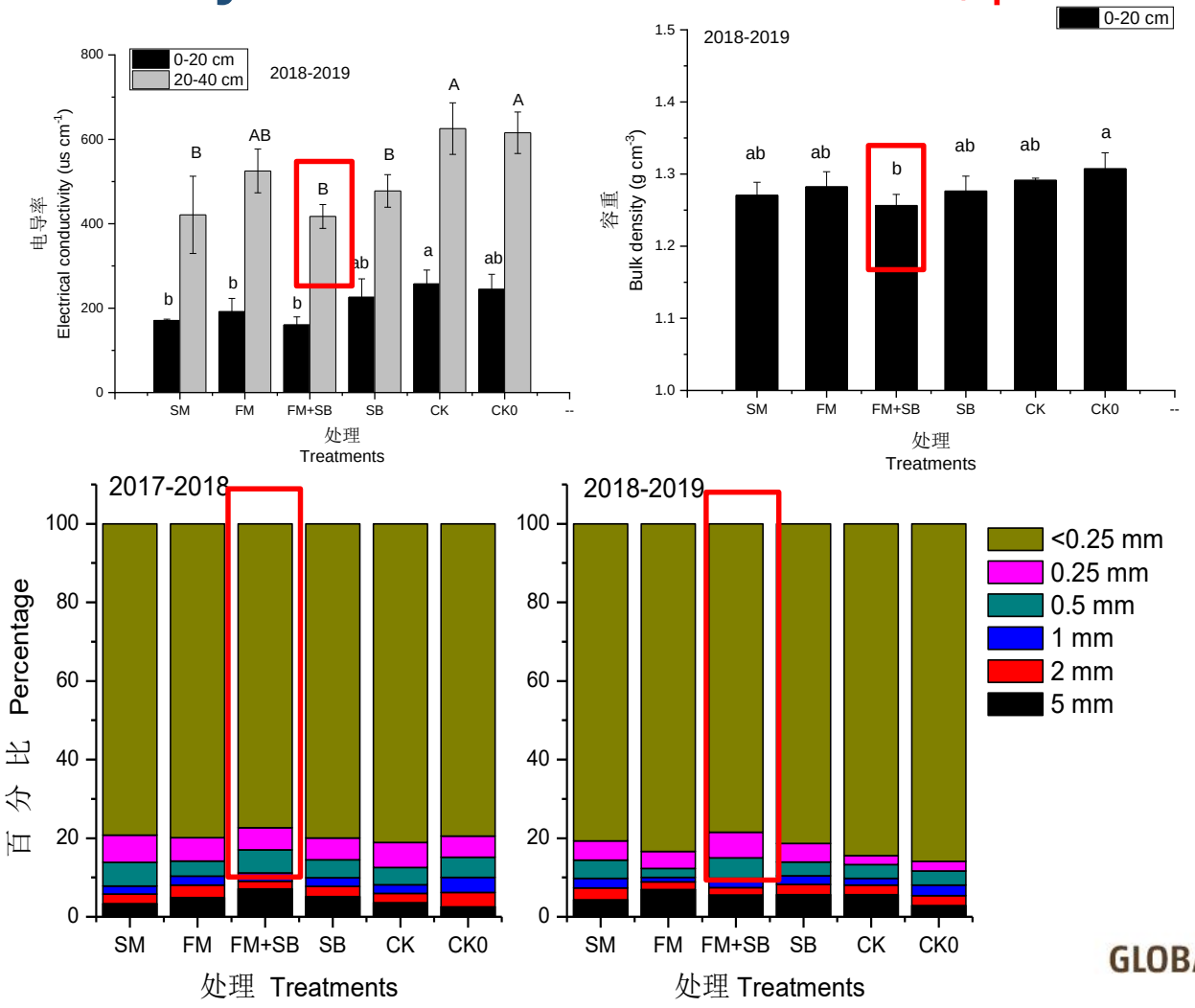
Treatments	Biomass (kg ha^{-1})		Nitrogen content (%)		N uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Grain	Straw	Total
OM1	2964b	8869c	1.90b	0.48b	48.95	42.55	91.50d
OM3/4	3258b	12742b	1.93b	0.48b	54.66	61.43	116.1c
OM2/4	4013a	12820b	2.09ab	0.50ab	72.95	64.15	137.1b
OM1/4	4306a	15527a	2.17a	0.56a	81.25	86.46	167.7a
CK	4146a	13688b	2.18a	0.57a	78.72	77.72	156.4a
CK0	639c	2361d	1.91b	0.48b	10.63	11.23	21.86e

