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Response of CIMMYT Spring Wheat Lines to Saline-Alkali Stress

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Abstract: In order to explore the physiological and biochemical mechanism of different wheat varieties with salt tolerance and alkali tolerance under salt and alkali stress, 150 mmoL Ł-1 NaCl and 100 mmoL Ł-1 NaHCO3/Na2CO3(molar ratio 1:1) were used to simulate salt and alkali stress conditions respectively. The growth of wheat in soil was simulated in an artificial climate chamber with temperature 25℃, illumination 16 hours, temperature 22℃ and dark treatment 8 hours. The salt-alkali tolerance of 121 wheat seeds was tested, and the characteristics of salt-alkali tolerance of wheat germplasm resources were analyzed based on 11 traits. The results showed that under salt and alkali stress, 11 index values were significantly different among 121 wheat germplasm resources. Under NaCl stress, the germination rate and germination potential of wheat were lower than that without NaCl stress, and lower under alkali stress. The changes of embryo length, fresh weight and dry weight of embryo were relatively large under alkali stress, the preliminary analysis showed that alkali stress had more effect on the growth and development of wheat than salt stress. Among them all kinds of numerical value assume function relation. There were differences in the correlations among the traits under saline-alkali stress. Select the data relatively complete, there are differences in correlation, the coefficient of variation is relatively large groups of data for analysis.

1. Introduction

Saline-alkali stress is one of the most important abiotic stresses for plants. Soil salinization harms 20% of the global arable land, and is expected to reach a peak of 50% in 2025, which has an important impact on plant physiological activities. Generally speaking, the germination potential and germination rate of seeds show a downward trend under saline-alkali stress. Even if the germination is successful, the agronomic traits of seedlings and adult plants cannot reach the best or even qualified. For example, the radicle and plumule length of seeds will decrease under stress. Saline-alkali stress makes plant growth slowdown, biomass and organic matter accumulation decrease, and for crops, 1000-grain weight and seed setting rate may decrease, yield may below, or even no yield.

Saline-alkaline soil in China is mainly distributed in the northwest, north, northeast and some coastal areas of China [3][4].Tianjin is located in the north of the North China Plain, with the Bohai Sea in the east and the Yanshan Mountains in the north. The vast saline-alkali land in Tianjin has become a key issue limiting agricultural production in the region. Exploring how to use, improve and prevent these saline-alkali lands scientifically plays an important role in the economic development of Tianjin.

Seed germination is the initial stage of plant growth, but also a sensitive period to stress, so the identification of stress tolerance in seed germination is a better time to study the mechanism of abiotic stress [1][2].It is of great significance to screen excellent saline-alkali tolerant wheat germplasm and improve the saline-alkali tolerance of local wheat varieties for the development and utilization of vast medium and low yield fields.

Saline-alkaline soil in China is mainly distributed in the northwest, north, northeast and some coastal areas of China [3,4].China is the country with the largest area and total output of protected cultivation in the world, but due to the immature technology and the destruction of human factors, the problems of protected soil are becoming more and more obvious [5].The red line of China's arable land area is 1.8 billion mu, but these arable land are not all high-yielding areas, some are not suitable for planting crops at all, even if planted, the yield will not be very good, it is very likely that the yield is very low, or even no harvest. Therefore, it is of great significance for our food production and life to select high-quality varieties with strong resistance and high yield. In order to utilize the cultivated land area of our country rationally and effectively, improve crop yield and create greater economic value, it is urgent to study and screen saline-alkali resistant germplasm resources.

Saline-alkali tolerance of crops refers to the tolerance of crops to soil salinity, also known as the salt tolerance limit. Saline-alkali stress has a great impact on plant growth, mainly manifested as ion toxicity, osmotic stress and so on, which will lead to changes in plant gene expression and affect plant growth. Therefore, strengthening the tolerance of plants to saline-alkali and reducing the sensitivity to saline-alkali can better improve the growth quality of plants[6][7].The germination rate of plant seeds is low under saline-alkali stress, so it takes a long time to screen out saline-alkali resistant wheat varieties adapted to saline-alkali soil, which is of great significance to the transformation of saline-alkaline soil, the development of surrounding economy and the improvement of grain yield.

