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Combining Ability of Japonica Rices for Salinity Tolerance at Seedling Stage

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자포니카 벼 품종의 幼苗 耐鹽性에 대한 組合能力

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ABSTRACT : This experiment was conducted to evaluate the combining ability of japonica rices for improving the salinity tolerance at seedling stage. Nine varieties used in partial diallel analysis included three varieties of each tolerant, moderately tolerant and susceptible one.

Twelve-day-old seedlings were grown in saline solution, initially at an EC of 6 dS / m for four days, followed by an EC of 12 dS / m for 20 days. The agronomic characters at seedling stage such as plant height, dry shoot weight and dry root weight were measured to analyze for combining ability of the parents.

General combining ability(GCA) and specific combining ability(SCA) effects were highly significant for all tested parameters. However, mean squares for GCA were about five times larger than that for SCA suggesting the preponderance of additive gene action.

Among tolerant varieties, Gaori and Namyang 7 were good combiner for improving the salinity tolerance at seedling stage in GCA as well as SCA.

Key words : Diallel analysis, Combining ability, Seedling stage, Japonica rice.

Salinity in one of the main obstacles to rice production in deltas, estuaries and coastal fringes. It is also serious impediment to the growth of irrigated rice in arid and semi-arid regions[1,2,8,9].

The influence of salinity on the growth of rice is related to the stage of plant development at which the salinity is imposed. For example, it has been reported that salinity delays germination but does not appreciably reduce the final percent germination[10]. It has also been noted that rice is least tolerant to salinity during the young seedling stage, and that its tolerance appears to increase with age, but that all varieties are not equally salt-tolerant[6].

Recently, Korea was compelled to reclaim seacoast. And also much emphasis is being placed on the utilization of saline soils in Korea for rice cultivation. Rice production in saline area can be increased considerably if salinity tolerant varieties are developed. However, one of the limitation in the development of tolerant varieties is the insuffic-

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ient genetic informations on salt tolerance[4,7].

The present study was conducted to evaluate the combining ability of some japonica rice genotypes for salinity tolerance at seedling stage which is helpful to the breeding programs for developing improved japonicas with salt tolerance.

MATERIALS AND METHODS

The materials consisted of a partial diallel set were nine parents, three tolerant (Agami M1, Gaori, and Namyang 7), three moderately tolerant (Yunlen 11, Yunlen 12, and Akihikari), and three susceptible varieties (Yeosudo, Daegudo and Jinling 78~102). Some salt tolerance characteristics of these varieties are given in Table 1. More than 150 seeds of F_1 for each cross were harvested 25 to 30 days after pollination. Naked seeds similar to F_1 were also produced for the parents by removing the upper 1/3 of their lemma and palea before flowering.

The seeds consisted 45 entries (9×9 paritial diallel) were heat treated at 45℃ for three days in a forced draft oven to break the dormancy. The seeds were then surface sterilized with 0.1% $HgCl_2$ for 2~3 minutes and rinsed thoroughly with distilled water. The sterilized seeds were soaked in petridish with water for 24 hours and incubated for 48 hours at 30℃. The pregerminated seeds were sown, two seeds per hole and 10 holes per variety, on a styrofoam sheet with 100 holes and a nylon net bottom.

Seeding was similar to split-plot design with four replications, where normal and saline media. The sheet were floated in distilled water for four days tray of size 30×24×18cm. Salinity treatment was given to appropriate trays, at EC of 6 dS/m for first four days and then, it was increased to EC of 12dS/m. The controlled trays were maintained with normal nutrient solution.

