Effect of salinity water irrigation on maize growth in northwest region

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ABSTRACT

Because of the scarcity of water resources and serious environment, it becomes much more emergence to develop the water saving agriculture. Drip irrigation and straw mulch both at home and abroad were wide studied. However, How to utilize saline water reasonably, scientificly, efficiently and safely has always been a core problem in farmland irrigation using saline water. Based on the relative research about salinity water irrigation, this paper studied on the effect of different salinity water irrigation and soil salt contents on maize growth in a plastic bucket experiment in Yonggu village, Ningxia shizuishan city of Ningxia located in Yellow River Irrigation district. The main results are as follows, showed that the salinity water had much greater effect on maize emergence rate than that of soil initial salt content. With the increase of irrigation water salinity and soil initial salt content, the maize height all decreased. Under the same soil saline content, the mineralization of water had much greater effect on maize emergence rate than that of soil initial salt content, moreover, with the increase of saline content, the difference become more obviously. Though the salinity water can reduce the production of maize, it is still be helpful to the growth of maize comparing to no irrigation.

Keywords: salinity water irrigation, emergence rate, emergence time, height of the maize, production
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INTRODUCTION

Soil salinization and soil water pollution were great concerned with fast development in northwest part of China. However, due to the shortage of freshwater resources and industry competition, the demand of agricultural production on poor quality water, such as mineralization water increased greatly [1-3].

However, the salinity water contains some salt and it will increase the salt content in the soil when the mineralization water was used for irrigation. When the salt content was much lower, the salt can be absorbed by plants, promoting the growth of crops, thus play an positive role; but when accumulated salt content exceeds a certain level, crop growth is inhibited, causing crops wither, and even death, declining output [4-8]. Therefore, when we use mineralizaiton water for irrigation, inevitably causes increased salt content in the soil, increased as the irrigation time, salinity of irrigation water will gradually accumulate in the soil, which can lead to salinization of soil, thus having an impact on crop growth. Therefore, in order to save scarce freshwater resources and to use the mineralizaiton water properly, the effect of the mineralizaiton water could not be ignored. As a result, the different salinity of irrigation water on maize was studied in this paper.

EXPERIMENTAL SECTION

Experiment site: The experiments were carried out in Yonggu village, Ningxia shizuishan city located in Yellow River Irrigation district, of which East longitude is between 106 ° ~107 °, and the latitude is between 38 °~40 °. To the East of the experiment site, it was Pro yellow, while for the West, it was Helan Mountain. The climate here

belongs to temperate continental, and it is very drought and rain little, but the evaporation is extremely strongly and the annual evaporation for one year is about 10.3 times of the precipitation. Though the groundwater is rich, of which the salinity is less than 3.5 g/l, but due to the great evaporation, the salinity in the soil was quite high. As a result, it has been a long time to flooding the salt in the experimental area with Yellow River water. The typical crop was maize.

Methods: The crop used in this experiment was maize. In order to reduce the effect of environment factor, the experiments were carried out in the plastic buckets, of which the diameter above is 50 cm, the basin diameter is 40 cm down, the height is 60 cm, and there were 10 drainage holes at the bottom. The soils were sampled from surface 20 cm thick soil of the farmland in the xiyonggu village, and then dried to a 2 mm sieve. In each plastic bucket the total weight was 30 kg. The urea fertilizer and compound organic fertilizer were the same to that in the field 450 400 kg/hm^2 kg/hm^2. Before planting the soil moisture was at about 80% field capacity. After all the plastic buckets were packed well with soil and then were left outside under the rain canopy. The experiments take about 6 month, from May 2010 to November 2011.

In order to determine the salt tolerance of the maize, irrigation water with 4 mineralization and 4 soil salt contents were supplied (Table.1). Each treatment got 6 replications.

In this paper, the effect of mineralization on crop emergence rate, emergence time, as well as the crop height was studied.