This experiment is to screen the germplasm of saline-alkali tolerance in wheat. In this experiment, germinating paper and artificial climate chamber were used to simulate the environment of two different concentrations of saline-alkali solution selected by pre-test, in which water was set as the blank control. The saline-alkali tolerant plant seeds are screened under the second condition.

2. Materials and Methods

2.1. Research Materials

121 CIMMYT spring wheat advanced lines.

2.2. Test Method

2.2.1 Selection of Suitable Salinity and Alkalinity

Six kinds of plant seeds were randomly selected for the preliminary experiment, and the NaCl concentration was set as 50,100,150,200 and 250 mmol ·L-1, and the mixed solution of NaHCO3 and Na2CO3 (molar ratio was 1:1) was used as the alkali stress. Concentration gradients of 50, 100, 150, 200, 250 mmol ·L-1 were set.Water was used as the blank control, and the germination paper was selected for the preliminary test. Oaking the germinating paper in different solutions, taking out the germinating paper, spreading the germinated paper on a disinfected and sterilized tray, averagely dividing the tray into six groups with 20 wheat seeds in each group, covering the tray with another piece of germination paper with the same solution, putting the germination paper into a fresh-keeping bag, setting the temperature in an artificial climate box at 25 deg C, carrying out illumination for 16 hours at the temperature of 22 deg C, carrying out dark treatment for 8 hours, measuring the germination potential after three days,it was found that there were significant differences between the stress group and the control group through the germination potential, but the lethality rate did not affect the concentration of each trait determined in the later period. The results showed that 150 mmol ·L-1 NaCl was the ideal concentration for screening the salt tolerance of wheat, and 100 mmol ·L-1 NaHCO3 and Na2CO3 mixed solution (molar ratio of 1:1) was the ideal concentration for screening the alkali tolerance of wheat.

2.2.2 Test Treatment

Seed pretreatment and salt and alkali stress experiments 121 wheat materials were treated with 150 mmoL ·L-1 NaCl to simulate salt stress and 100 mmoL ·L-1 NaHCO3 and Na2CO3 mixed solution (molar ratio of 1:1) to simulate alkali stress. Put the seeds into a 50mL centrifuge tube, pour 75% alcohol (enough to cover the seeds) and shake for 15 minutes for disinfection. After shaking, rinse with distilled water for 5 times. After air-drying, lay 2 layers of filter paper at the bottom, and add 10mL of stress treatment solution at one time. Then 5% sodium hypochlorite was used to disinfect and shake for 5 minutes, and finally distilled water was used to wash five times. The seeds were evenly placed on the germination paper with the selected salt solution and alkali solution with sterilized tweezers, the germination paper was divided into upper and lower parts, the upper and lower parts were more than one test material, each test treatment was repeated three times, each repetition was 20 seeds. In this study, the germinating paper soaked in the same solution was then covered, the germinating paper was rolled up, and put into the storage bag and the artificial climate box. In this study, the temperature of the artificial climate chamber was adjusted to 25℃, the light was 16 hours, the temperature was 22℃, the dark treatment was 8 hours, and the germination rate was measured on the third day and the seventh day.

2.3. Measured Data

The germination potential (GP) and germination rate (GR) were counted, and 5 seedlings were randomly selected from each treatment to measure the root length (RT) and bud length (GR).BL), coleoptile length (CL), root fresh weight (root fresh weight, RFW), root dry weight (root dry weight, RDW), shoot fresh weight (bud fresh weight, BFW), shoot dry weight (bud dry weight, BDW), seedling fresh weight (seedling fresh weight, SFW) and seedling dry weight (seedling dry weight, SDW).

