

Line × Tester Analysis in Rice Genotypes under Salinity Stress Conditions

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ABSTRACT A major challenge to economies reliant on agriculture is salinity, which especially affects rice, which is a staple diet for half of the world's population. Nine parental genotypes and the 18 F1 hybrids that resulted from crossing six female (line) genotypes with three male (tester) genotypes were examined in a Line × Tester study. Plant height, panicle length, tillers per plant, grains per panicle, main panicle weight, 1000 grain weight, and yield per plant were the nine features that were evaluated. Bas-2000 and Bas-198, who excelled in a variety of qualities, were shown to be the greatest performers under typical situations by General Combining Ability analysis. In terms of panicle length, grain weight main panicle, and yields per plant, Super-Basmati performed the worst. Bas-198 proved to be the best line under salinity, and Ks-282 was the best tester. Super Basmati × Bas-Pak was found to be the best cross for tillers per plant and yield per plant under normal conditions by Specific Combining Ability analysis, but Shaheen-Basmati × Bas-Pak fared better under salinity stress. On the other hand, under normal circumstances, Shaheen-Basmati × Ks-282 performed the worst in most features, however under salinity stress, 5170 × Ks-282 performed the worst.

Keywords: *General combining ability; Specific Combining Ability. Salinity; Line; Tester*

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INTRODUCTION The Systemic breeding methods, collection of the parents with the attractive attributes showing good GCA results within yield and high estimations of the SCA results of the crosses become necessary. The following framework line cross tester method which is introduced in studies mentioned as much powerful gear existing for estimations of GCA and aids in to select the attractive parents or crosses for utilization of pure-bred breeding (Rashid, et al., 2007). Phenomena gives systemic advance to a huge scale analysis of the constant difference and best controlled study of resulting numbers. Effects do not expose which parents good and poor. For eradication of this problem, that is much needed to assemble information of our nature of additive and non-additive gene action. Analysis of Line x tester gives the information on GCA and the SCA results of the parents found useful in estimation of different type of gene trials which owns the legacy of traits. Information of environment and the extent about gene action scheming yield and its gears are very much useful for crop enhancement. Combining ability studies gives the knowledge on two parameters of variance. Its major part is very significant to choose the parents, crosses, acceptance of a suitable breeding process to be followed to choose attractive sergeants (Salgotra et al., 2009).

Feasibility of breeding of salts tolerance in rice, as there was no antagonism between high yield and salt tolerance (Mahmood, 2002). Salinity is serious condition of environment which

adversely counters physiological processes of plant and severely affects plants productions (Singh & Diw, 2017). General and specific combining ability studies are powerful tool existing to calculate General and specific combining abilities and the aid in choosing the attractive the parent or cross. The combining abilities study provides an alert of the variance because of general and specific combining ability which follow a relation calculation of additives and non-additives genes action. Breeder uses these variances component to calculate the genes actions and assess the genetics abilities of parent in hybrids combination. Lines x testers study is called as the most potent tool for calculating general GCA of parent and selections of most attractive parent and cross with the higher SCA for exploitations of heterosis. Important GCA and SCA for yields and yields component was highlighted. Hence the following studies were done to evaluate the genes actions, GCA and SCA for yields and yields contribution of trait in the rice (*Oryza sativa* L.).

Hence, enhancing the production is of higher significance in breeding program. Decreased plants height, moderates tillering, and compacts panicles, enhanced kernels number per panicles, enhanced thousands of kernels weight, high yields are much important rice traits to be improve in breeding programs (Paterson et al., 2005), result best cross combinations is of higher significance. Lines × testers study is mostly use to evaluation of GCA and SCA abilities of different line and also to calculate gene

results and its very helpful in decide of relative abilities of females and the male line to create the attractive hybrids combination. It gives information on genetics component and also enables breeder to select suitable breeding procedure for hybrids varieties or genotypes creation program. Magnitude of the genes actions involves in the appearance of qualitative trait very vital for the booming creation of crops genotypes. Many workers signified the prevalence of main genes actions for a greater part of the yields trait but a scientist examined the prevalence of additives genes actions. Predominance of non-additives genes actions in the expressions of yields and yields linked traits. The plant breeders (Swati, Prashant Goel, & Ramesh, 2004) examined higher heritability for grains yields and reasonable heritability plants height. The scientist (Saleem, Mirza, & Haq, 2008) observed higher specific heritability including the higher genetics advances in reaction to the choices in next populations for all analyzed characters.