Effects of different treatments on nitrogen utilization efficiency

Treatments	N harvest index（%）	N recovery efficiency（%）	N agronomy efficiency（kg·kg^{-1}）	N partial factor productivity（kg·kg^{-1}）
OM1	53.50	30.95	10.34	13.18
OM3/4	47.08	41.88	11.64	14.48
OM2/4	53.21	51.22	15.00	17.84
OM1/4	48.45	64.83	16.30	19.14
CK	50.32	59.82	15.59	18.43
CK0	48.63			

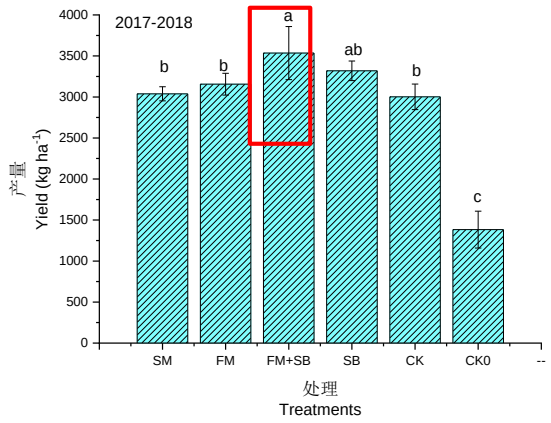
- Plant N uptake and N agronomic efficiency of 1 / 4 OM + 3 / 4 CF were the highest

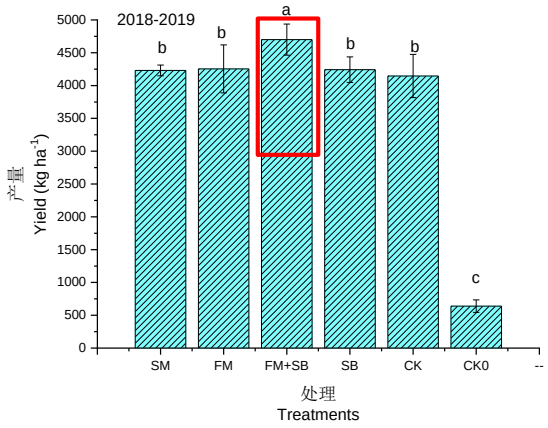
Results: 2. Effects of mulching and straw interlayer on control of salinity and nutrient loss ---- EC, pH and macro-aggregates

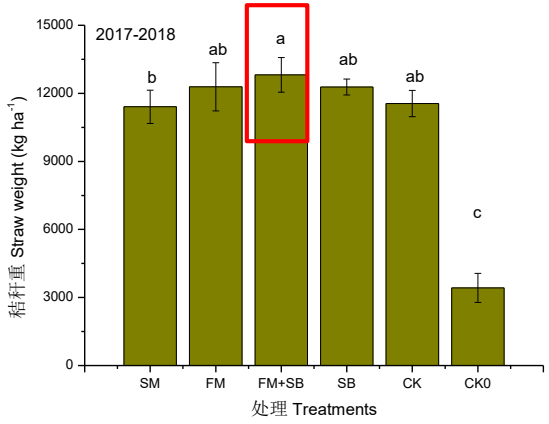


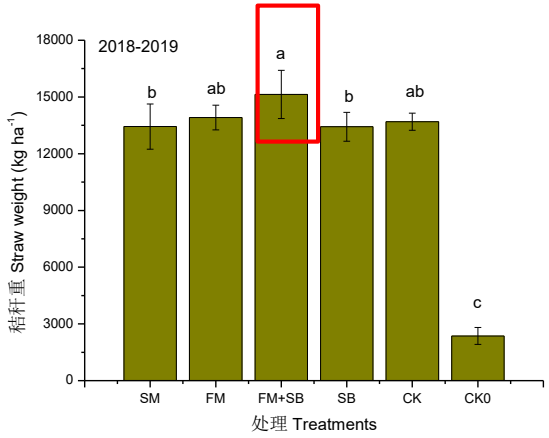
- All treatments reduced soil salinity to varying degrees, film mulching and straw interlayer had the most significant effect.
- FM + SB treatment had the highest content of water stable macro-aggregates.