Germination potential (GP) = number of germinated seeds in 3 days/number of tested seeds ×100%

Germination rate (GR) = number of germinated seeds in 7 days/number of tested seeds ×100%

Relative value = (control value-stress value)/control value

2.4. Data Processing

Coefficient of variation C ·V = (standard deviation SD/Mean) ×100%
Standard Deviation = sqrt ((x1-x) ^ 2 + (x2-x) ^ 2 +..(xn-x)^2)/n)

The tested traits of the tested materials were analyzed by the membership function value method. Because the data of this experiment were analyzed by the relative value, the smaller the membership function value was, the stronger the saline-alkali tolerance was.U(Xi)=(Xi-Xmin) /(Xmax -Xmin)i=1,2, 3,…In the formula, U (Xi) refers to the membership function value of the ith comprehensive index, Xi refers to the ith comprehensive index value, Xmax refers to the maximum value of the ith composite index, and Xmin refers to its minimum value.

Excel 2010 was used to sort out the test data, and SPSS19.0 for correlation analysis and factor analysis, and Rstudio for cluster analysis.

3. Results and Analysis

3.1. Preliminary Analysis of the Data Obtained From the Test

The overall germination rate of water is 25%, 21%, 22.9%, which is more than 20%, while the germination rate of salt is 14%, 11%, 14%, which is relatively stable, but the germination rate is not high and the germination situation is not as good as the control, but it is higher than that under alkali stress, because the germination situation of alkali is only 7.5%, 7.5%.7.0%, so the preliminary analysis showed that alkali stress had a greater impact on seed germination. According to the preliminary judgment of the overall situation, the growth of seeds under salt stress is better than that under alkali stress. Some seeds can not grow and germinate at all under salt and alkali stress. There are 77 groups that germinate under salt conditions and can measure salt, while there are only 45 groups of alkali. And generally according to the data analysis, in general, the resistance to alkali stress is good, the resistance to salt stress is good, but the resistance to salt stress is not necessarily resistant to alkali stress.The growth of radicle, plumule and coleoptile of seedlings under saline-alkali conditions was analyzed, and the length of plumule, coleoptile and radicle under alkali conditions was significantly lower than that of the control group, and lower than that under salt stress, which showed that the growth of seedlings under alkali stress was the worst.

The method for obtain that dry weight of the seedling is to weigh the whole seedling after dry, including the endosperm and the seed coat of the bud, the root and the seed, wherein the endosperm which is not completely absorb still accounts for a large proportion. The rate of absorption and transformation of endosperm in the control group was much higher than that in the stress group, and the endosperm was transformed into tender organs, which lost more water after air-drying, and the dry weight became smaller. The growth rate of the stress group seedlings was slower, and the absorption and transformation of endosperm was less. When the water was lost after air-drying, the weight of the endosperm in the stress group was larger, so the dry weight of the stressed group seedlings was greater than that of the control group. By comparing the mean values of salt and alkali stress, it was found that the dry weight of seedlings under salt stress was lower than that under alkali stress, and the other traits were higher than those under alkali stress.

The statistics of seedling germplasm resources obtained by calculation are shown in Table 1 below. According to the analysis in Table 1, the germination potential of water in the germination stage is more stable than that under saline-alkali stress, and the coefficient of variation is only 9.08%, while the coefficient of variation under salt stress is 48.00%, and that under alkali stress is 60.31%. The germination rate is relatively stable compared with the germination potential. The coefficient of variation under salt stress and alkali stress were 5.73%, 8.52% and 3.15% respectively, which showed that the germination rate of wheat had been basically stable. In other aspects such as radicle length, plumule length and coleoptile length, the coefficient of variation is relatively large, among which the coefficient of variation of alkali is the largest, which shows that the alkali situation is not stable in this case, and there are varieties with strong alkali tolerance.

3.2. Correlation Coefficient Analysis

Table 2 shows germination potential, germination rate, radicle length, radicle fresh weight, radicle dry weight, plumule length, plumule fresh weight, plumule dry weight, dry seedling weight, seedling fresh weight and coleoptile length under salt stress. Correlation analysis was conducted on the membership function values of each trait under saline-alkali stress (Table 2).The results showed that there was no significant correlation between seedling fresh weight and germination potential, germination rate; germination potential and bud length, coleoptile length, root length; bud fresh weight and germination potential; root fresh weight, germination potential and germination rate; seedling dry weight and germinating potential; bud dry weight and germinating potential, root dry weight with germination potential, germination rate, other relationships were significantly correlated.