In following research attempt were made to studied GCA and SCA or hybrids vigor in F1 hybrid for the tillers numbers, plants heights, panicle lengths, spikelets per panicle for each and grains yields trait.

MATERIAL AND METHODS

Research trial was conducted with nine genotypes, including six lines and three testers. Six lines were consisting of Basmati 2000, Super Basmati, Shaheen Basmati, Bas-198, Bas-515, 5170 while Basmati-385, Basmati-Pak, KS-282 were used as three testers. To conduct the experiment, the selections of seeds were made according to their conditions as they should be healthy and viable.

Nursery Sowing

Three different sets were used for the sowing purpose of research or experimental material. At 1st May of 2017, the 1st set of all genotypes were sown, while for the surety of the synchronization of flowering time, other two sets were sown after ten days of sowing of 1st set. Separated seedbed was prepared on loamy soil for the sowing of the seeds of rice genotypes. Farmyard manure and thin layer of silt mixture was placed in ratio of about 3:1 for the covering of seeds. The beds were irrigated with showers for two times on daily basis. To avoid the seedlings from heat and for the conservation of moisture were covered with wheat straw and date palm branches till they got height of 1.5".

Transplanting of the Nursery Seedlings

Transplantation of seedlings was done after thirty days. They were transferred on the sandy loam soil of the research field having dabbled hybridization block in three sets. The distance between rows of genotypes and plant to plant were 25cm respectively and each row contained ten plants. The distance between two genotypes was one meter. This area was left for the collection of pollen from the testers and cultural practices. Regarding the sowing date there were three hybridization blocks.

Irrigation Schedule

Proper irrigation was cared for the production of the crop. It was cared that water level should be increased gradually from 4.0 cm to 8.0 cm at the time of transplantation. The crop irrigation was stopped after of 7 to 10 days of interval to make sure aeration and then continued.

Line × Tester Crosses

Line × tester analysis was designed with six lines and three testers create 18 F1 hybrids (Kempthorne, 1957). Testers and lines were not selfed and each male tester was mated with each line. The soil lump was used for uprooting of the plants of lines to save them from shocks of moisture deficient and earthen pots filled with fertile soil were used for their transplantation depending upon the flowering stage. Irrigation was done on daily basis for these pots and after placing in wire house emasculation was started.

For the emasculation purpose, the only flowers were kept that will bloom and remaining spikelet that was immature consisting early flowering were removed successfully. For the fertilization purpose, the florets of panicle were clipped off with an oblique position having top 1/3 of lemma and palea just before the anthers. For emasculation, tweezers were used. The butter paper bags were used for the covering of panicles which were emasculated for the prevention of crossing. The paper tag tied with the plant was used to write the date of emasculation on it.

Pollination

For the confirmation of that no anther remained on any floret, emasculated florets were again checked before pollination in the next morning. The panicles of the testers that were shedding pollens were taken for pollination purpose between (9:00 am to 10:00 am) and collected panicles were shaken on the florets of each panicles of each line. The line and testers were identified from pollinated panicles. After F1 seed harvesting the collected Seeds dried and stored at room temperature for sowing of next year.

Field Experiment

Separate seed beds were prepared for the sowing of 18 crosses and nine parents as described during season in 2018. The same pattern was used for sowing of nursery as same in 2017 sowing. With the randomized block design, seedlings of 25 old days were transplanted in the field. Total three replications were done with the various 27 genotypes. Three rows were used for the plantation of each genotype consisting 10 plants for each row. The row to row and plant to plant distance was 25 cm. For the minimization of border effects, the non-experimental rice varieties were grown on the side of the border side of each genotype. The above described fertilizer requirements were used with specific pattern. At the time of transplantation half of the nitrogen was applied while rest of the concentration was applied in two doses. From remaining half dose, half was used after thirty-day transplantation and remaining half was used after sixty days of transplantation. During the nursery transplantation, full dose of P was applied. Irrigation and protection measures followed as was in first season of sowing. Controlled irrigation was stopped before 15 days of harvesting.

