The 9th International Oat Conference, Beijing, China

Research progress of oat tolerance to salt in Inner Mongolia

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June 22, 2012

Working Group

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Visions of oat cultivation for desertification control in China

- 38 million ha dryland in China
- 67 million ha grassland under degradation
- 613 million ha sand land in China
- 33 million ha saline and Alkali land in China

All of these land types adapt to oat cultivation.

Ecological adaptation of oat in different areas of Inner Mongolia

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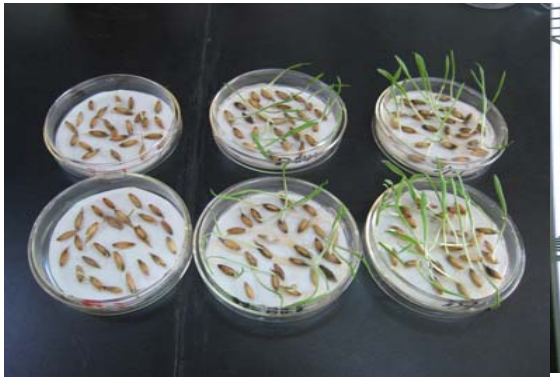
1. Effects of salt and Alkali on oat germination and seedlings

36 varieties → Salt tolerance varieties
Medium Salt tolerance varieties
Salt sensitive varieties

Salt tolerance evaluation standard →
0.4% can improve germination rate
0.8% is the ceiling of germination
2.0% is the ceiling of seedlings



1. Effects of salt and Alkali on oat germination and seedlings

- 0.2% can improve germination rate
- 0.8% is the ceiling of growth and development;
- 1.0% is the ceiling of germination

2. Yield of oat under salt and alkali stresses

Experiment design

Salt stress gradients:0%, 0.2%, 0.4%,0.6%,0.8%,1.0%

Salt solutions: NaCl：Na_2SO_4 =2：1, 2006

NaCl：Na_2SO_4 =1：1, 2007

Oat varieties: No.1 Neinongdayou

Trial in 2007

Trial in 2006

Tab.1 Yield of oat under salt stresses

Salt contents (%)	Yield (g/plot)		Decrease (%)	
	2006	2007	2006	2007
0.0(CK)	11.73aA	12.86aA	0	0
0.2	10.88aA	12.94aA	7.25	-0.67
0.4	9.81bB	8.91bB	16.3	24.87
0.6	6.37cC	4.08cC	45.6	65.6
0.8	4.11dD	0.32cD	64.9	97.3
1.0	3.31eD	0.03cE	71.8	99.75

Note:The date with the different small letters show significant differences($P<0.05$),and with the different capital letters show high sig- nificant differences($P<0.01$) in same column。

