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ORIGINAL ARTICLE

# Evaluation of rice (Oryza sativa L.) Lines for morphological characteristics using line*tester analysis

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## ABSTRACT

To study the combining behavior of quantitative traits in rice, line*tester (4*3) progeny was generated involving 7 parents; 4 different lines,namely Super Basmati,Basmati 385, Basmati515 and KSK 133 and 3 well-adapted testers, namely, Basmati 198, PK 386 and KS 282. Super basmati, Basmati 515, Basmati198, Basmati 385, KSK 133 and PK 386 were found to be effective general combiners that provide excellent segregates for further selection. Basmati 385* KS 282, Super Basmati* KS 282, KSK 133* PK 386, Super Basmati* PK 386 and Basmati515* KS 282 hybrid combinations have higher specific combining ability (SCA) effects on grain yield and its components and can be used to exploit hybrid vigor to increase yields.

KEY WORDS
Rice;
Line*Tester;
Combiningability;
Gene action

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## Introduction

This is particularly important in regions such as Asia, where agricultural landscapes are dominated by rice cultivation [1,2].
Improving rice yield is a difficult challenge due to its polygenic characteristics and multipleyield-influencing factors, such as plant height, panicle length, grain number, and thousand-grain weight [3].

To significantly increase rice yields,it is crucial to understand the genetic architecture behind these traits. Traditional breeding methods, while effective to some extent, often fail to exploit the full genetic potential due to their limited ability to analyze complex relationships between genes. Quantitative genetics and biometricmethods, such as Line*Tester (L*T)analysis, provide a precise method to assess genetic variation and interactions in rice breeding [4]. Line*Tester analysis helps breeders evaluate the ability of different parent lines to work together, which is critical for cross-generation and genetic improvement.

Line*Tester analysis focuses on GCA and SCA, including dominance and epistasis [5]. GCA is critical for identifying parents who impart desired traits to their offspring across a broad range of genetic backgrounds, while SCA reveals the unique performance of certain cross combinations. Understanding these genetic characteristics is critical to producing high-yielding rice varieties that are both productive and stable in different environments [6].

Selection of superior lines and test items with high GCA and SCA values can help accelerate hybrid rice breeding. These promising parents produce rice hybrids that are superior to standard inbred varieties in terms of yield and resistance to environmental stress [7]. L*T analysis can help breeders selectsuperior parent and hybrid combinations with high hybridvigor, thereby improving yield and traits [8-10]

This study used Line*Tester analysis to evaluate the genetic potential of various rice lines and testers, focusing on yield and yield-related parameters. This study aimed to identify potential hybrids that can help produce high-yielding and stress-tolerant rice varieties by examining the synergistic abilities of selected parental lines. Given the ongoing difficulties faced by climate change and the growing demand for food, the need for improved varieties is greater than ever [11]. The study hypothesizes that by using this approach, it will be able to provide useful insights into the genetic mechanisms controlling rice productivity, thereby assisting breeding efforts to ensure future food security.

## Materials and Methods

This experiment was conducted in the research area of Faculty of Agricultural Sciences at the University of the Punjab, Lahore during the year 2022-23.The germplasm was composed of super Basmati, Basmati 385, Basmati 515, KSK-133 (females). And the testers Basmati 198, PK 386 and KS-282 (males). The F1 hybrids were developed by using Lines*Testers 4*3 design. The crosses among line and testers yielded 12 F1 hybrids. During the first growing season, lines and testers were grown. At the anthesis stage, crossing was done between lines and testers to produce F1 hybrids. In the following growing season, lines, testers, and hybrids were grown separately and compared based on multiple parameters such as plant height, spikelets/panicle, panicle length, grains yield per plant and 1000 grainsweight. The plant height was measured using a Stadiometer from the base of the stem to the top of the plant. The weight of 1000 grains were also determined by weighing them and calculating the result. The overall grain yield for each plant was also calculated. After calculating all of the factors, GCA and SCA were calculated using an Excel sheet.