The seed emergence rate and emergence time could be calculated as follows,

$$\eta = \frac{N_s}{N} \tag{1}$$

$$T = \frac{\sum_{i=1}^{n} G_i t_i}{\sum_{i=1}^{n} G_i} \tag{2}$$

Where, η is the emergence rate；

N_s the emergence number；

N the number of the seeds；

T emergence time；

G_i the emergence number in each day；

t_i——the days that has Gi seed emerged, day；

n——the days after emergence,day。

Table 1 Experimental scheme

	Treatments	salinity 1	salinity 2	salinity 3	salinity 4	Soil salt 1	Soil salt 2	Soil salt 3
Maize	Irrigation water salinity g/L	0.1	4	6	8	0.3	0.3	0.3
	Soil salt content g/kg	0.8	0.8	0.8	0.8	1.75	2.25	2.75

RESULTS AND DISCUSSION

Effect of irrigation water salinity and soil salt content on maize emergence rate and time
Based on the experiment results, the measured rate of maize emergence and emergence time varies with irrigation water salinity, as well as changes in soil salt content were shown in Fig.1. Moreover, the significantly analysis of different irrigation water salinity and soil salt on maize emergence and time were also analyzed (Table 2). From Fig1 it could be found that the maize emergence rate decreased but the emergence time increased when the irrigation water salinity was much larger; however, when the soil initial salt contents were much lower, the effect was not so obviously. In Fig.1, when the irrigation water salinity reached at treatment 3 or 4, the emergence rate began significantly reduced, emergence time increased.
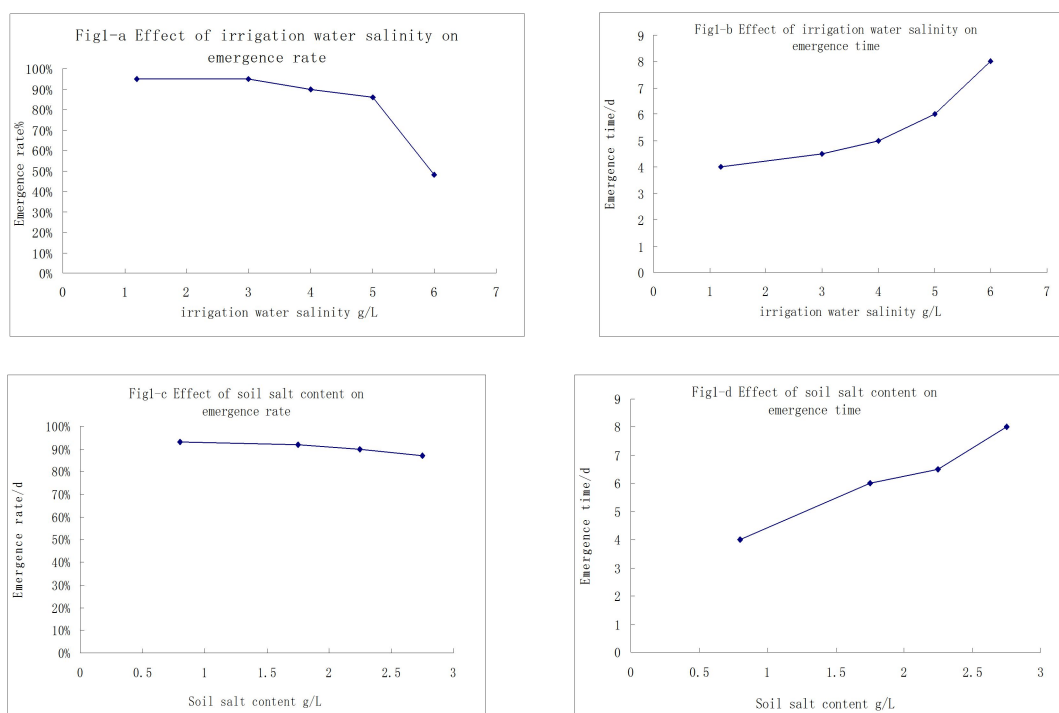
Fig.1 Effect of irrigation water's salinity and initial salt content on corn's emerging rate and time

From Fig.1, it could also be found that soil initial salt content has little effect on maize emergence rate and time when the salt content was much lower. However, variance became obviously with the increase of the irrigation water salinity and soil salt content. The irrigation water salinity has much more effect on maize emergence time comparing to that of soil salt content. Therefore, the appropriate irrigation water salinity must be considered when the salinity water was used for irrigation, so that it will have smaller effect on crop emergence rate and emergence time.

In order to analyze the effect of irrigation salinity and soil salt content, Significance analysis were also done (Table 2). From table 2, it could be found that Each treatment has reached significant levels in 5%, and on the same level, and the effects of irrigation water salinity is greater than that the initial soil salt content for maize emergence.