For salinity experiment nursery (18 crosses) were shifted into saline soil plot with 5 dsm salinity. Salinity plot area was dug 1 foot deep. A polythene sheet was laid to avoid any leaching of salts, which could affect both data and also pollute nearby healthy land.

Agronomic Traits Measured like PH, NTP, SWP), Panicle length (PL), Number of grains per panicle (NGP), 1000-grain weight (TGW), Yield per plant (YP)

Statistical Analysis

All of the analysis was performed for normal and salinity stress conditions separately and their results were compared. The observed data were initially subjected to ANOVA technique obtained from lines, testers and crosses made by Steel and Torrie (Steel & Torrie, 1960). Genotypes showing significant difference for traits were subjected to L×T (Kempthorne 1957). Genetic components were calculated following Contribution of lines, testers and their interaction to the total variance calculated using the methods given by Singh and Chaudhary (Singh & Chaudhary, 1977).

RESULTS AND DISCUSSION

Seven different traits were used to record the data and then subjected for the analysis of variance used by (Singh and Chaudhary, 1985) to find out differences among rice genotypes. Mean squares are represented in Table 1. Results were highly significant ($P = 0.05$ and 0.01) in all the selected genotypes. The analyses were conducted for salinity stress and their results were compared with the treatments under normal conditions. Results about lines, testers and crosses were subjected to analysis of variance by using the techniques of Steel and Torrie (1980). Genotypes showing significant difference for traits were subjected to L×T. All genotypes were showing significance so further preceded for L×t analysis (Kempthorne, 1957).

This genotypic SS were further segregated into parents, parents vs. crosses and crosses. Their results were also showed highly significant results among themselves. Genotypic significance results among parents and hybrids explained the indication of genetic variability to be manipulated for the betterment of production and their several contributing traits. Genetic variability among different characters have always been valuable such as height, tiller count/plant, length of panicle, 1000 grains weight and total yield/ plant and these results were explained by numerous researchers including, Sharma (Sharma & Mani, 2005). Significance of relative water have also been said by Gomez and Kalmani (Gomez & Kalamani, 2003). After this SS for crosses were divided into lines, testers and line × tester components. All the traits showed significance results among lines except panicle length and total production/ plant. However, interaction between testers and line × tester showed significant results among all characters. Mean square significance due to lines (females) and testers (males) showed prevalence of additive variance even though mean square significance due to line × tester exhibited non-additive variances that were important for them (Mishra & Verma, 2002). Plant height (PH), Number of tillers per plant (NTP), Seed weight per panicle (SWP), Panicle length (PL), Number of grains per panicle (NGP), 1000-grain weight (TGW), Yield per plant (YP)

Combining Ability Effects under normal conditions

Plant Height (PH)

Under normal conditions, Lines had mean square value of 135.47 whereas testers had 0.39 mean square for plant height and L×T was 35.06. In General, combining ability highest performer line was Bas-198 (3.63) and lowest was Bas-2000 (2.98). In specific

combining ability the best performer was Bas-198* KS-282 (-5.61). Meanwhile the variance of half sib line was 11.15679 and testers was -1.92593 and the average stands at 0.763179. And σ_{SCA} is 3.20 contribution of lines was 65.8% and testers contributed 0.076% and L×T contribution stands at 34.07%.

Under salinity stress conditions, Lines had mean square value of 541.63 which was significant whereas testers had 33.64 mean square for plant height and L×T was 101.71 which was also significant. While in General combining ability highest performer line was Bas-2000 (-10.02) and lowest was Bas-198 (8.23). In specific combining ability, the best performer was Bas-2000 * Bas-Pak (-4.14). Meanwhile, the co-variance of the half-sib line was 48.88 and testers were -3.78, and the average stands at 3.64. And σ_{SCA} is 29.96. The contribution of lines was 71.41% and testers contributed 1.77% and ×T contribution stands at 26.8%.