2. Yield of oat under salt and alkali stresses

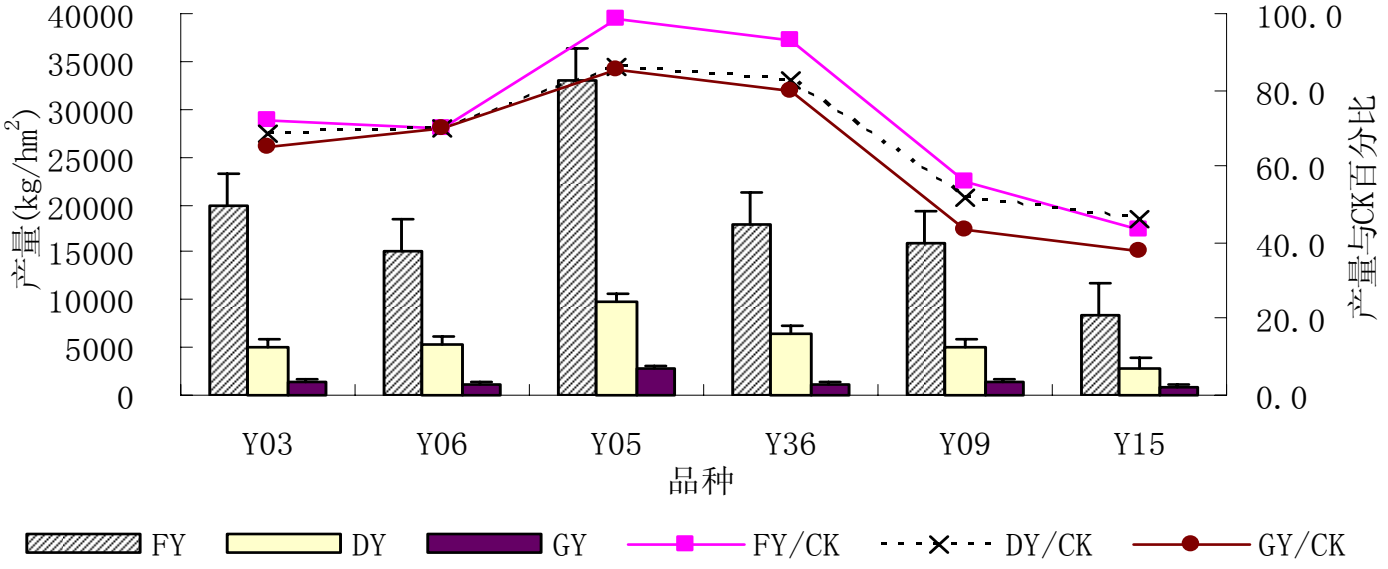
•Effect of emergence

•Emerging time of oat was delayed with the rising of salt content;

•0.8% salt content emerged lately 10 days than CK

2. Yield of oat under salt and alkali stresses

Yield of different oat varieties under lower salt contents



In lower salt stresses, fresh yield, dry yield and grain yield of different oat varieties have significant difference. Yield of salt sensitive varieties drop by 50% in 0.3% salt content.

3. Effects of nutrients and cultivation methods on salt and alkali accumulation

Tab.9 Nutrient factors design (g/pot)

Treatments	N	P	$CaSO_4.2H_2O$
T1	0	0	0
T2	1	0.65	0
T3	1	0.65	10
T4	2	0.65	0
T5	2	0.65	10
T6	1	1.30	0
T7	1	1.30	10
T8	2	1.30	0
T9	2	1.30	10
T10	0	0	0