Table 1: Statistical analysis of 121 wheat germplasm resources under saline-alkali stress

Trait	Control group			Salt stress			Alkali stress		
	Average	Standard deviation	Coefficient of Variation/%	Average	Standard deviation	Coefficient of Variation/%	Average	Standard deviation	Coefficient of Variation/%
GP	0.1303	0.0118	9.08	0.00823	0.00432	48.00	0.0380	0.02295	60.31
GR	0.2299	0.01318	5.73	0.1288	0.01098	8.52	0.072	0.00227	3.15
RT/cm	9.6165	2.700	28.08	7.002	1.729	24.70	0.998	0.6392	64.05
RFW/g	0.0832	0.05821	69.98	0.0851	0.600	70.59	0.0410	0.01743	42.46
RDW/g	0.0293	0.01888	64.45	0.0236	0.0077	32.73	0.0119	0.00566	47.48
BL/g	8.000	2.470	31.00	6.728	1.807	26.79	2.324	1.361	57.06
BFW/g	0.2744	0.1081	39.41	0.1720	0.0600	34.90	0.1187	0.04522	42.46
BDW/g	0.03898	0.01266	32.25	0.0276	0.0077	32.73	0.0239	0.0108	45.40
SFW/g	0.5960	0.1822	30.56	0.4960	0.1210	25.40	0.4080	0.0867	21.30
CL/cm	2.692	0.5899	21.91	3.394	0.7825	23.06	2.65	0.7071	26.68
SDW/g	0.1602	0.02554	15.94	0.1744	0.0302	17.30	0.1775	0.0338	19.06

Table 2: The correlation coefficients among the values of membership functions of 11 traits of wheat germplasm resources under salt stress

Trait	BL/cm	CL/cm	RT/cm	GP%	GR%	SFW/g	BFW/g	RDW/g	SDW/g	BDW/g	RDW/g
BL/cm	1										
CL/cm	0.715**	1									
RT/cm	0.715**	1.000**	1								
GP%	0.274**	0.328**	0.328**	1							
GR%	0.070	0.098	0.098	0.228**	1						
SFW/g	0.360***	0.373**	0.372**	-0.011	-0.660	1					
BFW/g	0.613**	0.559**	0.558**	0.262*	-0.380	0.327**	1				
RDW/g	0.343**	0.519**	0.519**	0.183	-0.260	0.314**	0.583**	1			
SDW/g	0.596**	0.629**	0.691**	0.384**	-0.580	0.366**	0.599**	0.589**	1		
BDW/g	0.654**	0.699**	0.698**	0.243*	-0.610	0.372**	0.770**	0.561**	0.658**	1	
RDW/g	0.708**	0.795**	0.794**	0.153	-0.610	0.366**	0.607**	0.575**	0.677**	0.744**	1

Note: * and ** indicate significant correlation at P<0.05 and P<0.01 levels,respectively

Table 3 shows the correlation coefficients among the subordinate function values of 11 traits under alkali stress. It can be seen from Table 3 that the correlation coefficients among other traits under alkali stress are significant except that the correlation coefficients between seedling fresh weight and germination potential and germination rate are not significant.

According to the correlation coefficient of the subordinate function of 11 characters under saline-alkali stress, the various indicators of wheat in the germination period are closely related, and it is not possible to judge whether wheat is saline-alkali resistant or not by analyzing a single indicator.It is necessary to make a comprehensive analysis based on multiple indicators in order to better and more accurately evaluate which kind of wheat has good saline-alkali resistance and is suitable for planting in saline-alkali land.