Panicle Length (PL)

In normal experiment, Lines had mean square value of 1.42 whereas testers had 1.56 mean square for plant Panicle length and L×T was 1.62. While in General combining ability highest performer line was Bas-198 (1.5) and lowest was Shaheen Basmati (-0.97). In specific combining ability the best performer was Bas2000*Ks-282 (1.84) and lowest was Bas-198*Ks-282 (1.2). Meanwhile co variance of half sib line was -0.02184 and testers was -0.00357 and average stands at -0.00196 and σ_{SCA} was 0.148. Contribution of lines was 26.92% and testers contributed 11.77% and L×T contribution stands at 61.3%.

Under salt stress conditions, Lines had mean square value of 1.42 whereas testers had 1.56 mean square for plant Panicle length and L×T was 1.62. While in General combining ability highest performer line was Bas-198 (1.8) and lowest was BAS-2000 (-2.3). In specific combining ability the best performer was Bas2000*Ks-282 (3.09) and lowest was Bas-2000*Bas-Pak (-1.7). Meanwhile co variance of half sib line was 0.016 and testers was -0.297 and average stands at -0.0176 and σ_{SCA} was 1.43. Contribution of lines was 33.22% and testers contributed 1.87% and L×T contribution stands at 64.90%.

Number of Tillers per Plant (NTP)

Under normal experiments, Lines had mean square value of 18.02 whereas testers had 19.57 mean square for Tillers per plant and L×T was 42.95. While in General combining ability highest performer line was Super Basmati (2.09) and lowest was Bas-2000 (-2.2). In specific combining ability the best performer was Super Basmati*Bas-Pak (3.48) and lowest was Shaheen Basmati*Bas-pak(-3.7). Meanwhile co variance of half sib line was -2.77037 and testers was 0.089798 and average stands at -0.30233. And σ_{SCA} is 11.53. Contribution of lines was 16.12369% and testers contributed 7% and L×T contribution stands at 76.87%.

Under salinity stress conditions, Lines had mean square value of 33.19 whereas testers had 17.13 mean square for Tillers per plant and L×T was 42.29 which was significant. While in General combining ability highest performer line was 5170 (3.5) and lowest was Shaheen-Basmati (-2.84). In specific combining ability the best performer was Bas-198*Bas-Pak (4.62) and lowest

was Bas-198*Ks-282(-3.02). Meanwhile co variance of half sib line was -1.01 and testers was -1.4 and average stands at -0.169. And σ SCA is 11.81. Contribution of lines was 26.63 % and testers contributed 5.5% and L×T contribution at 67.87%.

Number Grains per Panicle (NGP)

Under non-stressed conditions, Lines had mean square value of 537.93 whereas testers had 810.57 which was significant mean square for Grains per Panicle. While L×T was 289.51 which was also significant. While in General combining ability highest performer line was Bas-2000 (5.4) and lowest was Bas-515 (-8.44). In specific combining ability the best performer was Bas198*Ks-282 (6.2). Meanwhile co variance of half sib line was 27.60 and testers was 28.95 and average stands at 4.02. And σ SCA is 88.63. Contribution of lines was 37.33% and testers contributed 22.5% and L×T contribution stands at 40.2%. Under salinity stress conditions, Lines had mean square value of 2703.72 whereas testers had 288.13 which was significant mean square for Grains per Panicle. While L×T was 1925.35 which was also significant which was also significant. While in General combining ability highest performer line was Super Basmati (16.44) and lowest was Bas-2000 (-16.17). In specific combining ability the best performer was Shaheen Basmati*Bas-385 (6.2). Meanwhile co variance of half sib line was 86.45 and testers was -90.96 and average stands at 1.089. And σ SCA is 634.9. Contribution of lines was 40.53% and testers contributed 1.73% and L×T contribution stands at 57.74%.