3. Effects of nutrients and cultivation methods on salt and alkali accumulation and oat yield

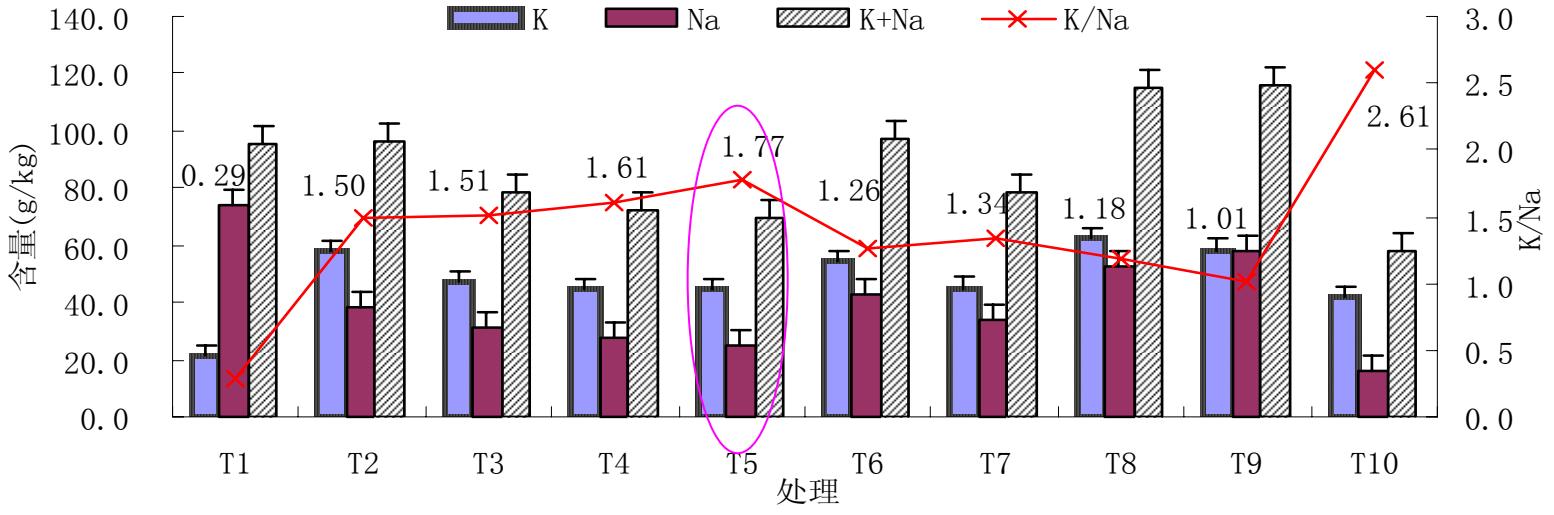


Fig.2 K^+ and Na^+ contents in leaves and stems in different nutrients

T5 is the most ideal treatment for salt control and yield increasing, yield increased by 47.8%～84.8%。

3. Effects of nutrients and cultivation methods on salt and alkali accumulation and oat yield

- Cultivation trials: two tillage methods are zero-till and convention till; The tillage depth treatments are 3㎝, 5㎝,7㎝ and 9cm.

- Germination rate of 5cm depth is the highest.

- Yield of 7cm depth with conventional till increased by 43.1%～64.1%.

3 cm

5 cm

7 cm

9 cm

4. Saline tolerance of different crops

Comparison of saline tolerances among different crops

Tab. 1 Concentration of different soil ions in the field

Ions	$1/2Ca^{2+}$	$1/2Mg^{2+}$	$K^{+}+Na^{+}$	HCO_3^{-}	$1/2SO_4^{2-}$	Cl^{-}	$1/2Co_3^{2-}$
cmol/kg	1.18	0.82	4.8	0.49	3.56	2.75	0

Tab. 2 Yield of different crops in Saline-alkaline soil

Crops	Dry matter weight		Yield	
	(kg/hm^2)	(crop/CK%)	(kg/hm^2)	(crop/CK%)
Millet	6382.7	66.0	540.0	78.5
Oat	5381.7	44.3	492.6	42.2
Wheat	1184.3	8.5	261.1	7.6
alfalfa	5239.0	40.2	-	-

*Note: CK was the yield of different crops on loamy soil

Saline-alkaline tolerance of Millet, Oat and Alfalfa are much higher than that of Wheat.

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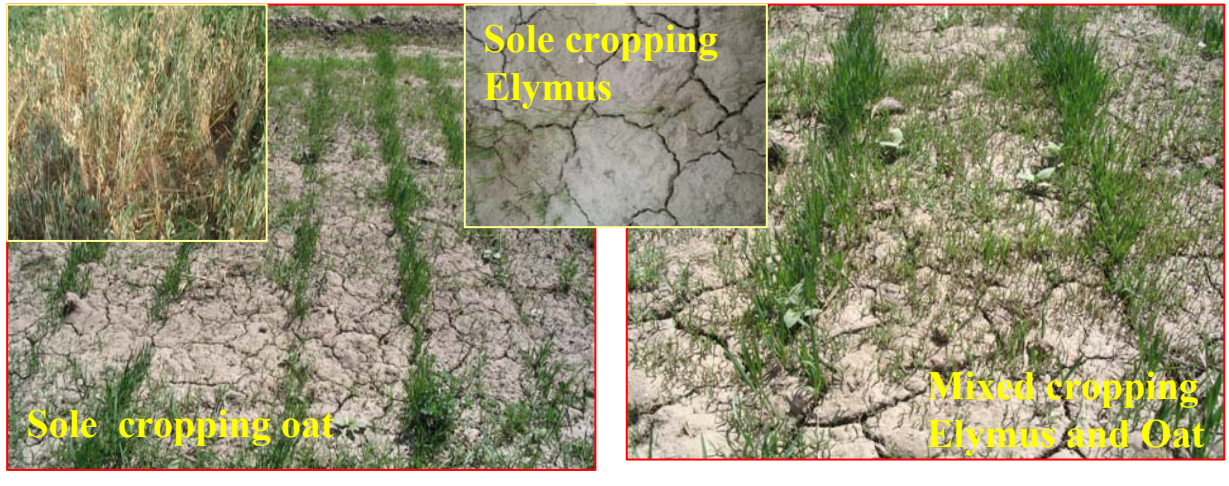
5. Mixed cropping of oat and grass