## Results and Discussions

This experiment was conducted to ascertain the impact of General CombiningAbility (GCA) and Specific Combining Ability (SCA) on various parameters in Line*Tester analysis

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with seven parents. Four parents were used as lines, while three parents were used as testers.

## Analysis of Variance (ANOVA)

After studying several aspects of rice breeding, the results revealed interesting designs and significantimprovements to the crop. An important parameter that determines floweringtime and maturity, the number of days to reach 50% flowering, showed significant differences between genotypes, parents and hybrids (Table 1). This suggests that this parameter has considerable genetic influence, allowing plant breeders to select specific flowering times based on environmental conditions. Likewise, plant height and panicle length are important characteristics for yieldand lodging resistance, yielding significant resultson all parameters. It demonstrates more genetic differences between all parameters, allowing plant breeders to modify plant structure to improve yield and performance.

Grain yield per plant is the main characteristic used to calculate total yield varied significantly between genotypes, parental lines and crosses. This shows that grain yieldis influenced by genetics and environment. Plant breeders can focus on selecting superior genotypes and combinations of different parents. They must focus on agronomic measures to increase yields.

**Table 1.** Mean square valuesof all parameters of 7 parents and 12 F2 populations were evaluated by line*tester analysis (4*3) of Rice during the year 2022-23 at FAS.

| Source of Variation (SOV) | D 50%F | PH (cm) | Spikelets/panicle (no.) | PL (cm) | GY/P (g) | 1000 GW (g) |
|---|---|---|---|---|---|---|
| Rep (Replications) | 4.895 | 3.211 | 0.158 | 0.684 | 3.807 | 1.596 |
| Gen (Genotypes) | 148.994* | 449.452* | 250.78 | 26.973* | 58.885* | 25.195 |
| Parents | 184.079* | 780.603* | 393.714 | 43.857* | 67.095* | 40.206 |
| Crosses | 143.081* | 294.270* | 184.21 | 19.515* | 45.422* | 14.977 |
| P*C | 3.53 | 169.549 | 125.444 | 7.699 | 157.72 | 47.521 |
| L (Lines) | 229.667 | 672.917 | 426.62 | 33.407 | 85.583 | 26.25 |
| T (Testers) | 425.528 | 581.861 | 360.028 | 53.083 | 108.69 | 42.25 |
| L*T | 5.639 | 9.083 | 4.398 | 1.38 | 4.25 | 0.25 |
| Error | 43.173 | 59.845 | 45.574 | 5.138 | 18.627 | 6.972 |

## General Combining Ability (GCA)

Table 2 shows the GCA effectsof the parents. Regarding grain yield per plant, two lines; Basmati 385 and KSK 133 and one tester PK 386 showed significant and desirable GCA effects, in line with the work of, who documented several promising rice genotypes with high GCA effects [12]. For panicle length; KSK 133 among lines and PK 386 among testers showed significant and desirable GCA effects. Basedon GCA effects, Super Basmati and Basmati 515 among the lines and Basmati 198 among the testers were considered to be good general combiners for reducing plant height, while Basmati 385, KSK 133 and PK 386 are considered to increase grain yield per plant. High GCA effects indicate the presence of beneficial genes with additive genetic effects.As a result, a multiple-crossing program using the good generalcombiners found in this work is recommended to create superior genotypes.