Results: 2. Effects of mulching and straw interlayer on control of salinity and nutrient loss ---- Yield and straw weight









- Yield and straw weight of barley of different treatments were all higher than CK.
- Barley yield and straw weight of film mulching and straw interlayer treatment was the highest.

Results: 2. Effects of mulching and straw interlayer on control of salinity and nutrient loss ---- Nitrogen use efficiency

Nitrogen balance of coastal salinized farmland under different treatments

Treatments	N input (kg ha^{-1})			N output (kg ha^{-1})		
	N rate	Initial N	Net mineralization	Crop uptake	Residual N	Apparent loss rate
SM	225	20.42	63.97	120.3	70.77	118.3
FM	225	26.78	63.97	129.8	66.84	119.2
FM+SB	225	24.05	63.97	135.6	74.29	103.2
SB	225	26.71	63.97	129.8	65.60	120.3
CK	225	19.73	63.97	126.6	65.05	117.1
CK0	0	12.24	63.97	35.77	40.43	0.00

- Apparent nitrogen loss of film mulching with straw interlayer treatment was the smallest.

Barley yield, nitrogen content and N uptake of different treatments in 2018-2019

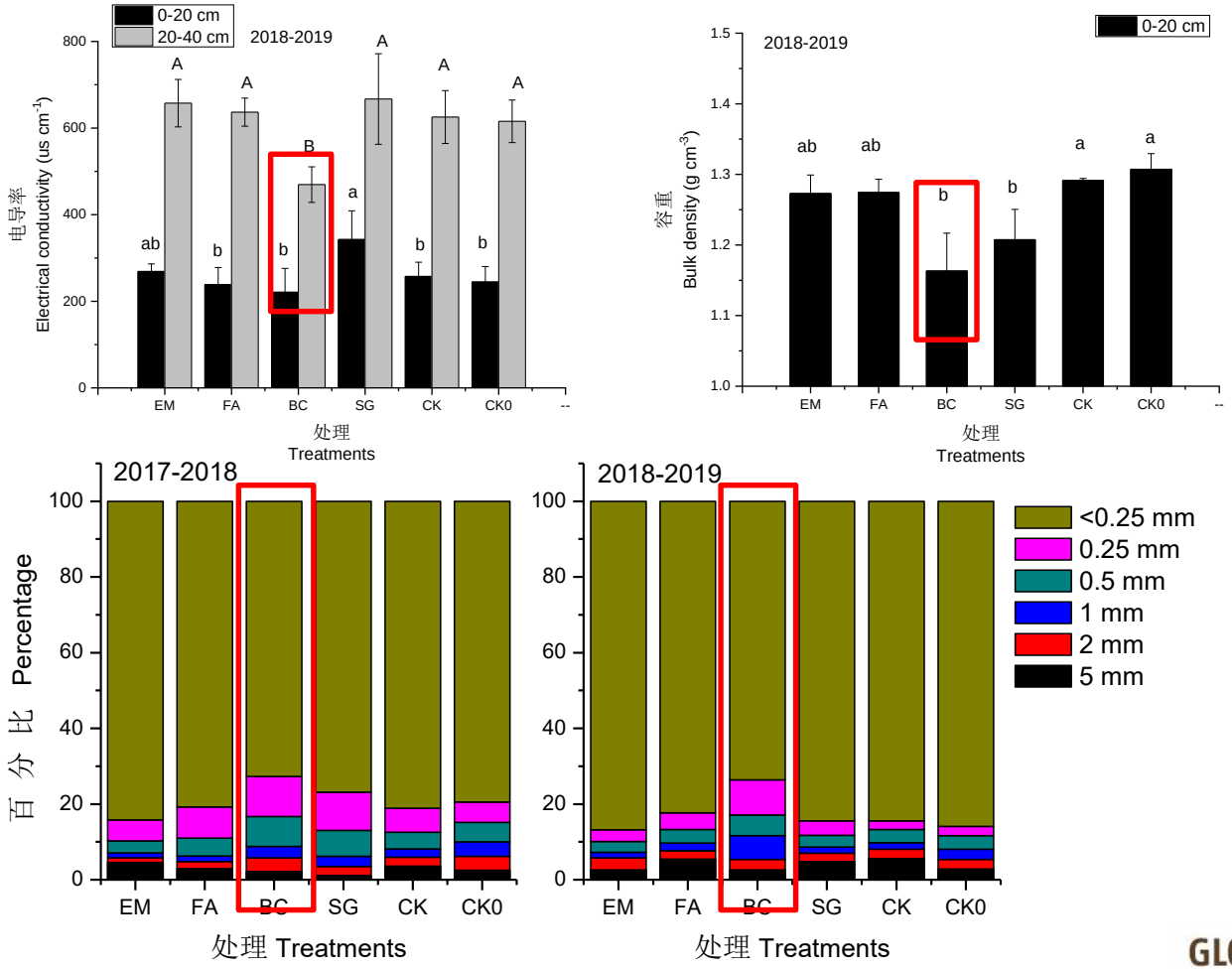
Treatments	Biomass (kg ha^{-1})		Nitrogen content (%)		N uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Grain	Straw	Total
SM	4230b	13436b	2.18a	0.57a	80.31	75.92	156.2ab
FM	4254b	13913ab	2.22a	0.58a	82.14	80.09	162.2ab
FM+SB	4700a	15133a	2.14a	0.55ab	87.68	83.02	170.7a
SB	4242b	13425b	2.16a	0.55ab	79.59	73.68	153.3b
CK	4146b	13688ab	2.18a	0.57a	78.72	77.72	156.4ab
CK0	638.8c	2361c	1.91b	0.48b	10.63	11.23	21.86c