Alfafa and Elymus were difficult to get out in saline soil.

Oat seeds are big and with strong germinate ability.

So mixing oat with alfalfa or Elymus, the germination ratio increased significantly.

emergency



Another experimental site in 2008

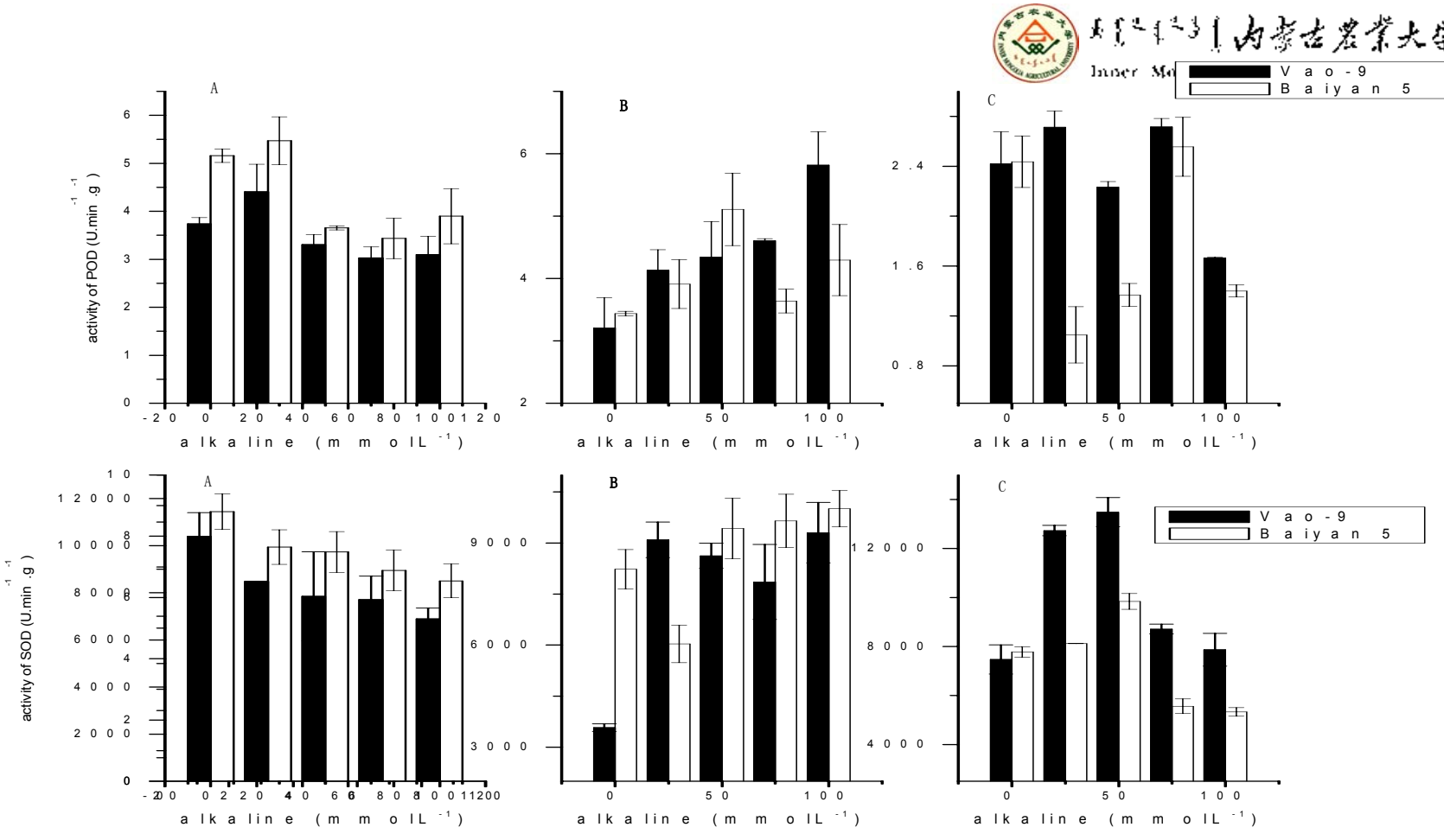
6. Mixed cropping of oat and grass