Seed Weight per Panicle (SWP)

In non-stressed experiment, Lines had mean square value of .93 whereas testers had .64 for mean square for seed weight per Panicle. While L×T was 0.63 which was significant. While in General combining ability highest performer line was Bas-198 (2.02) and lowest was Super Basmati (-2). In specific combining ability the best performer was Shaheen Basmati*Bas-pak (1.95). Meanwhile co variance of half sib line was 0.0335 and testers was 0.0007 and average stands at 0.002 and σ SCA is 0.1087. Contribution of lines was 38.09% and testers contributed 10.49% and L×T contribution stands at 51.41%.

Under salinity stress conditions, Lines had mean square value of 1.79 whereas testers had .96 which was significant for mean square for Grains weight main Panicle. While L×T was 1.29 which was also significant. While in General combining ability highest performer line was Bas-198 (3.17) and lowest was Super Basmati (-3.57). In specific combining ability the best performer was Shaheen Basmati*Bas-pak (2.38). Meanwhile co variance of half sib line was 0.055 and testers was -0.0185 and average stands at 0.0032 and σ SCA is 0.33. Contribution of lines was 37.63% and testers contributed 8.05% and L×T contribution stands at 54.31%.

1000 Grain Weight (TGW)

In normal experiment, Lines had mean square value of 26.53 whereas testers had 72.13 gram for mean square which is significant for Grains per Panicle. While L×T was 19.63 which

was also significant. While in General combining ability highest performer line was Bas-2000 (2.1) and lowest was Bas-515 (-2.1). In specific combining ability the best performer was Super Basmati*Ks-282 (2.2). Meanwhile co variance of half sib line was 0.766 and testers was 2.94 and average stands at 0.25 and σ SCA is 3.8. Contribution of lines was 27.97% and testers contributed 30.6% and L×T contribution stands at 41.41%.

Under salt stress conditions Lines had mean square value of 28.58 whereas testers had 115.54 gram for mean square which is significant for Grains per Panicle. While L×T was 27.9 which was also significant. While in General combining ability highest performer line was Bas-198 (1.8) and lowest was Super Basmati (-1.5). In specific combining ability the best performer was Super Basmati*Ks-282 (2.02). Meanwhile co variance of half sib line was 0.076 and testers was 4.87 and average stands at 0.31 and σ SCA is 4.96. Contribution of lines was 21.89% and testers contributed 35.39% and L×T contribution stands at 42.72%.

Yield per Plant (YP)

Under normal conditions, Lines had mean square value of 177.79 whereas testers had 122.93 gram which was significant for mean square for Grains per Panicle. While L×T was 161.23 which was significant. While in General combining ability highest performer line was Bas-515 (3.33) and lowest was Super Basmati (-6.71). In specific combining ability the best performer was Bas-515*Bas-Pak (4.78). Meanwhile co variance of half sib line was 1.84 and testers were -2.12 and average stands at 0.011. And σ SCA is 49.18. Contribution of lines was 32.36% and testers contributed 8.95% and L×T contribution stands at 58.69%. Under salinity stress conditions, Lines had mean square value of 285.21 whereas testers had 142.57 gram which was significant for mean square for Grains per Panicle. While L×T was 280.47 which was also significant. While in General combining ability highest performer line was Bas-515 (4.8) and lowest was Super Basmati (-7.3). In specific combining ability the best performer was Bas-515*Bas-Pak (6.6). Meanwhile co variance of half sib line was 0.53 and testers were -7.66 and average stands at 0.44, while σ SCA is 88.5. Contribution of lines was 31.58% and testers contributed 6.31% and L×T contribution stands at 62.1%. Mean performance and GCA effects by parents with nature of combining ability were used as a selection of parent for hybridization. Parents with better GCA effects and performance always considered desired and good parents. Alone SCA effects of hybrids have inadequate values as a parental choice for breeding programs and this was considered that SCA effects should be used along with the as hybrid means and GCA of the respective parents (Kenga, Alabi, & Gupta, 2004).