Table 3: The correlation coefficients among the subordinate function values of 11 traits of wheat germplasm resources under alkali

Trait	BL/cm	CL/cm	RT/cm	GP%	GR%	SFW/g	BFW/g	RDW/g	SDW/g	BDW/g	RDW/g
BL/cm	1										
CL/cm	0.565**	1									
RT/cm	0.516**	0.605**	1								
GP%	0.254**	0.482**	0.380**	1							
GR%	0.143*	0.407**	0.267**	0.602**	1						
SFW/g	0.253*	0.355**	0.255*	0.200	0.107	1					
BFW/g	0.373**	0.387**	0.497**	0.603**	0.366**	0.461**	1				
RDW/g	0.252*	0.356**	0.429**	0.562**	0.405**	0.366**	0.691**	1			
SDW/g	0.345**	0.460**	0.468**	0.633**	0.435**	0.506**	0.908**	0.763**	1		
BDW/g	0.336**	0.335**	0.409**	0.467**	0.241	0.427**	0.862**	0.566**	0.845**	1	
RDW/g	0.295**	0.336**	0.473**	0.581**	0.455**	0.463**	0.804**	0.614**	0.834**	0.730**	1

Note: * and ** indicate significant correlation at P<0.05 and P<0.01 levels,respectively

3.3. Analysis of Characteristic Value and Contribution Rate of Principal Components under Salt and Alkali Stress

The subordinate function values of 121 wheat materials were analyzed for the main components, and the results were shown in Table 4 and Table 5. The contribution rate of the first main component under salt stress was 54.08%, of which the contribution rate of coleoptile length was 0.913, and the contribution rate of the second main component was 11.545%, of which the dry weight of seedlings was the largest. The contribution rate of the first main component was 62.355% under alkali stress and salt stress, in which the contribution rate of the fresh weight of embryo was 0.922, and the second main component was 10.700%, in which the fresh weight of radicle was the most.

Table 4: Characteristic values and contribution rates of principal components under salt and alkali stress

Treatment	Principal component	I	II
Salt stress	Characteristic value	5.949	1.270
	Contribution/%	54.082	11.545
	Cumulative contribution	54.082	65.628
Alkali stress	Characteristic value	6.859	1.177
	Contribution/%	62.355	10.700
	Cumulative contribution	62.355	73.055

Table 5: Two load matrices of principal component factors under salt and alkali stress

Treatment	Principalcomponent	Characteristics of the measured indicators										
		RT	RFW	RDW	BL	BFW	SDW	SDW	CL	GP	GR	CL
Salt stress	I	0.912	0.682	0.875	0.832	0.779	0.860	0.826	0.913	-0.058	0.309	0.913
	II	-0.29	0.050	-0.86	-1.26	0.060	-0.02	0.123	-0.30	0.750	0.760	-0.030
Alkalistress	I	0.880	0.772	0.867	0.774	0.922	0.774	0.927	0.774	0.554	0.762	0.829
	II	0.040	0.104	-0.082	-1.87	-1.63	-2.85	-1.08	-1.87	0.706	0.502	0.059

According to the above principal component analysis, the dry weight of coleoptile is an important characteristic value to evaluate the salt tolerance under salt stress, and the fresh weight of plumule and radicle is an important characteristic value to evaluate the alkali tolerance under alkali stress.

3.4. Sample Analysis

It can be seen from the overall germination situation that some test groups have no germination, which has a greater impact on the overall situation, and the data will also be affected when the germination situation of the control group is not optimistic. Therefore, we select ten groups of test data with complete data, appropriate germination data and good physical and chemical properties for the second sampling. On the third day, the germination potential was measured, and the germination potential of water and salt treatment was 24.50%, 24.00% and 24.50%, respectively. The average germination potential was 24.33% and the standard deviation was 0.0756. The germination potential of salt treatment was 19.00%, 22.50% and 25.5%, and the standard deviation was 0.0265. And the coefficient of variation is relatively small, the coefficient of variation of water is 12. 03, and the salt is 14. 56. The germination potential of water as the control group is not much different from that of CIMMYT spring wheat under salt stress. But the germination potential of seeds under alkali stress is relatively larger than that under salt stress. The germination potential of seeds under alkali stress is 19.00%, 12.50%, 13.50%, the average is 16.50%, the standard deviation is 0.0285, and the coefficient of variation is 23.33.It can be seen that alkali has a greater impact on seed germination, and the coefficient of variation of seeds under alkali conditions is relatively high, that is to say, different plants grow differently under alkali stress, so we can screen out the germplasm resources of salt tolerance.