Tab.6 Yield of different mixed cropping treatments

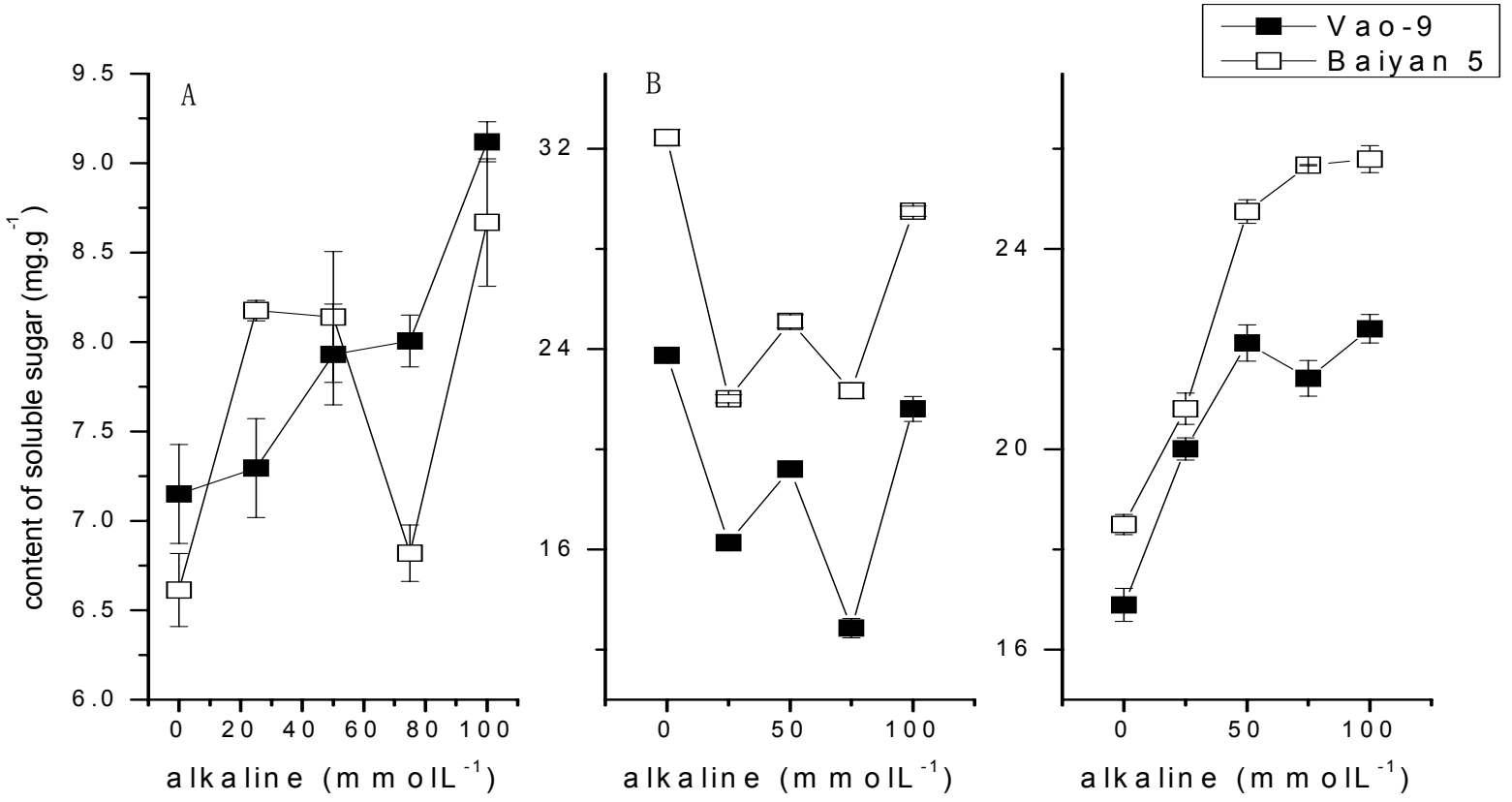
Treatment	Fresh weight (kg/hm^2)	Dry weight (kg/hm^2)
Mixed cropping with oat and alfalfa	14587aA	4976aA
Sole cropping oat	14205bB	4946aA
Mixed cropping with oat and Elymus	12418cC	4183bB
alfalfa	almost 0dD	almost 0dD
Elymus	almost 0dD	almost 0dD