Table 2 Effect of different irrigation water's salinity and soil's initial salt content on maize's emerging situation

	treatment	Treatment1	Treatment2	Treatment3	Treatment4
Emergence rate	Irrigation water salinity	95.4a	94.2aA	79.2bB	24.5cB
	Soil salt content		97.1aA	94.1aA	79.12bA
Emergence time	Irrigation water salinity	4.65a	5.12bA	7.01cB	6.80dB
	Soil salt content		5.03bA	5.97cA	5.61dA

Note：lowercase letter means 0.01 level significant；Capital letter means 0.05 level significant

Effect of irrigation water salinity and soil salt content on maize growth
Effect of irrigation water salinity and soil salt content on maize height during seeding stage

Plant height is an effective indicator during seedling growth period, so the effect of irrigation water salinity and soil salt content on plant height of maize were studied and shown in Fig2. Fig.2 shows that the different salinity levels of irrigation water and different soil salt content have great effects on maize height. When the irrigation water salinity and soil salt content increased, the maize height show a diminishing trend; Moreover, the height of the maize with salinity water irrigation was much lower comparing to that in the soil containing salt and the difference became much more obviously with the increase of salt content. This may due to the presence of eelgrass. initial salinity of irrigation water and soil salinity on crop germination time had a certain impact, making it highly salt processed, low salt levels in control seedlings grow weaker and the growing season short, resulting in crop plant height is relatively low [9-11].
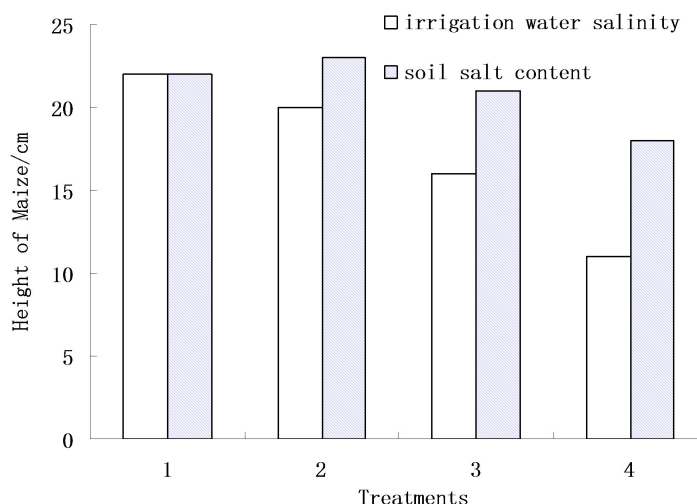
Fig.2 Effect of different irrigation water's salinity and soil's initial salt content on maize height during seeding period

In order to analyze the influence of soil salt content on growth of maize, the soil salt content at seeding period was measured in each plastic plot and the results were shown in Figure 3.From Fig.3, it could be found that soil salt content has a great effect on plant height. As soil salt content increased, plant height of maize showed a decreasing trend. Relationship between plant height of maize and soil salt content fitting linear relationships, painted in Fig.3, which indicated that plant height of maize and soil salt content linearly has a negative correlation.

And the fitting formula was shown as follows,

$$\eta = -aCS + b, \qquad\qquad\qquad\qquad (3)$$

where, a shows sensitive of the crop growth of seedlings to soil salt concentrations.
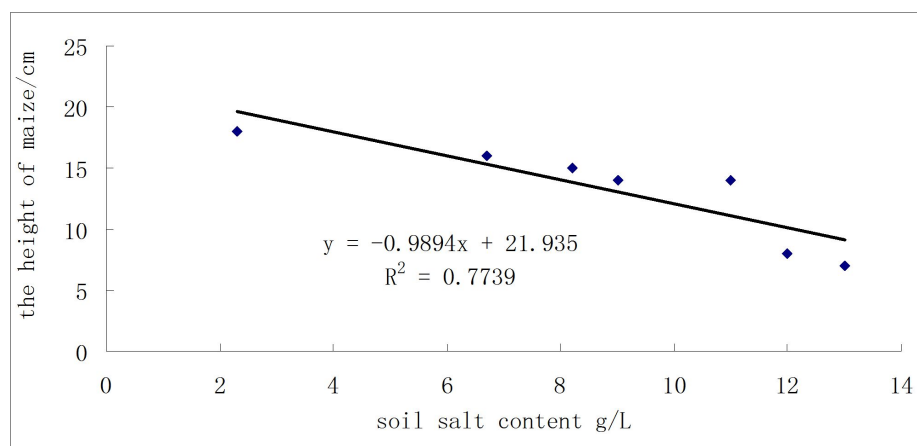

Fig.3 Effect of soil salt content on the height of maize during seeding period

Effect of irrigation water salinity and salt content on height of maize during heading stage

According to the measured results, the plant height and stem diameter of maize under different treatments were shown in Table 3. From table 3, it can be seen that the treatment with 0.1 g/l irrigation water salinity demonstrate the largest height and the diameter of maize, while in the CK treatment, plant height and stem diameter was the smallest. The height and diameter of the maize became much smaller with the increase of irrigation water salinity which indicated that even salinity water for irrigation, compared to no irrigation water of CK treatment, could promote the increase of]maize growth.