Effects of different treatments on nitrogen utilization efficiency

Treatments	N harvest index (%)	N recovery efficiency (%)	N agronomy efficiency (kg·kg^{-1})	N partial factor productivity (kg·kg^{-1})
SM	51.41	59.72	15.96	18.80
FM	50.63	62.39	16.07	18.91
FM+SB	51.37	66.16	18.05	20.89
SB	51.93	58.41	16.01	18.85
CK	50.32	59.82	15.59	18.43
CK0	48.63			

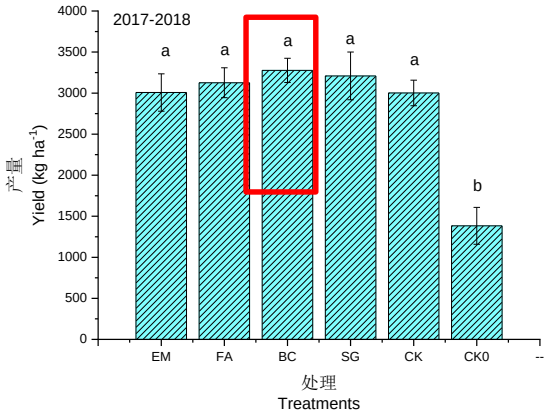
- Plant N uptake and N agronomic efficiency of film mulching and straw interlayer was the highest

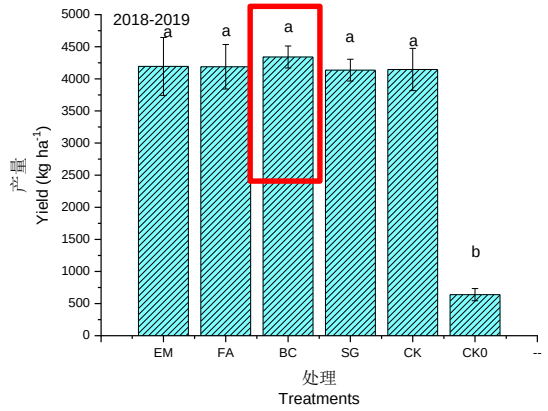
Results: 3. Effects of modifier application on control of salinity and nutrient loss ---- EC, pH and macro-aggregates