Yield of mixed cropping with oat and alfalfa were significantly higher than that of mixed cropping with oat and Elymus. There were no yield with sole cropping alfalfa and Elymus.

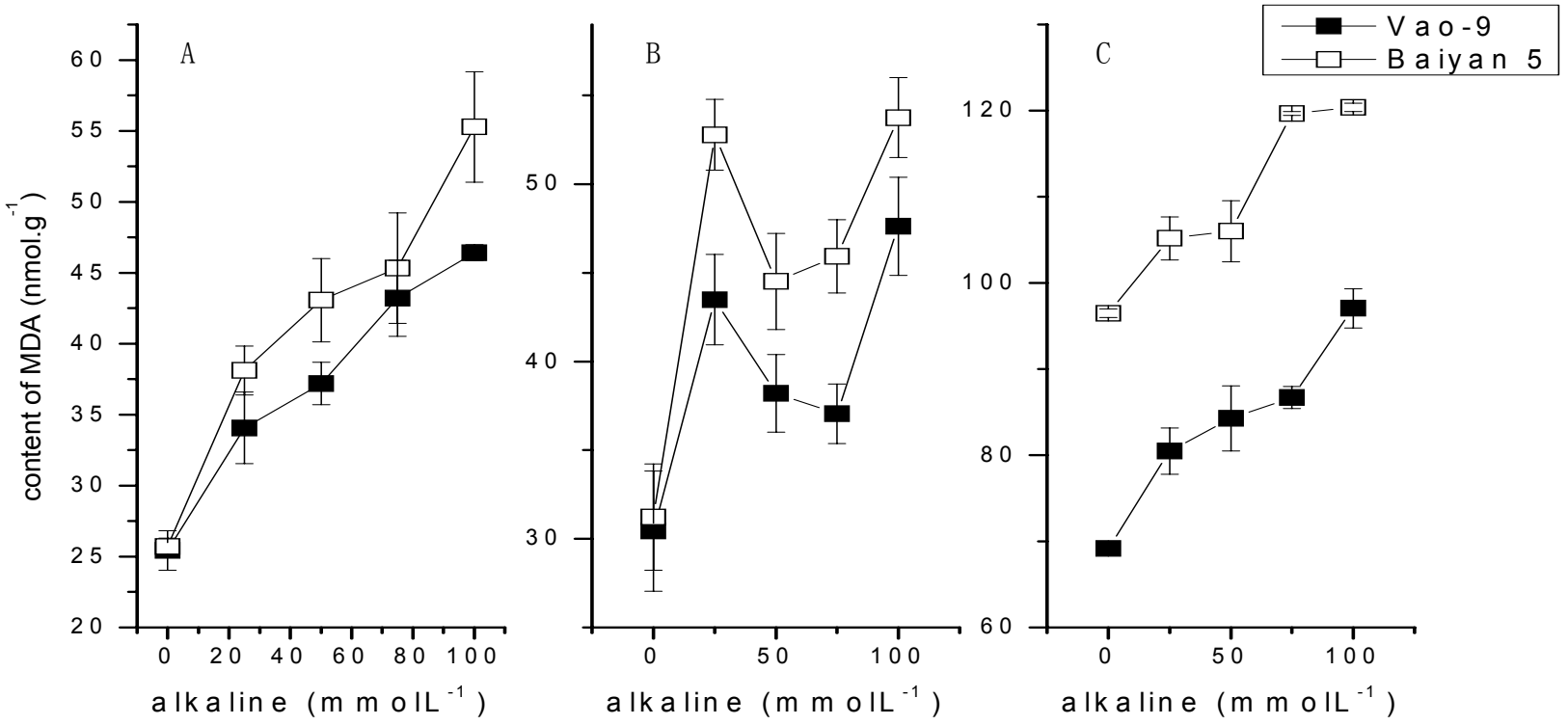
6. Physiological indexes in alkali stress