Table 1: Analysis of variance according to L×T design for various traits of rice in normal conditions

Source	d.f	PH	PL	NTP	NGP	SWP	TGW	YP
Replication	2	22.26ns	0.9ns	44.79*	2.11ns	0.29ns	3.66ns	7.18ns
Genotypes	26	536.73*	6.87*	59.78*	6573.32*	1.05*	45.31*	589.27*
Parents	8	367.33*	2.58*	25.01*	4816.7*	1.89*	26.37*	859.88*
Crosses	17	60.51*	1.55ns	32.87*	423.87*	0.72*	27.89*	161.59*
P. vs Crosses	1	9987.56*	131.58*	795.56*	125166.72*	0.02ns	493.01*	5694.82*
Lines	5	135.47*	1.42ns	18.02ns	537.93ns	0.93ns	26.53ns	177.79ns
Testers	2	0.39ns	1.56ns	19.57ns	810.57*	0.64ns	72.57*	122.93*
L x T	10	35.06ns	1.62ns	42.95*	289.51*	0.63*	19.63*	161.23*
Error	52	25.45	1.18	8.35	23.62	0.30	8.21	13.67

Note: *significant, N. S=Non-significant

Table 2: Analysis of variance according to L×T design for various traits of rice in salinity conditions

Source	d.f	PH	PL	NTP	NGP	SWP	TGW	YP
Replication	2	27.46ns	4.02ns	8.64ns	38.04ns	0.11ns	7.25ns	41.9ns
Genotypes	26	291.26*	4.94*	33.41*	5359.57*	1.75*	35.55*	498.82*
Parents	8	367.33*	2.58ns	25.01*	4816.7*	1.89*	26.37ns	859.88*
Crosses	17	223.09*	5.66*	36.65*	1961.67*	1.4*	38.41*	265.64*
P. vs Crosses	1	841.41*	11.47*	45.65*	67466.89*	6.49*	60.37*	1574.23*
Lines	5	541.63*	6.4ns	33.19ns	2703.72ns	1.79ns	28.58ns	285.21ns
Testers	2	33.64ns	0.9ns	17.13ns	288.13*	0.96*	115.54*	142.57*
L x T	10	101.71*	6.25*	42.29*	1925.35*	1.29*	27.9*	280.47*
Error	52	11.85	1.95	6.85	20.68	0.29	13.01	14.97

Note: ** Highly significant, *significant, N.S=Non-significant

Table 3: General combining ability effect of lines and testers for different parameters in rice genotypes under normal conditions

Parents	PH	PL	NTP	NGP	SWP	TGW	YP
Super Basmati	-0.79NS	-0.57NS	2.10*	1.63NS	-2.00*	-1.62NS	-6.72*
Shaheen Basmati	0.46NS	-0.97NS	0.71NS	-1.79*	1.68*	1.53NS	2.57*
Bas-2000	-2.97*	-0.91NS	-2.29*	5.41*	0.97NS	2.12*	-0.24NS
Bas-198	3.63*	1.55NS	0.13NS	2.66*	2.03*	1.10NS	-0.36NS
Bas-515	1.19NS	-0.30NS	-0.79NS	-8.45*	-1.32NS	-2.10*	3.33*
5170	-1.52NS	1.21NS	0.13NS	0.54NS	-1.36NS	-1.03NS	1.41NS
S.E (G.C.A) Lines	1.68	0.36	0.96	1.62	0.18	0.96	1.23
Bas-Pak	0.09NS	-1.01NS	0.92NS	6.48*	0.29NS	3.01*	0.35NS
Bas-385	-0.14NS	-0.25NS	0.84NS	-1.57NS	1.29NS	-2.94*	-3.16*
KS-282	0.05NS	1.25NS	-1.77*	-4.91*	-1.58NS	-0.07NS	2.81*
S.E(G.C.A)Testers	1.19	0.26	0.68	1.15	0.13	0.68	0.87

Table 4: Specific combining ability effect of 18 crosses on different parameters in rice genotypes under normal condition