On the seventh day, the germination rate of the test materials was determined, which is of great significance in production and life, and is an important factor to determine whether the seeds can be sold to farmers. The germination rate of seeds on the market should be at least more than 80%, but due to the influence of laboratory conditions and test methods, the germination rate of seeds is not very high, but the test conditions are unified, and the test is still reliable. In the case of germination rate, the germination rate of water in the control group without salt or alkali stress was significantly higher than that in the other two groups, which was 46.00%, 42.50% and 47.00% respectively, and the average was 45.17%. Relatively speaking, the germination rate under salt stress was not very different from that under alkali stress. But the germination rate under salt stress was 27.50%, 23.00%, 30.50%, the number of comments was 27.00% which was significantly greater than the germination rate under alkali stress was 20.00%, 20.00% and 16.00% and the number of comments was 18.67%. From this analysis, it can be concluded that the effect of alkali stress on seed germination rate is more obvious than salt stress. And the germination rate of water tends to be flat, the coefficient of variation is only 5.23, while the coefficient of variation under salt stress is 13.98, while the coefficient of variance under alkali stress is 12.37, which is more or less reduced compared with the coefficient variation of germination potential, which also proves that with the extension of time, the germination rate of water tends to be flat. Both the data of the plant itself and the data under salt or alkali stress will become more and more flat and representative.

For the analysis of seedling growth, it is necessary to analyze the growth status from the length of coleoptile, plumule and root. By analyzing the growth status of seedlings in the control group, from the most basic point of view, the radicle, plumule and coleoptile grown from seeds under salt stress are longer than those under alkali stress, and most of them cannot be measured under alkali stress due to their growth status. As long as the data of germination are relatively complete, it is possible to measure.

The data of coleoptile length, plumule length, root length, seedling fresh weight, bud fresh weight, root fresh weight, seedling dry weight, bud dry weight and root dry weight were determined when they could be measured. The data were relatively complete, including 91 groups of control group, 77 groups of salt treatment, and only 45 groups of alkali treatment. A total of 10 groups of suitable data were selected from these groups for analysis.

The average coleoptile length, plumule length and root length of the seedlings are shown in the table 6, and the standard deviation and coefficient of variation are calculated for comparison.

According to the comparison, the bud length, coleoptile length and root length of some embryos under salt stress are similar to those under no stress, but there are significant differences between the control group and the alkaline group. The following are the results of data analysis.

The length of plumule, coleoptile and radicle was 9.800 cm, 3.001 cm and 10.17 cm respectively under normal condition, while it was only 4.978 cm, 2.887 cm and 6.115 cm under salt stress. Relatively speaking, the growth of plumule, coleoptile and radicle was only 2.215 cm under alkali stress.1.768 cm and 1.234 cm, and relatively speaking, the coefficient of variation was the largest under alkali stress, so it could be concluded that the growth of seedlings under alkali stress was the worst and the variation was the largest, so the main attention should be paid to the growth of seedlings under alkali stress when screening.

Seedling fresh weight, bud fresh weight, root fresh weight, seedling dry weight and root dry weight are roughly the same as those of germ, coleoptile and radicle, so too much analysis is not done.