SOD and POD activity decreased at jointing stage and increased at heading stages for both cultivars.



Soluble sugar contents were increased at jointing, grain filling stage, the soluble sugar contents in alkali-tolerant cultivar (Vao-9) were lower than in sensitive-cultivar (Baiyan 5) .

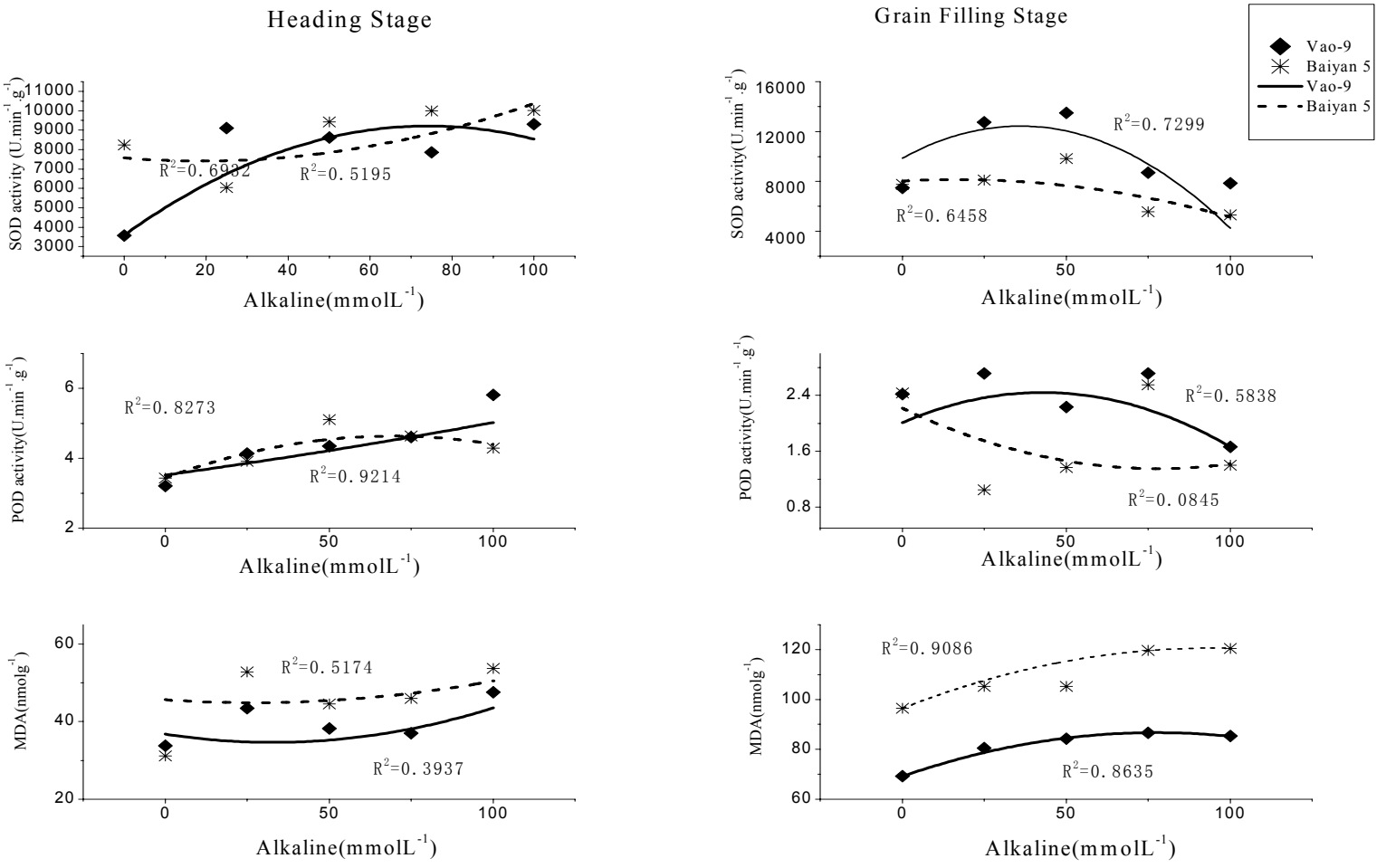


Under alkali stress, the MDA contents in two cultivars increased under alkali stress at jointing, heading and grain filling stages.

Alkali stress reduced yield significantly except for that Vao-9 in 25 mmolL^{-1} treatment. In 25, 50, 75 100mmolL^{-1} alkali treatment, the yield reduction of Vao-9 were 3.50%, 35.60%, 47.54%, 51.20%, while yield decrease of Baiyan 5 were 11.27%, 38.29%, 48.72%, 60.97%, respectively.

Table 1 Effect of alkali stress on yield and components with pot experiment

Treatment	Grain weight (g)		Grain number per spike		Effective panicles		Yield(g)	
	Vao-9	Baiyan 5	Vao-9	Baiyan 5	Vao-9	Baiyan 5	Vao-9	Baiyan 5
CK	1.99A	1.96A	6.11C	3.88B	5.80A	4.38A	11.87BA	11.21A
J25	1.93A	1.75B	6.80B	4.16B	6.90A	4.60A	11.78B	9.95B
J50	1.89BA	1.66B	8.86A	4.87A	7.20A	5.00A	7.86C	8.56C
J75	1.72B	1.43C	6.00C	3.16C	5.10A	5.03A	6.40D	7.94D
J100	1.48C	1.25C	3.53D	3.31C	6.00A	4.88A	5.96E	4.38E



•The fitting degree of regression alkaline and SOD, POD activities in Vao-9 was higher than in Baiyan 5. The fitting degree of regression alkaline and MDA in Vao-9 was lower than in Baiyan 5.

Conclusion

1. Oat is a kind of crop with salt tolerance and the critical concentration of saline-alkaline tolerance is 1.0%.
2. The threshold salt concentration of achieving higher yield is 0.4% and the yield will reduce by 50% when salt concentration is over 0.6%.
3. Oat has a good appearance of growing when sow them in the depth of 7cm in saline-alkaline soil.
4. Mixed cropping cultivation with oat and grass will significantly increase the emerging ratio of grass.
5. Soluble sugar, MDA, SOD, POD can be used for discriminating oats for their potential to tolerate alkali.

Acknowledgements

Above research works are supported by：

- Ministry of Agriculture, China
- Ministry of Science and Technology, China
- National Natural Science Foundation of China
- Science and Technology Department of Inner Mongolia
- National Natural Science and Foundation of Inner Mongolia

Thanks!