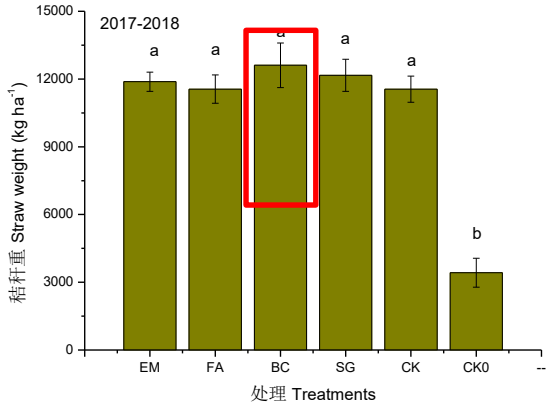


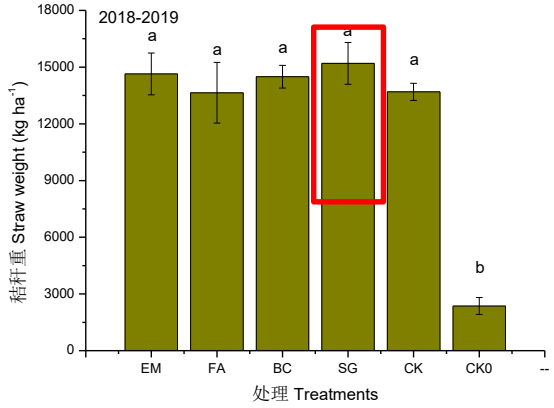
- Application of modifiers reduced soil salinity in some extent, while biochar application had the most significant effect.
- Biochar application treatment had the highest content of water stable macro-aggregates.

Results: 3. Effects of modifier application on control of salinity and nutrient loss ---- Yield and straw weight









- Yield and straw weight of barley with different modifier application were all higher than CK.
- Barley yield and straw weight of biochar application treatment were the highest.

Results: 3. Effects of modifier application on control of salinity and nutrient loss ---- Nitrogen use efficiency

Nitrogen balance of coastal salinized farmland under different treatments in 2018-2019

Treatments	N input (kg ha^{-1})			N output (kg ha^{-1})		
	N rate	Initial N	Net mineralization	Crop uptake	Residual N	Apparent loss rate
EM	225	83.72	35.53	158.49	33.89	151.86
FA	225	77.07	35.53	149.49	37.33	150.78
BC	225	81.79	35.53	168.74	38.36	135.23
SG	225	81.91	35.53	160.91	36.87	144.66
CK	225	82.87	35.53	156.44	36.96	149.99
CK0	0	16.33	35.53	21.86	30.00	0.00

- Apparent nitrogen loss of biochar application treatment was the smallest.

