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Effect of NaCl stress on germination of birch seeds

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ABSTRACT

We studied the salt-tolerant germination of birch seed introduced from abroad and used 0, 0.2%, 0.4%, 0.6%, 0.8% and 1% of NaCl solution to deal with 26 families of birch seed. Experimental results showed that as NaCl concentrations increasing, the germination energy, index of germination and germination percentage of all families of birch seed were all decline, initial germination time and mean time to germination were increasing. Different families of seed germination respond differently to NaCl stress. Seeing from the results of the experimental analysis, we know 7th, 8th, 10th, 16th, 20th, 22th, 24th families of seed germination were better, and those families' salt-tolerance were stronger than 26th and other families of birch seed.

Key words: Birch; NaCl stress; Seed germination percentage; Salt tolerance

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INTRODUCTION

Seed germination is a definite turning point in the plant life cycle. In saline environments, seed germination is subject to different degrees of inhibition. The majority of crop seed germination stage and early seedling stage are the most sensitive to salt stress. As the seed is the main plant reproductive material, its salt-tolerant condition at the germination stage can reflect the level of salt-tolerant plant to some degree, which is beneficial for early selection and evaluation of salt-tolerant plants. In recent years, studies on the breeding of salt-tolerant plants and cultivation have aroused the concern of scholars at home and abroad. It is estimated that there are about 5000~6000 species of halophytes around the world, there are also more than 500 kinds of Halophytes in china [1]. Reports about herbaceous plants are more among these and about woody plants are less. Studying on characteristics and mechanism of salt tolerance in trees can provide a theoretical reference and basis for the selection of planting tree species in Saline-alkali soil areas.

Birch is ornamental, greening, timber and excellent tree species, it likes light and has strong adaptability to the climate and can resist barren and severe cold, in addition, it has deep roots, good natural regeneration and grows fast, so it is the standard pioneer tree species. Birch has strong absorption of Sulfur dioxide, Hydrogen fluoride and other harmful gases. In wood utilization, Birch is the material of choice for veneer and plywood's production and processing of raw materials and has higher use value and economic value. At home there have been many reports on the breeding and cultivation of birch, genetic transformation, transgenic insect resistance, molecular markers of fiber traits, drought stress, construction of suppression subtractive hybridization library research[2-8], however, studies on salt tolerance of birch rarely reported.

In the experiment we used birch from Nawurzum reserve, Kustanay, Kazakhstan, as experimental materials for the study of salt-tolerance under NaCl stress. The salt types of birch from Nawurzum reserve are very precious salt-tolerant germplasm resources. Study on salt tolerance is designed to find the salt-tolerant mechanism of birch and screen salt-tolerant tree species, then providing pioneer plants for biological improvement of saline-alkali soil, which will help the early selection of salt-tolerant birch and evaluation of salt tolerance.

EXPERIMENTAL SECTION

2.1 Materials brief introduction

The selected materials are three kinds of birch from Nawurzum reserve, Kustanay, Kazakhstan. They are *Betula kirghisorum*, *Betula pendula* and *Betula pubescens*. Meanwhile we carried on the experiment by the domestic birch (*Betula platyphylla* from birch intensive breeding garden of Northeast forestry University) as the comparison. In these materials there are 12 familes of *Betula pendula*, 4 families of *Betula pubescens*, 9 families of *Betula kirghisorum*, and 1 families of *Betula platyphylla*, there is a total of 26 birch families.