Both saline and normal culture solutions were renewed weekly and their pH was maintained daily at 5.5. The glasshouse was maintained at 29℃/21℃ day/night temperature and a minimum relative humidity of 70% during the day. After 20 days, all seedlings were measured for height and their shoots and roots were taken separately. They were ovendried for 72 hours at 70℃ and weigh-

Table 1. Origin, plant type and the level of salinity tolerance of varieties used in 9×9 diallel cross

Designation	Origin	Plant♪ type	Tolerance level: Visual score (0~9)	Tolerance level: Shoot Na^+conc.(%)	Grouping
Agami M1	Japan	TR	3.9±0.42	1.48±0.14	Tolerant
Gaori	Korea	TR	4.2±0.57	1.69±0.08	Tolerant
Namyang 7	Korea	IM	3.8±0.57	1.39±0.09	Tolerant
Yunlen 11	China	IM	5.4±0.57	1.89±0.10	Moderate
Yunlen 12	China	IM	6.4±0.48	1.88±0.06	Moderate
Akihikari	Japan	IM	6.8±1.14	1.81±0.19	Moderate
Yeosudo	Korea	TR	8.0±0.67	2.26±0.21	Susceptible
Daegudo	Korea	TR	7.3±0.67	2.32±0.14	Susceptible
Jinling 78~102	China	IM	8.6±0.57	2.76±0.29	Susceptible

♪ TR : Traditional, IM : Improved

Table 2. Mean RRPH, RRSW and RRRW of parents under saline condition at seedling stage in japonica rice

Parent	Code	Parameter		
		RRPH♩	RRSW♪	RRRW♫
Agami M1	P1	39.61	39.00	33.33
Gaori	P2	31.47	35.49	15.00
Namyang 7	P3	26.21	35.72	25.00
Yunlen 11	P4	33.73	61.71	64.71
Yunlen 12	P5	37.31	68.26	75.00
Akihikari	P6	34.99	69.77	71.88
Yeosudo	P7	45.82	67.02	67.50
Daegudo	P8	36.93	59.89	56.25
Jinling 78-102	P9	33.28	60.72	55.56

♩ RRPH : Reduction ratio of plant height
♪ RRSW : 〃 shoot weight
♫ RRRW : 〃 root weight

ed.

The general combining ability(GCA) and specific combining ability(SCA) analysis were carried out according to Method II(half set of diallel excluding reciprocals) Model I (fixed effects for genotypes) outlined by Griffing.[5]

Table 3. Analysis of variance for combining ability for RRSW and RRRW in a 9×9 diallel cross

Source of variation	DF	Mean Square	
		RRSW♪	RRRW♫
GCA	8	507.8270**	649.0820**
SCA	36	124.2510**	145.1510**
Error	132	6.1004	1.6213

♪ RRSW : Reduction ratio of shoot weight
♫ RRRW : 〃 root weight

RESULTS AND DISCUSSION

The mean performance of the nine parents for reduction ratio of plant height(RRPH), shoot weight(RRSW) and root weight(RRRW) by salt treatment are presented in Table 2. The results showed that the reduction ratio of shoot weight and root weight were lower in the tolerant parent than in susceptible ones, but reduction ratio of plant height did not show any trend.

Analysis of variance for combining ability for RRSW and RRRW showed highly significant general combining ability and specific combining ability(Table 3). GCA effects were much higher than SCA effect.

The estimates of GCA and SCA effects for shoot weight are presented in Table 4. Among tolerant parents, Gaori was found to be the best general combiner, followed by Namyang 7 and Agami M1 in the trait of shoot weight.

Progeny of Agami M1 × Yeosudo(tolerant × susceptible) showed the highest SCA effects in the shoot weight, followed by Yunlen 11 × Akihikari(moderate × moderate), Namyang 7 × Jinling 78-102(tolerant × susceptible), and Gaori × Namyang 7 (tolerant × tolerant).