Barley yield, nitrogen content and N uptake of different treatments

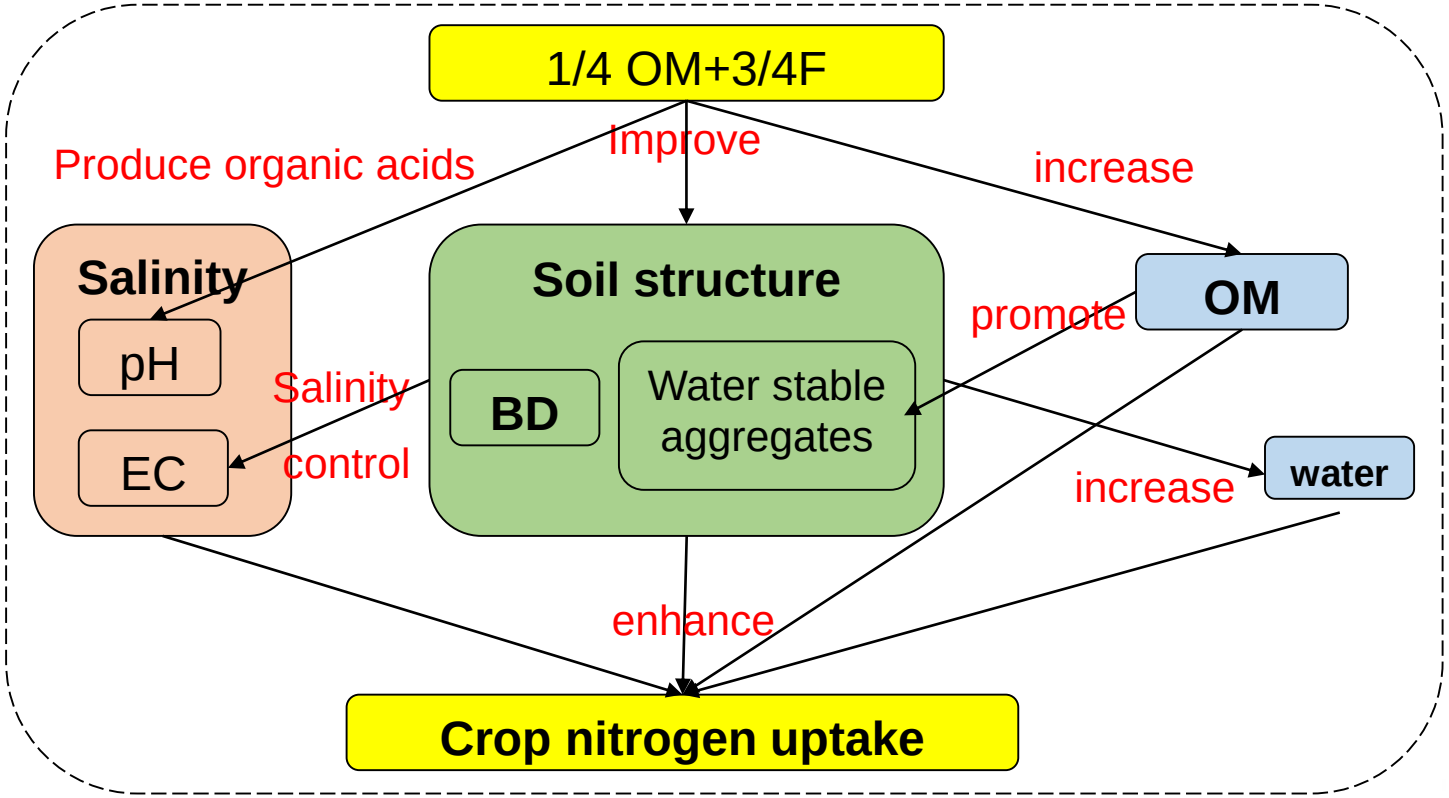
Treatments	Biomass (kg ha^{-1})		Nitrogen content (%)		N uptake (kg ha^{-1})		
	Grain	Straw	Grain	Straw	Grain	Straw	Total
EM	4194a	14640a	2.09ab	0.56a	76.12	82.38	158.5a
FA	4189a	13645a	2.02b	0.56a	73.55	75.94	149.5a
BC	4340a	14494a	2.23a	0.58a	84.33	84.41	168.7a
SG	4136a	15198a	2.08ab	0.57a	75.00	85.91	160.9a
CK	4148a	13688a	2.18ab	0.57a	78.72	77.72	156.4a
CK0	638.8b	2361b	1.91b	0.48b	10.63	11.23	21.86b

Effects of different treatments on nitrogen utilization efficiency

Treatments	N harvest index (%)	N recovery efficiency (%)	N agronomy efficiency (kg·kg^{-1})	N partial factor productivity (kg·kg^{-1})
EM	48.03	60.73	15.80	18.64
FA	49.20	56.72	15.78	18.62
BC	49.97	65.28	16.45	19.29
SG	46.61	61.80	15.54	18.38
CK	50.32	59.82	15.59	18.43
CK0	48.63			