2.2 Experimental processes and methods

The full grain seeds were selected to test germination capacity. Firstly, we used 0.3% $KMnO_4$ solution to disinfect these seeds for 15 min, and washed these with water. The test set six kinds of NaCl concentration, respectively, 0, 0.2%, 0.4%,0.6%,0.8% and 1%, we placed 50 seeds on the dish qualitative filter paper and repeat 3 times for each treatment, then put in 30 ℃constant temperature incubator to carry on the germination test. Every 24h we observed and recorded the situation of seed germinate, when the radical length reaches seed length, the embryonic bud length reaches half of the seed length, as the standard of seed germination. We started to calculate germination energy when the germinated seed number achieves the peak, we calculated germination percentage when the germinating seeds average less than 1% of the total number of test of seeds in the last stage of Germination for 5 d, and calculated index of germination and mean time to germination. The germination criterion is calculated as follows:

Germination percentage (%) = (the number of normal germinated seeds /the total number of tested seeds) x100%;

Relative germination percentage (%) = (processing germination percentage / Comparison germination percentage) x100%;

Germination energy (%) = (the number of normal germinated seeds when normally it reaches the peak / the total number of tested seeds) x100%;

Germination index = Σ(Gi/Di), Gi is the I-day's number of germinated seeds , Di is the number of days;

Mean time to germination= Σ(Gi $\times$ Di) / ΣGi;

We applied the Excel and SPSS software to analyze and examine the obtained tentative data. According to the experimental data analysis, we carried on the salt endurance appraisal of various seedling sources of birch.

RESULTS

3.1 Effect of initial germination time and mean germination time under NaCl Stress

The initial germination time is reflecting the indicator of seed germination starts speed. Research indicated that: in non-NaCl salt processing, except for 21th family in the third day of germination, Other family seeds began to germinate after setting at the bed in the second day; Under 0.2% of salt concentrations, 5th family,11th family,21th family and 25th family began to germinate after setting at the bed in the third day, 9th family didn't germinate until the end of seed germination, Other family seeds began to germinate in the second day; Under 0.4% of salt concentrations, 5th family and 21th families did not germinated,17th family,24th family and 25th family began to germinate in the third day, 9th family and 11th family began to germinate in the fourth day, Other family seeds began to germinate in the second day; Under 0.6% of salt concentrations,1th,2th, 6th,8th, 12th,14th, 16th,17th, 19th,22th and 23th family began to germinate in the second day, 3th,4th and 9th family began to germinate in the fourth day, 5th,11th and 21th family didn't germinate; Under 0.8% of salt concentrations,6th,9th, 10th,12th, 13th,14th, 16th,18th, 19th,20th,22th,24th and 25th family began to germinate after setting at the bed in the second day, 1th,7th,15th,17th and 23th family began to germinate in the third day,3th,4th,8th and 15th family began to germinate in the fourth day, 2th family began to germinate in the fifth day,11th and 26th family began to germinate in the sixth day,5th and 21th family didn't germinate; Under 1% of salt concentrations, all family seeds didn't germinate after setting at the bed in the second day, 12th,13th,14th and 22th family began to germinate in the third day, 7th,9th,16th ,23thand 24th family began to germinate in the fourth day,1th,6th,8th,17th,19th and 23th family began to germinate in the fifth day,2th,4th,15th and 20th family began to germinate in the sixth day, Other family seeds didn't germinated. So we can analyze: with the increasing of salt concentration, the majority of family seed's initial germination time has different degrees of delay. Under relatively low salt concentration (0.2%), the germination time of each family seed and the initial germination time in salt-free condition were not significantly difference, the initial germination time of birch is not sensitive to low salt stress.