Table 6: Statistics of wheat germplasm resources under saline-alkali stress

Trait	Control group			Salt stress			Alkali stress		
	Average	Standard deviation	Coefficient of Variation/%	Average	Standard deviation	Coefficient of Variation/%	Average	Standard deviation	Coefficient of Variation/%
GP	0.2433	0.00756	12.03	0.2233	0.0265	14.56	0.1650	0.0285	23.33
GR	0.4517	0.0193	5.23	0.2700	0.0308	13.98	0.1867	0.0188	12.37
RT/cm	10.17	1.020	10.57	6.115	1.966	33.89	2.215	1.467	69.79
RFW/g	0.08616	0.04798	58.70	0.1109	0.08889	84.49	0.0355	0.01474	43.67
RDW/g	0.03238	0.00830	27.035	0.02832	0.00514	19.15	0.0012	0.0395	33.83
BL/g	9.800	1.326	14.26	4.978	2.004	42.44	2.215	1.467	69.79
BFW/g	0.3462	0.00830	27.035	0.02832	0.00514	19.15	0.0012	0.0395	33.83
BDW/g	0.04916	0.007694	5.217	0.0295	0.00777	27.75	0.3113	0.01648	55.80
SFW/g	0.67207	0.4282	105.41	0.5334	0.1333	26.35	0.4184	0.07427	18.71
CL/cm	3.001	0.4822	16.94	2,887	0.7819	28.55	1.768	0.9979	58.87
SDW/g	0.16342	0.01807	11.656	0.1756	0.03281	19.70	0.1781	0.01164	6.891

4. Discussion

4.1. Determination and Analysis of Germination Period

Saline-alkali land seriously affects crop production. It is of great significance to screen saline-alkali resistant germplasm resources for agricultural production. Wheat germination period plays a vital role in wheat growth, which is an important period to determine whether wheat can grow into seedlings, and is also the easiest period to measure, so this period is mostly used for testing, and this period has the characteristics of easy operation, easy repetition, short cycle and so on.Saline-alkali tolerance of wheat is a quantitative genetic trait controlled by multiple genes[8], which is formed under the cooperation of multiple pairs of genes. So far, no morphological index has been found to be an index to identify whether it is salt-alkali tolerant. Therefore, it is necessary to evaluate the saline-alkali tolerance of different varieties by measuring the morphological indexes of wheat at germination stage and comparing their differences between saline-alkali treatment and control, which can provide a basis for saline-alkali tolerance breeding of wheat [9].

4.2. Effects of Saline-Alkali Stress on Plant Growth

Salt damage in natural environment is mainly caused by high concentration of Na^+ and Cl^-.The main components of alkaline soil are Na_2CO_3 and $NaHCO_3$, and alkaline soil has high PH [10].In this experiment, sodium chloride was used as salt stress, and sodium carbonate and sodium bicarbonate mixed solution with molar mass of 1:1 was used as alkali stress. Different concentrations of saline-alkali were used as pretreatment to analyze the effects of different concentrations of saline-alkali stress on wheat materials, and the concentrations which had more obvious effects on wheat germination and contrasted with the control group were screened out. Finally, the suitable concentration of NaCl solution for identification of salt stress in wheat germination period was 150 mmol ·L^{-1}.The concentration of $NaHCO_3$ and Na_2CO_3 was 100 mmol ·L^{-1} (molar ratio 1:1).

Under salt stress of plants, Zhang Ya et al [11]discussed the changes of osmotic adjustment and chlorophyll fluorescence characteristics of wheat under salt stress, and the results showed that the most intuitive performance of plants under environmental stress was the change of growth status, and the fresh weight of roots and leaves of plants under salt stress was lower than that under normal conditions. Liu et al. discussed the cloning of wheat TaGF14m gene and its salt stress response analysis, indicating that TaGF14m gene may negatively regulate salt stress tolerance through SOS pathway [12-13].Wheat is an important food crop. Salt stress seriously affects the growth and development of wheat. The salt tolerance mechanism of wheat is not completely clear. In addition, exogenous active substances also have a great impact on wheat [14-15].

5. Conclusion

In this experiment, the average value of seedling dry weight was alkali stress>salt stress> CK, and the average value of other traits was CK>salt stress>alkali stress, excluding the data that could not be used due to various reasons. When the seeds germinate, they consume their own accumulated dry matter, the dry weight decreases, and other organic matter accumulates. According to the above experimental data, it can be seen that there is no difference with the theory. The experiment shows that wheat is tolerant to salt, and its resistance to salt is higher than that of alkali.

Compared with the control group, the germination rate was not much different, and the germination rate was high, the length of radicle and embryo was appropriate, and the fresh weight and dry weight of seedlings and embryo were in good condition.