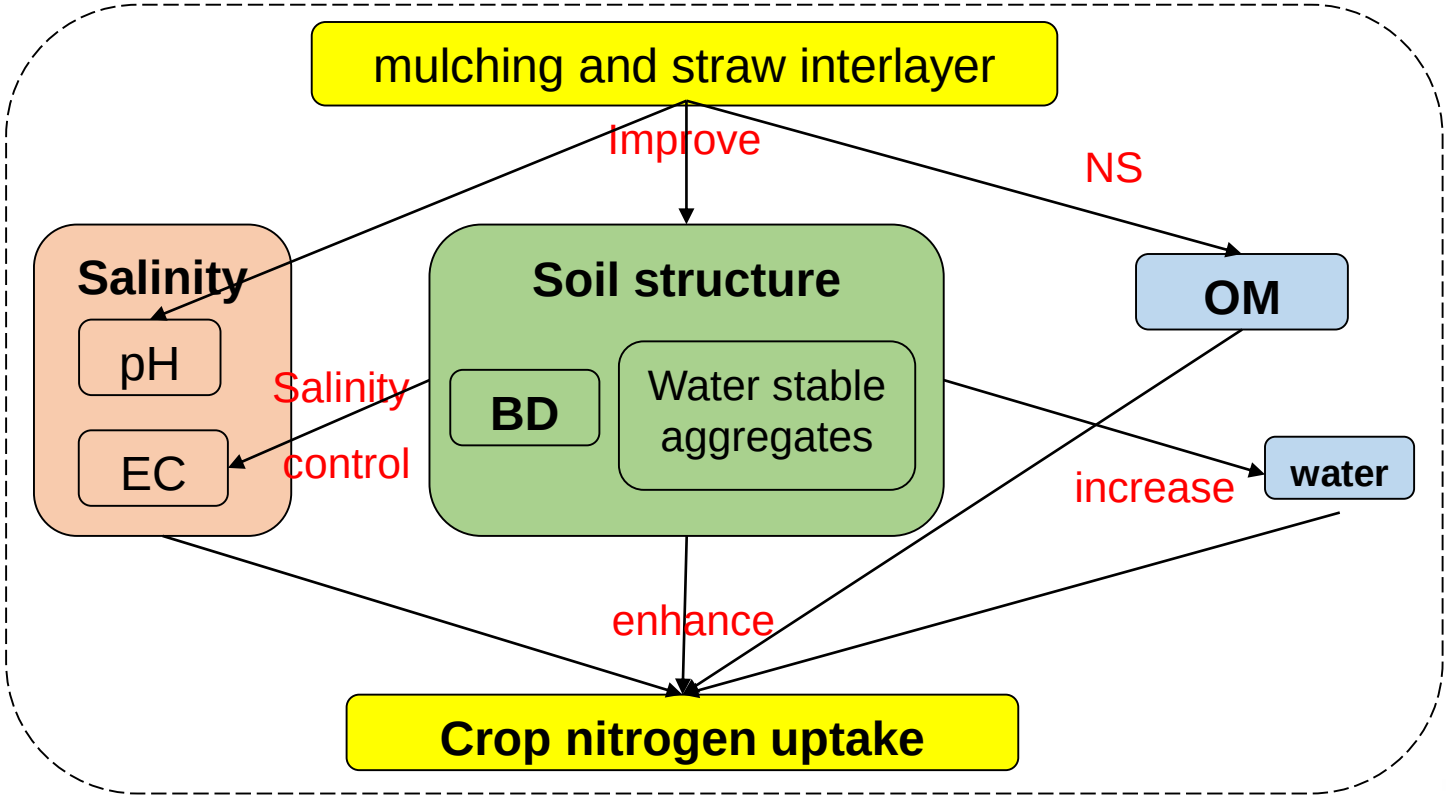
- Plant N uptake and N agronomic efficiency of biochar application were the highest

Discussion: 1. organic-inorganic fertilizers application on control of salinity and nutrient loss