Mean time to germination is an indicator of measuring the speed of seed germination. The smaller the value of the mean time to germination is, indicating that the faster seeds germinate, the better germination capacity is also. In this experiment the mean time to germination is to see table 1,9th and 21th family seeds bud extremely few, maybe the seed itself is immature or degenerate, not for analysis.The analysis of other seeds' mean time to germination is as follows: Compared with the non-NaCl processing, when the salt concentration reached 0.2%, the 10th seed's mean time to germination reduced 0.37d ,the 12th seed's reduced 0.04d, the 14th seed's reduced 1.28d, the 19th seed's reduced 0.58d, the 23th seed's reduced 0.26d, the 24th seed's reduced 0.24d,the mean time to germination of other family's seeds was increasing, between the range of 0.01~1.3d.When the salt concentration reached 0.4%,compared with the 0.2%-NaCl processing, the 6th seed's mean time to germination reduced 0.94d ,the 13th seed's reduced 0.88d, the 16th seed's reduced 0.52d, the 20th seed's reduced 0.1d, the 22th seed's reduced 0.23d, the mean time to germination of other family's seeds was increasing, between the range of 0 ~ 2.4d.When the salt concentration reached 0.6%,compared with the 0.4%-NaCl processing, the 13th seed's mean time to germination reduced 0.12d ,the16th seed's reduced 0.08d, the 20th seed's reduced 0.11d, the 24th seed's reduced1.37d, the mean time to germination of other family's seeds was increasing, between the range of 0.13 ~ 2.73d. When the salt concentration reached 0.8%, compared with the 0.6%-NaCl processing, the 17th seed's mean time to germination reduced 3.05d, the14th seed's reduced 1.47d, the 10th seed's reduced 0.29d, the 4th seed's reduced 0.22d, the 3th seed's reduced 0.11d, the 15th seed's reduced 0.04d, the mean time to germination of other family's seeds was increasing, between the range of 0.03 ~ 2.81d. When the salt concentration reached 1%, compared with the 0.8%-NaCl processing, except that 2th and 18th seed's mean time to germination reduced slightly, the mean time to germination of other family's seeds was significantly increasing, the increasing range of 0.32~9.31d.

We can see from the above analysis of the mean time to germination that, under the condition of low concentration of NaCl, the mean time to germination of each family seed has not change significantly. With the increasing of salt concentration , the influence of salt stress on seed germination is gradually obvious , the increased range in the mean time to germination enlarges gradually, which indicates that salt stress has a certain degree of inhibition to the mean time to germination of each family seed. With the rising of NaCl concentration, the degree of inhibition is increasing.

Table 1: Mean time to germination of birch seed under different concentrations of NaCl stress (d)

Birch family	NaCl(%)					
	0	0.2	0.4	0.6	0.8	1
1Betula pendula	2.30	2.69	3.00	3.68	4.41	6.00
2Betula pendula	3.06	3.32	4.07	4.35	5.83	5.75
3Betula pendula	2.32	2.89	3.74	5.11	5.00	-
4Betula kirghisorum	2.44	2.80	3.26	4.93	4.71	5.50
5Betula kirghisorum	3.00	4.00	4.50	5.33	5.86	-
6Betula kirghisorum	2.14	3.44	2.50	3.45	3.80	5.89
7Betula pubescens	2.52	3.00	3.56	4.58	5.22	6.00
8Betula pubescens	2.51	2.52	3.05	3.67	4.83	5.36
9Betula pubescens	-	-	-	-	-	-
10Betula pendula	3.41	3.04	3.28	3.58	3.29	3.61
11Betula kirghisorum	2.50	3.00	5.40	5.80	6.00	-
12Betula pendula	3.00	2.96	2.96	3.36	4.48	7.19
13Betula pendula	2.75	3.52	2.64	2.52	3.82	6.20
14Betula pendula	3.32	1.94	3.70	3.83	2.36	6.64
15Betula pendula	2.72	3.15	3.75	4.73	4.69	14.00
16Betula pendula	2.92	3.31	2.79	2.71	3.70	6.63
17Betula kirghisorum	1.81	2.80	3.83	6.56	3.51	11.09
18Betula pubescens	2.78	3.74	4.62	5.22	7.25	7.00
19Betula pendula	3.31	2.73	3.12	3.42	5.06	-
20Betula kirghisorum	2.42	3.04	2.94	2.83	4.82	-
21Betula kirghisorum	-	-	-	-	-	-
22Betula pendula	2.75	2.73	2.50	3.47	4.68	8.08
23Betula kirghisorum	2.62	2.36	2.73	3.30	4.57	6.60
24Betula pendula	2.55	2.31	3.79	2.42	5.23	7.35
25Betula kirghisorum	2.71	3.51	3.18	4.67	4.70	-
26Betula platyphylla	2.81	3.17	4.14	5.47	6.00	6.00

Note: - represents the seed failed to germinate or sprout.