Crosses	PH	PL	NTP	NGP	SWP	TGW	YP
Super Basmati * Bas-Pak	0.72NS	0.93NS	3.48*	-0.82NS	-0.97NS	-0.90NS	-4.34*
Super Basmati * Bas-385	-0.21NS	-0.50NS	-1.08NS	0.56NS	-0.08NS	-1.31NS	0.99NS
Super Basmati * KS-282	-0.51NS	-0.42NS	-2.41*	0.26NS	1.05NS	2.22	3.35*
Shaheen Basmati * Bas-Pak	-0.57NS	-0.39NS	-3.71*	4.48*	1.95*	1.44*	-0.48NS
Shaheen Basmati * Bas-385	-0.25NS	1.11NS	2.32*	1.00NS	-0.21NS	0.26NS	-2.51*
Shaheen Basmati * KS-282	0.82NS	-0.72NS	1.39NS	-5.48*	-1.74*	-1.70NS	2.99*
Bas-2000 * Bas-Pak	-0.65NS	-0.95NS	1.02NS	-0.03NS	-0.67NS	-2.01*	2.96*
Bas-2000 * Bas-385	-0.90NS	-0.89NS	-1.54NS	1.71*	-0.27NS	0.72*	-1.38NS
Bas-2000 * KS-282	1.54NS	1.85*	0.52NS	-1.68*	0.94NS	1.28NS	-1.58NS
Bas-198 * Bas-Pak	1.60NS	1.35NS	-1.38NS	-2.61*	-0.81NS	-0.59NS	-2.84*
Bas-198 * Bas-385	0.32NS	-0.08NS	1.25NS	-3.60*	0.63NS	0.25NS	1.90*

Bas-198 * KS-282	-1.93*	-1.27NS	0.12NS	6.20*	0.18NS	0.34NS	0.95NS
Bas-515 * Bas-Pak	-0.53NS	0.07NS	1.35NS	-1.42NS	0.27NS	1.34NS	4.78*
Bas-515 * Bas-385	0.93NS	0.24NS	-1.01NS	1.51NS	-1.56NS	-0.16NS	-0.94NS
Bas-515 * KS-282	-0.40NS	-0.32NS	-0.34NS	-0.09NS	1.29NS	-1.18NS	-3.84*
Bas-Pak * 5170	-0.57NS	-1.01NS	-0.78NS	0.40NS	0.23NS	0.72NS	-0.07NS
Bas-385 * 5170	0.10NS	0.12NS	0.06NS	-1.18NS	1.50NS	0.25NS	1.93*
KS-282 * 5170	0.48NS	0.89NS	0.72NS	0.78NS	-1.72*	-0.97NS	-1.86*
S.E _(S.C.A) =	2.91	0.63	1.67	2.81	0.32	1.65	2.13

Note: *significant, N. S=Non-significant

Table 5: General combining ability effect of lines and testers for different parameters in rice genotypes under salinity conditions

Parents	PH	PL	NTP	NGP	SWP	TGW	YP
Super Basmati	2.60*	1.07NS	-0.68NS	16.44*	-3.57*	-1.51NS	-5.99*
Shaheen Basmati	-6.05*	-2.23*	-2.84*	-6.94*	1.98*	0.58NS	2.14*
Bas-2000	-10.02*	-2.34*	-1.44NS	-16.18*	0.79NS	1.45NS	3.85*
Bas-198	8.23*	1.86*	0.47NS	2.88*	3.17*	1.83*	-0.05NS
Bas-515	1.33NS	0.71NS	0.98NS	-3.49*	-1.70*	-1.44NS	-2.63*
5170	3.91*	0.93NS	3.52*	7.28*	-0.67NS	-0.91NS	2.69*
S.E(G.C.A)Lines =	1.15	0.47	0.87	1.52	0.18	1.20	3.34
Bas-Pak	1.94*	0.23NS	1.65NS	2.89*	0.56NS	2.60*	-1.37NS
Bas-385	-1.07NS	-0.77NS	-1.50NS	1.33NS	1.46NS	-3.25*	-3.22*
Ks-282	-0.87NS	0.53NS	-0.15NS	-4.22*	-2.03*	0.65NS	1.81*
S.E(G.C.A)Testers =	0.81	0.33	0.62	1.07	0.13	0.85	0.91