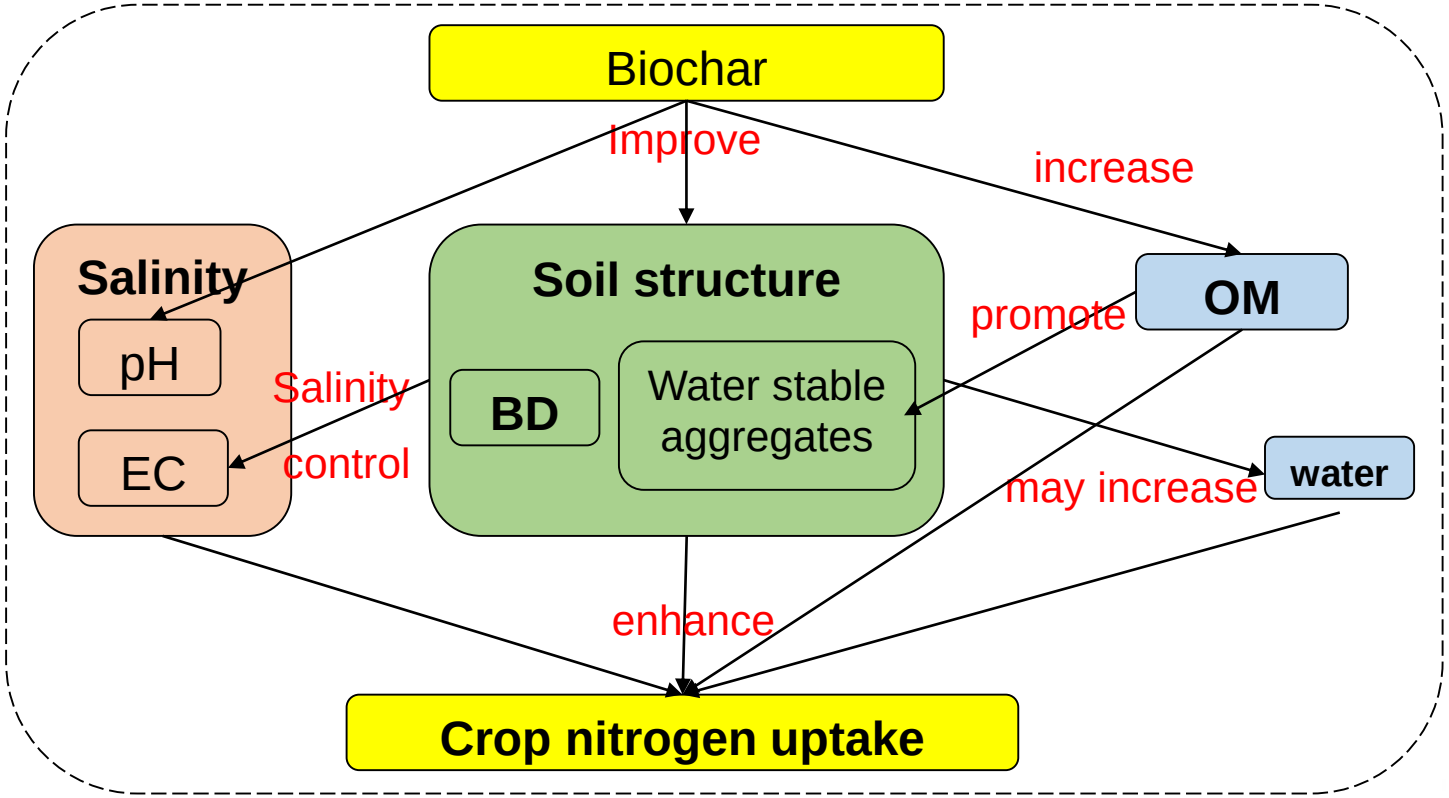
- Organic fertilizer can reduce soil salinity by improving soil structure, promoting salt discharge and reducing salt surface accumulation, and reducing soil pH by organic acid produced with OM decomposition.
- Appropriate organic-inorganic fertilizer ratio has better effect on balanced nutrient supply, so as to promoted crop growth and improve nitrogen use efficiency.

Discussion: 2. mulching and straw interlayer on control of salinity and nutrient loss



- Film mulching straw interlayer (FM + SB) can enhance salt leaching and improve soil water content and porosity, so that promote crop yield and improve nitrogen use efficiency by regulating soil water and salt transport and improving soil structure.

Discussion: 3. modifiers application on control of salinity and nutrient loss



- Biochar (BC) has the best effect on reducing salinity obstacle, promoting crop growth and improving nitrogen use efficiency, mainly through improving soil structure and increasing soil organic matter content.

Conclusion

- Organic fertilizer can effectively reduce salinity obstacles by improving the soil structure, water holding capacity and fertility level. However, higher organic fertilizer ratio can not provide sufficient nitrogen supply. OM 1/4 treatment had the best effect on better nitrogen use efficiency.
- Mulching and straw interlayer had good effects on salt reduction and yield increase. Performance of film mulching together with straw interlayer was the best, which mainly promoted crop yield and improved nitrogen use efficiency by reducing salinity, improving soil structure and increasing soil water content.
- Different modifiers have various effects on reducing salinity, alkalinity and increasing organic matter content. Biochar application more effectively reduced soil salinity, increased soil organic matter content and improved soil structure, so as to promote crop growth and improve nitrogen utilization efficiency.

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Virtual meeting

Thank you!

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