3.2Effect of seeds germination energy under NaCl stress

Seed germination energy is the percentage for normal germination of seeds accounting for seeds tested in the seed germination initial period (within a specified date).Germination energy is an indicator to determine the field seedling. The higher seed germination energy is, the stronger seed vitality is also, germinating neatly, consistent emergence and big growth potential. We conducted a statistical analysis about the seed germination energy of 26 families of birch seeds in different concentrations of NaCl stress, the results indicated that: the seed germination energy was significantly difference between different NaCl concentrations. It can be seen from table 2, Compared with seed germination energy in the 0.2% NaCl processing, seed germination energy of the same family in NaCl-free condition has no significant change, but with the increasing of salt concentrations, most of the family's seed germination energy has the obvious declining trend. When the salt concentration is in 1% NaCl, the seed germination energy of each family reduced to the minimum level, which indicates that salt stress has a certain degree of inhibition to seed germination energy, with the increasing of salt concentrations, the degree of inhibition significantly increased. In the same salt concentration, there are some differences between the seed germination energy of different families. In the non-salt processing ,the seed germination energy of 10th family was maximum, reaching 56.67%, the second is 24th family's, reaching54.67%, 24th family's reached 50%,10th family's had no significantly differences with 24th ,18th,22th ,15th ,16th, 8th ,4th and 20th family's, but had significantly differences with other families, the seed germination energy of 21th family was minimum, the second is 9th family's, germinating extremely few; When the salt concentration is in 0.2% NaCl, the seed germination energy of 10th family was maximum ,reaching 57.33%, the second is 3th family's, reaching 56.67%,24th, 15th and 18th family's were all above 50%,10th family's had no significantly differences with 3th ,24th,15th ,18th ,16th, 7th and 4th family's, but had significantly differences with other families. the seed germination energy of 9th family was minimum, the second is 21th and 11th family's ,germinating extremely few; When the salt concentration is in 0.4% NaCl, the seed germination energy of 16th family was maximum, reaching 46.67%,10th, 22th and 24th family's were all above 40%,there was no significant difference between them. the seed germination energy of 5th family was minimum, the second is 21th and 9th family's; When the salt concentration is in 0.6% NaCl, the seed germination energy of 24th family reached 44.67%, followed by the family, 8th, 16th and 22th,their seed germination energy were respectively, 38.89%, 34.67%, 33.33%, there was no significant difference between them. The seed germination energy of other families were all below 30%; When the salt concentration is in 0.8% NaCl, the seed germination energy of 16th family was maximum, reaching 22%, the seed germination energy of other families were all below 20%; When the salt concentration is in 1% NaCl, the seed germination energy of 16th family was maximum, but less than 10%. In the same salt concentration, there is different sensitivity to salt stress between different families, which shows that there are differences in salt tolerance between different families. In the low 0.2% salt concentration processing, the seed germination energy of some families are rising, which shows that it is also possible to promote seed germination in the low salt condition.

Table 2: Germination energy of birch seed under different concentrations of NaCl stress