**Table 2.** General combining ability effects among lines and testers for various traits were evaluated in 4*3 mating design of Rice during the year 2022-23.

| Parental Genotypes | D 50%F | PH (cm) | Spikelets/panicle (no.) | PL (cm) | GY/P (g) | 1000 GW (g) |
|---|---|---|---|---|---|---|
| Lines | | | | | | |
| super Basmati | -5.94 | -2.47* | -2.53 | -0.89 | -2.03 | -0.92 |
| Basmati 385 | -1.94 | 4.53 | 2.03 | 0.67 | 1.42* | 1.08* |
| Basmati 515 | 2.17 | -10.92* | -7.86 | -2.11 | -3.03 | -1.92 |
| KSK 133 | 5.72 | 8.86 | 8.86 | 2.33* | 3.64* | 1.75* |
| Testers | | | | | | |
| Basmati 198 | -5.53 | -0.31* | | 0.33 | -0.28 | 0.08 |
| PK 386 | -0.78 | 7.11 | 5.19 | 1.92* | 3.14* | 1.83* |
| KS 282 | 6.31 | -6.81 | -5.72 | -2.25 | -2.86 | -1.92 |



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## Specific Combining Ability (SCA)

Specific combining ability (SCA) effectsare presented in Table 3 and none of the hybrids showed significant and desirable SCA effects on all parameters. However, in terms of grain yield per plant, three hybrid combinations; Super Basmati*KS 282, Basmati 385*KS 282 and KSK 133*PK 386 emerged as promisingspecific combinations due to their SCA effect.These findings are consistent with the high SCA effects observed in several promising specific combiners to increase yield per plant reportedby Singh [13]. For other traits, different sets of cross combinations were identified as good specificcombinations based on their SCA effects. KSK 133*Basmati 198 and Basmati 385*KS 282 were effective in early flowering, while three combinations; Basmati 515*KS 282, Basmati 385*PK 386 and Super Basmati*PK 386 were found to reduceplant height. As discussed by Shrivastava, these results are consistent with the identification of top-specific combiners of shorter plant heights [14].

**Table 3.** SCA of hybrids for all parameters.

| F2 Population | Days to 50% Flowering | Plant Height (cm) | Spikelets per panicle (no.) | Panicle length (cm) | Grain Yield/Plant (g) | 1000 Grains Weight (g) |
|---|---|---|---|---|---|---|
| super Basmati *Basmati 198 | -0.14 | -0.03 | -0.03 | -0.11 | 0.94* | -0.08 |
| super Basmati * PK 386 | -1.22 | -1.44* | 0 | -0.36 | -1.47 | 0.17 |
| super Basmati * KS 282 | 1.36 | 1.47 | 0.03 | 0.47 | 0.53* | -0.08 |
| Basmati 385* Basmati 198 | 1.53 | 0.31 | 0.03 | 0.33 | -1.17 | -0.08 |
| Basmati 385* PK 386 | -0.22 | -1.44* | 0.04 | 0.75 | 0.08 | 0.17 |
| Basmati 385* KS 282 | -1.31* | 1.14 | -0.07 | -1.08 | 1.08* | -0.08 |
| Basmati 515* Basmati 198 | 0.08 | -0.25 | 0 | 0.11 | 0.28 | -0.08 |
| Basmati 515* PK 386 | 0.33 | 2.33 | -0.02 | -0.47 | 0.86* | 0.17 |
| Basmati 515* KS 282 | -0.42 | -2.08* | 0.02 | 0.36 | -1.14 | -0.08 |
| KSK 133* Basmati 198 | -1.47* | -0.03 | 0 | -0.33 | -0.06 | 0.25 |
| KSK 133* PK 386 | 1.11 | 0.56 | -0.02 | 0.08 | 0.53 | -0.5 |
| KSK 133* KS 282 | 0.36 | -0.53 | 0.02 | 0.25 | -0.47 | 0.25 |

## Conclusions

The study concluded that both additive and dominant gene action played an important role in the inheritance of most traits. Super Basmati, Basmati 515, Basmati 198, Basmati 385, KSK 133 and PK 386 were found to be strong general combiners. Furthermore, the hybrid combinations Basmati 385*KS 282, Super Basmati*KS 282, KSK 133*PK 386, Super Basmati*PK 386 and Basmati 515*KS 282 gave higher grain yield.

## Disclosure Statement

No potential conflict of interest was reported by the authors.

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