Table 3 Effect of irrigation water's salinity on maize's height and stem diameter during heading stage

Irrigation salinity (g/L)	treatment					
	CK	fresh water	0.1	4	6	8
height/cm	105.2d	123.2ab	156.3a	139.4a	129.4b	120.8c
stem diameter/cm	1,74d	2.45a	2.52a	2.34a	2.20b	2.14c

In order to study on the effect of irrigation water salinity and soil salt content, the crop growth model of Overman(1984) was used, which was showed as follows,

$$Y = \frac{A}{2}\left[1 + erf\left(\frac{t-\mu}{\sqrt{2}\sigma}\right)\right]$$
（4）

Where,

Y is the amount of dry matter,kg/hm^2；

A is the largest amount of dry matter,kg/hm^2；

t is the time,the week since Jan 1st, wk；

μ, σ are the Quality based on time allocation,wk；

erf ——Error function, $erf(x) = \frac{2}{\sqrt{\pi}}\int_0^x \exp\left(-u^2\right)du$ 。

Thus the formula could be written as,

$$H = \frac{H_0}{2}\left[1 + erf\left(\frac{t-\mu}{\sqrt{2}\sigma}\right)\right]$$
（5）

Where,

H is the height of the maize,cm；

H_0 is the largest height of the maize,cm；

t is the days after seeding,d；

μ, σ are the Quality based on time allocation,d；

erf Error function

Based the model above, the experimental data were fitted, and the parameters were shown in Table 4.

Table 4   Fitting result of changes of maize's height with time after saline water irrigation

Irrigation water salinity (g/L)	2011			
	H_0	μ	σ	R^2
CK	130.36	36.57	8.23	0.998
fresh water	146.98	33.65	10.12	0.990
0.1	154.79	35.43	10.23	0.995
4	145.08	36.32	11.75	0.978
6	146.55	35.32	9.88	0.995
8	123.76	35.12	10.47	0.998

Effect of irrigation water salinity on maize'production

Table 5 shows the effect of irrigation water salinity on maize production.From table 5, it could be found that the plant height and diameter under fresh water irrigation of corn are the largest, and CK are the smallest. Seed maturity, plant height and stem diameter of corn increases with the salinity of irrigation water decreased. Based on the significant analysis showed that the corn plant height, stem diameter between values show little differences, but for CK treatment, stem diameter value is significantly lower than that of other treatment.

Table5 Effect of irrigation water's salinity on maize's height and stem diameter

Irrigation water salinity （g/L）	CK	fresh water	0.1	4	6	8
height/cm	141.4	144.5	143.5	143.1	143.1	142.4
stem diameter/cm	2.36b	2.58a	2.57a	2.55a	2.56a	2.50a

Based on experiment result , the effect of irrigation water salinity on maize's production were shown in 4 g/L, 6 g/L, 8 g/L varied greatly comparing to the CK. Moreover, when the irrigation water salinity was larger that 4g/L, the production will be influenced which will become much more obviously if the water salinity was much higher. But comparing to no irrigation, the salinity water irrigation was still helpful for the growth of maize [12-14].

Table 6 Effect of irrigation water's salinity on corn's yield formation factor and yield during flowering stage

Irrigation water salinty（g/L）	CK	Fresh water	0.1	4	6	8
（g）	345a	412a	409a	381a	366a	340a
Grain weight（g）	957b	1157a	1149a	1151a	1145a	1143a
production（t/hm²）	14.27c	15.89a	15.67a	14.98a	14.76a	14.43b

CONCLUSION

In this paper, the effect of salinity water irrigation on maize' emergence, height and stem diameter, as well as the production were studied. The results show that the salinity water had much greater effect on maize emergence rate than that of soil initial salt content. With the increase of irrigation water salinity and soil initial salt content, the maize height all decreased. Under the same soil saline content, the mineralization of water had much greater effect on maize emergence rate than that of soil initial salt content, moreover, with the increase of saline content, the difference become more obviously. Though the salinity water can reduce the production of maize, it is still be helpful to the growth of maize comparing to no irrigation.

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