Birch family	NaCl(%)					
	0	0.2	0.4	0.6	0.8	1
1Betula pendula	35.56 efg	30.00 fg	24.44 ef	23.33 efgh	12.22 bcd	1.11 ab
2Betula pendula	33.33 defg	27.78 efg	16.67 def	13.33 bcde	0 a	1.11 ab
3Betula pendula	38.89 fgh	56.67 kl	37.78 g	6.67 abc	3.33 ab	0 a
4Betula kirghisorum	42.22 fghi	44.44 ijkl	24.44 ef	6.67 abc	7.78 abcd	1.11 ab
5Betula kirghisorum	3.33 ab	4.44 abc	0 a	1.11 ab	0 a	0 a
6Betula kirghisorum	7.78 ab	7.78 abc	12.22 cd	8.89 abcd	8.89 abcd	0 a
7Betula pubescens	32.22 defg	44.44 ijkl	38.89 g	22.22 efg	13.33 bcd	2.22 abc
8Betula pubescens	44.44 fghi	43.33 hijk	38.89 g	38.89 ij	15.56 cde	1.11 ab
9Betula pubescens	1.33 a	0.00 a	0.67 ab	0.66 a	0.67 a	0 a
10Betula pendula	56.67 i	57.33 l	40.00 g	28.00 fghi	9.33 abcd	0 a
11Betula kirghisorum	4.44 ab	3.33 abc	4.44 abc	0 a	0 a	0 a
12Betula pendula	18.67 bcde	34.67 fghi	26.67 efg	14.00 cde	8.67 abcd	3.33 abc
13Betula pendula	33.33 defg	30.67 fgh	36.00 fg	27.33 fghi	16.67 de	5.33 bc
14Betula pendula	14.00 abc	16.67 cde	15.33 de	14.67 cde	11.33 bcd	2.00 abc
15Betula pendula	47.78 ghi	50.00 jkl	25.56 efg	5.56 abc	3.33 ab	0 a
16Betula pendula	46.00 fghi	48.67 jkl	46.67 g	34.67 hij	22.00 e	6.00 c
17Betula irghisorum	16.67 abcd	8.67 abc	9.33 abcd	3.33 abc	8.67 abcd	4.00 abc
18Betula pubescens	50.00 ghi	50.00 jkl	26.67 efg	12.22 bcde	1.1 1a	0 a
19Betula pendula	28.67 cdef	28.00 efg	24.00 ef	12.00 bcde	6.00 abc	0.67 ab
20Betula kirghisorum	39.33 fghi	30.67 fgh	26.00 efg	19.33 def	8.00 abcd	0 a
21Betula irghisorum	0.66 a	1.33 ab	0 a	0 a	0 a	0 a
22Betula pendula	48.00 ghi	38.67 ghij	41.33 g	33.33 ghij	7.33 abcd	2.00 abc
23Betula kirghisorum	13.3 abc	14.44 bcd	11.11 bcd	8.89 abcd	4.44 ab	3.33 abc
24Betula pendula	54.67 hi	51.33 jkl	42.00 g	44.67 j	9.33 abcd	2.67 abc
25Betula kirghisorum	19.33 bcde	16.00 cd	8.00 abcd	2.67 abc	0 a	0 a
26Betula platyphylla	20.00 bcde	23.33 def	15.56 def	3.33 abc	0 a	0 a

Note: different lowercase letters in the same column indicate significant difference at the 0.05 level ($p < 0.05$).

3.3 Effect of the seed germination index under NaCl stress

We conducted a statistical analysis about the seed germination index of 26 families of birch seeds in different concentrations of NaCl stress and results indicate that the seed germination index was significantly difference between different concentrations. It can be seen from table 3, with the increasing of salt concentrations, the seedgermination index of all birch families seed has different degrees of reduction trend. 5th,9th and 21th family germinated extremely few and their germination index were the lowest, there is no rules to follow, maybe they have seed quality problems, which needs to continue testing. In NaCl concentration from 0 to 0.2%, the germination index of 3th, 6th, 7th, 12th, 14th, 16th and 23th family all increased, except that they were all decreasing. During of 0.2~0.6 and 0.6~1 elevated salt concentration, seed germination index showed a downward trend, and the drop rate increased. The inhibition of salt stress on seed germination capacity is the most obvious. Seeds in the high salt concentration of 1%, the germination index of each birch family seed are the lowest.

Table 3: Germination index of birch seed under different concentrations of NaCl stress