The GCA and SCA effects for root weight are presented in Table 5. Here also Gaori was found to be the best general combiner in the trait of dry root weight, followed by Na-

Table 4. General combining ability effects(diagonal) and specific combining ability effects (above diagonal) for reduction ratio of shoot weight in a 9×9 diallel cross

Male parent	Female parents								
	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9
P_1	−4.8976	0.0287	8.7780	13.7591	7.2935	12.3846	−27.2449	−9.9822	5.4032
P_2		−10.8537	−14.1534	−2.2497	6.8046	−10.3668	22.4087	−3.5061	6.3094
P_3			−9.8880	−12.3604	9.9039	0.4526	7.9025	9.2232	−16.0863
P_4				6.1134	4.4050	−17.4263	8.0541	4.4194	7.0973
P_5					5.5915	−9.7295	3.3140	−13.6463	−11.2009
P_6						3.8094	−0.7604	12.9648	−6.8322
P_7							6.0025	−14.0722	1.6382
P_8								1.0722	8.7785
P_9									2.9693

P_1 = Agami M1, P_2 = Gaori, P_3 = Namyang 7, P_4 = Yunlen 11, P_5 = Yunlen 12, P_6 = Akihikari, P_7 = Yeosudo, P_8 = Daegudo, P_9 = Jinling 78-102.

myang 7 and Agami M1. SCA effects of Agami M1×Daegudo (tolerant×susceptible) was the highest one, followed by Yunlen 12×Akihikari (moderate×moderate), Agami M1×Yeosudo (tolerant×susceptible), and Yunlen 12 × Jinling 78-102(moderate×susceptible) in the trait of root weight.

Griffing's[5] method of combining ability test in terms of both random and fixed model suggested that the choice of correct model depends on the nature of parental material used. Eberhart & Gardner[3] stated that the plant breeders and geneticists are usually interested in genetic information about a particular set of parents and should be using a fixed model in most cases. In this study, a fixed model was used since the parents were not randomly selected. As it mentioned above, good combiners tested will be adopted for useful japonica breeding materials with salt tolerance in near future. The higher GCA than SCA effects for all traits indicated that the additive gene action was more predominantly involved than the nonadditive

Table 5. General combining ability effects(diagonal) and specific combining ability effects (above diagonal) for reduction ratio of root weight in a 9×9 diallel cross

Male parent	Female parents								
	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9
P_1	−2.7057	0.4604	13.3960	−0.4299	9.3104	13.3263	−18.4476	−4.8110	11.6242
P_2		−15.3779	−7.2667	5.1949	−8.9749	−0.7865	17.8422	−2.0312	0.9615
P_3			−7.4786	−7.3469	33.7258	0.2417	−4.2046	7.6970	−14.2453
P_4				6.7273	4.3399	−15.9492	8.0519	2.8661	2.6188
P_5					6.7271	−27.0561	−0.8578	−13.6162	−18.0510
P_6						2.7087	0.8881	4.4572	−2.1251
P_7							7.9475	−0.7792	−3.7915
P_8								2.9909	7.5926
P_9									−1.5393

P_1 = Agami M1, P_2 = Gaori, P_3 = Namyang 7, P_4 = Yunlen 11, P_5 = Yunlen 12, P_6 = Akihikari, P_7 = Yeosudo, P_8 = Daegudo, P_9 = Jinling 78-102.

one in salt tolerance at seedling stage. The additive genetic variance is a fixable genetic component. Different SCA effects of F1 progeny suggested that there was some considerable influence of nonallelic gene interaction.

摘 要

자포니카 벼 내염성 품종육성을 위한 모본들의 조합능력을 아는 것은 교배친의 선정과 육종효율면에서 대단히 중요하다. 본 연구는 유묘기 내염성 관련형질에 대해 내염성 정도가 다른 9개 품종을 가지고, 이면 교배를 실시하여 모본 및 F_1에 대한 유묘기 내염성 검정을 통하여 조합능력을 평가할 목적으로 수행하였다.

유묘기 내염성 평가형질에 대한 일반조합능력 및 특수조합능력은 친품종간 및 F_1간에 고도로 유의한 차이가 있었으며, 특히 일반조합능력이 특수조합능력보다 크게 나타나서, 여기에는 상가적 유전자작용이 비상가적 유전자작용보다 훨씬 크게 관여하고 있음을 알 수 있었다. 각 모본들에 대한 일반조합능력은 Gaori, Namyang 7 그리고 Agami M1 같은 내염성 품종들이 지상부 건물중 및 뿌리 건물중 감소율에서 모두 다른 친품종들에 비하여 우수하였다.

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