Reasonable breeding of saline-alkali tolerant varieties is the most effective and economical method to solve the problem of crop yield reduction under saline-alkali conditions. Wheat is one of the main food crops in China, which can be planted in large quantities in northern China, but the research on wheat-related aspects is not very comprehensive, and many fields are less involved. In the long run, this experiment not only helps to improve the soil saline-alkali conditions, but also helps to improve the economic benefits and grain production in the corresponding areas. If the saline-alkali resistance of wheat is screened and selected, the varieties with better resistance will be planted in Tianjin and the local grain yield in Tianjin will be increased. Promote the development of related agriculture and contribute to the economic development of the country.

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References

[1] Liu Le, Wei Xiaohui. Effects of salt and alkali stress on seed germination and salt tolerance of bellows and Purple Leaf Bellows, Acta Northeast Forestry University Sinica, 2021,49(09)

[2] Li Hao. Screening of wheat varieties with strong comprehensive stress resistance. Agricultural Technology, 2019, 08.

[3] Wu, J., Tao, R., Zhao, P., Martin, N. F., & Hovakimyan, N. Optimizing Nitrogen Management with Deep Reinforcement Learning and Crop Simulations. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition 2022, (pp. 1712-1720).

[4] Rengasamy, Pichu. Soil processes affecting crop production in salt-affected soils. Functional Plant Biology, 2010, 37(7).

[5] Meng Xia. A brief talk on the main problems of facility soil in our country and their solutions. Water Conservation and ecology, Inner Mongolia Water Conservancy, 2013, (04)

[6] Khadiah Mansour. Agricultural Pollution Visualization under Multilevel Grid. Academic Journal of Environmental Biology (2022), Vol. 3, Issue 3: 9-17.

[7] Gong Zhizhong, Xiong Liming, Shi Huazhong, Yang Shuhua, Herrera-Estrella Luis R, Xu Guohua, Chao Daiyin, Li Jingrui, Wang Pengyun, Qin Feng, Li Jijang, Ding Yanglin, Shi Yiting, Wang Yu, Yang Yongqing, Guo Yan, Zhu Jiankang. Plant abiotic stress response and nutrient use efficiency. Science China. Life sciences, 2020, 63(5).

[8] Qiao Pei, Lu Cunfu, Li Hongmei, etc. Effects of salt stress on seed germination and physiological characteristics of wheat seedlings. Chinese Journal of Ecological Agriculture, 2013, 21(6): 720-727.

[9] Keepesi Igaliba G. Osmotic and salt stress induced alteration in soluble carbohydrate content in wheat seedlings. Crop Sci., 2000(40): 482-487.

[10] Li Yuanyuan, Chen Bo, Yao Lirong et al. 283 wheat varieties (lines) evaluation of salt-alkali tolerance at germination and germplasm screening report of China. Agricultural Science and technology, 2021,23(3) : 25-33

[11] Zhang Ya, Shi Shuqian, Li Yaping. Osmotic Regulation, And Chlorophyll Fluorescence Characteristics in Wheat Leaves under Different Salt Stresses. Journal of Applied Ecology 2021,12(12)

[12] Liu Jia, Guo Shujuan, Zheng Haoyuan et al. Cloning of wheat TaGF14m gene and analysis of its response to salt stress. Journal of wheat crops, 2021-04-25, 1

[13] Li Hongyan, Chen xiangqian, Niu fengjuan. Temporal Transcriptome Analysis Of Wheat Roots In Response To High Salt Stress, Journal of Plant Genetic Resources 2022,23(2) : 592 -604

[14] Feng Zhang, Sui chunying. Effects Of Exogenous Active Substances On Stress Resistance At Seedling Stage Of Wheat. Chinese Journal of Agronomy, 2022,38(9) : 14-19

[15] Shan Yunpeng, Chen Xinhui, Wan Ping, et al. Evaluation of drought resistance of adzuki bean germplasm resources at seedling stage and screening of drought resistance resources. Journal of Plant Genetic Resources 2019, 20(5): 1151-1159.