Birch family	NaCl(%)					
	0	0.2	0.4	0.6	0.8	1
1Betula pendula	5.10	3.86	2.68	2.44	1.46	0.29
2Betula pendula	4.84	3.60	2.67	1.70	1.05	0.24
3Betula pendula	5.71	7.13	4.83	1.82	0.55	0.00
4Betula kirghisorum	6.02	6.02	5.17	1.05	1.02	0.13
5Betula kirghisorum	0.51	0.58	0.00	0.19	0.00	0.00
6Betula kirghisorum	1.11	1.30	1.76	1.24	1.00	0.52
7Betula pubescens	4.49	5.65	3.79	2.84	2.24	0.98
8Betula pubescens	6.80	6.23	5.05	4.18	2.14	0.89
9Betula pubescens	0.28	0.00	0.06	0.11	0.17	0.00
10Betula pendula	12.32	10.88	8.67	5.25	1.99	0.28
11Betula kirghisorum	0.58	0.33	0.41	0.00	0.11	0.00
12Betula pendula	4.37	6.63	5.32	3.09	1.98	0.69
13Betula pendula	8.28	7.64	6.83	4.91	3.68	1.52
14Betula pendula	3.70	3.75	3.62	3.33	2.47	0.92
15Betula pendula	6.48	5.41	3.64	1.14	1.02	0.10
16Betula pendula	9.80	10.01	9.35	5.98	4.39	2.03
17Betula kirghisorum	2.96	1.63	1.65	0.63	1.78	1.02
18Betula pubescens	6.65	5.93	3.51	1.58	0.23	0.05
19Betula pendula	6.48	5.66	4.31	2.98	1.30	0.36
20Betula kirghisorum	7.90	6.08	4.51	3.85	2.24	0.07
21Betula kirghisorum	0.11	0.22	0.00	0.00	0.00	0.00
22Betula pendula	11.15	8.32	7.78	6.31	2.14	1.13
23Betula kirghisorum	1.82	2.12	1.48	1.36	0.64	0.34
24Betula pendula	9.97	9.74	7.25	7.88	3.14	2.45
25Betula kirghisorum	3.42	2.78	1.76	0.76	0.00	0.00
26Betula platyphylla	2.88	2.72	2.00	0.95	0.28	0.06

3.4 Effect of the seed germination percentage under NaCl stress

Germination percentage reflects the good and bad of seed quality, it is an important indicator of determining the seeding amount and one kind of the value of approved class. In order to better analyze the influence of salt stress on seed germination percentage of each birch family, regarding the best germination concentration corresponding to germination percentage as the base, we calculated out the relative germination percentage in each concentration processing, and the results were shown in Table 4. In non- NaCl processing condition, 1th, 2th, 8th, 9th, 13th, 15th, 17th and 20th family's seed germination percentage are the highest; In 0.2% NaCl salt concentrations, 3th, 4th, 5th, 7th, 10th, 12th, 16th, 18th, 19th, 21th, 23th, 25th and 26th family's seed germination percentage are the highest; From the above we can see in low salt 0.2% concentration processing, its inhibition of each family's seed germination was not obvious, it even increased the seed germination percentage; In 0.4% NaCl salt concentrations, 6th, 11th, 12th and 16th family's seed germination percentage are the highest, the seed germination percentage of other families begins to fall significantly, with the increasing of salt concentration, the relative seed germination percentage of each family falls even more sharply, in the high 1% salt concentration, the relative seed germination percentage is the lowest, some seeds basically don't germinate, which shows that most of the health and vitality of seeds lose their germinating capacity under salt stress. 5th, 9th and 21th family's seed germination percentage are all very low in the salt-free condition or low-salt concentrations condition, In range of 0.4%~1% NaCl salt concentration processing, the relative seed germination percentage is zero, These three families don't germinate well, may be because of seed itself, Therefore it must continue to collect seeds to carry on the experiment.

DISCUSSION

The determination results of birch seed germination indicate that with the increasing of NaCl concentration, the seed germination of all families are delayed, in particular in the extension of seed initial germination time and mean time to germination. Germination energy, germination index and germination percentage are commonly used as indicators to evaluate seed germination, they are key indicators to express the level of seed vigor and expression levels, they also reflect the seed germination speed, the degree of germination uniformity and seedling strong potential. In this experiment, the seed germination energy, germination index and germination percentage of birch seeds have little change between in non-NaCl processing condition and in low salt 0.2%concentration condition, but with the increasing of NaCl concentration, Salt stress on seed germination's inhibition gradually increased. Though in the entire germinating process, the change tendency is similar. There are significant differences on the degree. All the indexes' decline rates are the sharpest in the process of salt concentration increased during the two of which 0.4% to 0.6% and 0.6% to 1%. Seen from the above three indicators, 7th, 8th, 10th, 16th, 20th, 22th and 24th family's seed germination are better, their salt-tolerance is stronger than 26th domestic birch family and other family birch seeds.