Table 6: Specific combining ability effect of 18 crosses on different parameters in rice genotypes under salinity condition

Crosses	PH	PL	NTP	NGP	SWP	TGW	YP
Super Basmati * Bas-Pak	3.46*	1.99*	-0.01NS	-3.97*	-1.25NS	-0.55NS	-5.99*
Super Basmati * Bas-385	-3.24*	-1.45NS	-0.05NS	0.47NS	0.07NS	-1.48NS	2.14*
Super Basmati * KS-282	-0.22NS	-0.54NS	0.06NS	3.50*	1.18NS	2.03*	3.85*
Shaheen Basmati * Bas-Pak	0.10NS	-1.40NS	0.36NS	-9.13*	2.38*	1.09NS	-0.05NS
Shaheen Basmati * Bas-385	0.24NS	0.86NS	0.76NS	17.78*	-0.16NS	0.12NS	-2.63*
Shaheen Basmati * KS-282	-0.34NS	0.54NS	-1.12NS	-8.65*	-2.21*	-1.20NS	2.69*
Bas-2000 * Bas-Pak	-4.15*	-1.75*	-0.01NS	7.37*	-1.21NS	-2.22*	3.34*
Bas-2000 * Bas-385	2.45*	-1.34NS	0.61NS	-7.10*	-0.65NS	1.14NS	-1.97*
Bas-2000 * KS-282	1.70*	3.09*	-0.60NS	-0.27NS	1.86*	1.08NS	-1.37NS
Bas-198 * Bas-Pak	-1.15NS	0.58NS	4.62*	2.46*	-1.14NS	-0.27NS	-3.22*
Bas-198 * Bas-385	2.11*	0.82NS	-1.59NS	2.59*	0.88NS	0.00NS	1.81*
Bas-198 * KS-282	-0.96NS	-1.40NS	-3.03*	-5.05*	0.27NS	0.27NS	1.41NS
Bas-515 * Bas-Pak	-2.15*	-0.62NS	-2.51*	5.00*	0.42NS	0.72NS	6.60*
Bas-515 * Bas-385	0.43NS	0.62NS	0.98NS	-3.63*	-2.29*	0.02NS	-2.75*
Bas-515 * KS-282	1.72*	0.00NS	1.53NS	-1.37NS	1.88*	-0.74NS	-3.85*
Bas-Pak * 5170	3.88*	1.20NS	-2.44*	-1.73*	0.82NS	1.23NS	-0.68NS
Bas-385 * 5170	-1.98*	0.49NS	-0.71NS	-10.11*	2.16*	0.20NS	3.41*
KS-282 * 5170	-1.90*	-1.69*	3.15*	11.84*	-2.98*	-1.43NS	-2.73*
S.E _(S.C.A) =	1.99	0.81	2.81	2.63	0.31	2.08	2.23

CONCLUSION

A major challenge to rice growing is salinity, which has an effect on a crop that is essential to the world's food security. Using a line × tester analysis with six females and three male parents, this study explores the impact of salinity on rice

genotypes, producing eighteen F1 hybrids. Nine characteristics were evaluated, such as plant height and yield per plant. Under typical circumstances, Super Basmati fared poorly while Bas-2000 and Bas-198 did admirably. Testers appeared to be divided between Super Basmati and Bas-385. Ks-282 fared well

in salinity whereas Super Basmati suffered. Super Basmati × Bas-Pak in normal conditions and Shaheen-Basmati × Bas-Pak in salinity were two notable crosses. Top performers were Bas-515 and Bas-515 × Bas-Pak. Grain yield was highly impacted by line × tester interactions, wherein L×T accounted for 62.1% of genetic variance under salinity. This study highlights the complex relationships that exist between different rice genotypes under different circumstances, highlighting how crucial it is to choose the best combinations for increased yield and resilience.

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