Table 4: Relative germination percentage of birch seed under different concentrations of NaCl stress

Birch family	NaCl(%)					
	0	0.2	0.4	0.6	0.8	1
1Betula pendula	100.00	87.88	69.70	75.76	51.52	15.15
2Betula pendula	100.00	91.18	79.41	58.82	52.94	11.76
3Betula pendula	66.07	100.00	83.93	48.21	14.29	0.00
4Betula kirghisorum	88.64	100.00	84.09	34.09	31.82	4.55
5Betula kirghisorum	66.67	100.00	0.00	50.00	0.00	0.00
6Betula kirghisorum	58.33	75.00	100.00	91.67	66.67	41.67
7Betula pubescens	68.89	100.00	80.00	80.00	71.11	37.78
8Betula pubescens	100.00	95.45	90.91	95.45	65.91	31.82
9Betula pubescens	100.00	75.00	100.00	0.00	50.00	0.00
10Betula pendula	92.71	100.00	80.21	63.54	18.75	5.21
11Betula kirghisorum	74.07	55.55	100.00	0.00	37.03	0.00
12Betula pendula	53.70	100.00	100.00	57.40	48.15	16.67
13Betula pendula	100.00	89.52	97.14	95.24	64.76	38.09
14Betula pendula	92.32	96.17	92.32	100.00	73.09	50.00
15Betula pendula	100.00	97.87	76.59	31.91	27.66	2.13
16Betula pendula	97.44	100.00	100.00	80.76	65.38	38.46
17Betula kirghisorum	100.00	49.99	64.27	28.56	67.84	57.13
18Betula pubescens	89.09	100.00	81.81	41.81	7.27	1.81
19Betula pendula	95.83	100.00	85.41	72.91	39.58	10.41
20Betula kirghisorum	100.00	78.33	73.33	71.67	53.33	1.67
21Betula kirghisorum	50.12	100.00	0.00	0.00	0.00	0.00
22Betula pendula	100.00	82.67	84.00	89.33	40.00	24.00
23Betula kirghisorum	92.89	100.00	78.60	71.45	35.73	35.73
24Betula pendula	95.35	94.19	86.05	100.00	54.65	51.17
25Betula kirghisorum	96.81	100.00	64.54	32.27	0.00	0.00
26Betula platyphylla	87.52	100.00	91.69	62.52	20.84	4.17

Many factors including seed internal physiology and seed external ecological environment can influence the seed germination. NaCl can suppress the seed germination, which is generally believed that there are two reasons: first, the salt reduced the medium water potential, which causes the seed not to absorb enough moisture; second, seed inhaled excessive sodium and chloride ions resulting in ion toxicity and the decline in osmotic pressure under saline conditions [9]. Saline - alkali on plant damage mainly includes three aspects: osmotic stress, ion assault and nutritional imbalance, in particular in the affecting the germination of plant seeds, plant growth, development and bearing fruit. Salt-tolerance of plant is through a series of morphological and physiological adaptive response to reduce these injuries [10]. In this experiment, the germination of different families birch seeds was inhibited under NaCl stress, while some families birch seeds showed different degrees of salt tolerance to NaCl stress.

The salt-tolerant evaluation of different families birch seeds provides a theoretical basis for birch variety selective breeding. But whether we can use the salt-tolerant evaluation of birch seeds to replace the salt-tolerant evaluation of plant can not be determined. This needs natural and artificial salt alkaloid environment, we can determine birch's growth volume, growth and limit resistance salt ability to carry on the appraisal, or through some physiological indicators of salt alkaloid environment to evaluate the salt-tolerant ability. This requires further seedling test and forestation test to achieve.

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