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# GENETIC ANALYSIS OF PHOTOSYNTHETIC RATE IN RICE (*ORYZA SATIVA* L.)

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## ABSTRACT

**Crosses were made in a 7 x 7 diallel set, including reciprocals, involving diversified parents to study the inheritance of photosynthetic rate. The 42 crosses along with parents were evaluated for the trait. Combining ability analysis revealed the involvement of both additive and nonadditive gene effects with predominance of the former. The parent varieties Gowrisanna, Rasi and Halubbalu had significant and positive gca effects, indicating the possibility of using them as donors for high photosynthetic rate. The crosses Sona x Gowrisanna, Sona x Halubbalu, and Mahsuri x Rasi were found to be good specific combinations which involved at least one high general combiner.**

**Key words:** Rice, photosynthetic rate, combining ability, diallel.

The cultivation of semidwarf, high yielding varieties of rice has led to a major increase in rice production. This is attributed mainly due to increase in harvest index, without change in total biomass production. Further yield increase can occur through either increasing the harvest index or total biomass or both. Further increase in harvest index is unlikely. Photosynthetic rate or rate of $CO_2$ fixation is generally considered to be a primary factor in determining plant productivity, and considerable effort has been devoted to improve crop production through manipulation of this trait. Although many studies have shown varietal differences for photosynthetic rate in rice, studies on inheritance of this trait are limited. In the present study, an attempt has been made to understand the genetic constitution of seven cultivars of rice and to find out the nature of gene action involved in the expression of photosynthetic rate using a seven-parent diallel cross.

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## MATERIALS AND METHODS

The experimental material consisted of seven varieties of rice, viz., Sona, Shakti, Mangala, Gowrisanna, Halubbalu, Mahsuri and Rasi which were selected based on their variability for photosynthetic rate. These were crossed in all possible combinations. The $F_1$s (including reciprocals) along with parents were evaluated in battery containers where puddled condition was maintained. This experiment was conducted in the glasshouse of Crop Physiology Department, College of Agriculture, GKVK, Bangalore. Using the LICOR-6000 portable photosynthetic system, the photosynthetic rate of second leaf from top was measured on five plants in each treatment five times starting from the stage of tillering initiation to peak flowering. Observations were recorded between 9.30 A.M. to 11.30 A.M. The mean photosynthetic rate of five measurements at each stage was used for combining ability analysis as per Griffing [1].

## RESULTS AND DISCUSSION

The analysis of variance showed highly significant differences for treatments, indicating sizeable variability in the material used. The mean photosynthetic rates expressed in mg $CO_2\ m^{-2}\ sec^{-1}$ for parents and crosses are presented in Table 1. Mahsuri (0.87) and Halubbalu (0.82) among the parents and Sona x Gowrisanna (1.22) and Mangala x Rasi (1.09) among the crosses recorded high rate of photosynthesis.

**Table 1. Mean photosynthetic rate (mg $CO_2\ m^{-2}\ sec^{-1}$) in the parents (in bold), direct crosses (above the diagonal) and in reciprocal crosses (below diagonal)**

| Varieties | Sona | Shakti | Mangala | Gowris-anna | Halub-balu | Mahsuri | Rasi |
|---|---|---|---|---|---|---|---|
| Sona | **0.53** | 0.59 | 0.70 | 1.22 | 1.01 | 0.70 | 0.63 |
| Shakti | 0.67 | **0.61** | 0.74 | 0.79 | 0.86 | 0.56 | 0.92 |
| Mangala | 0.66 | 0.73 | **0.76** | 0.94 | 0.89 | 0.87 | 1.09 |
| Gowrisanna | 0.84 | 0.87 | 0.78 | **0.77** | 0.93 | 0.77 | 0.73 |
| Halubbalu | 0.97 | 0.87 | 0.61 | 0.90 | **0.82** | 0.63 | 0.83 |
| Mahsuri | 0.65 | 0.65 | 0.61 | 0.79 | 0.78 | **0.87** | 1.05 |
| Rasi | 1.07 | 0.73 | 0.74 | 0.83 | 0.71 | 0.79 | **0.78** |

CV 4.40%, CD at 5% 0.07.

The combining ability analysis indicated that both gca and sca variances were highly significant (Table 2), suggesting the role of both additive and nonadditive gene effects for photosynthetic rate. However, additive effects were predominant, as indicated by gca/sca ratio. Mock and Pearce [2] in maize and Hobbs and Mahon [3] in peas (*Pisum sativum* L.)

reported the role of both additive and nonadditive gene effects for photosynthetic rate. However, there is no report on combining ability and gene action for photosynthetic rate in rice. The variance due to reciprocals was also highly significant, indicating the influence of cytoplasmic factors.

**Table 2. Combining ability variances for photosynthetic rate**

| Source | d.f. | MSS |
|---|---|---|
| Gca | 6 | 0.034** |
| Sca | 21 | 0.022** |
| Reciprocals | 21 | 0.018** |
| Error | 48 | 0.001 |
| Gca/Sca | | 1.52 |

**Significant at 1% level.

Gowrisanna, Rasi and Halubbalu had highly significant and positive gca effects (Table 3). These cultivars can be used as parents in hybridization for improvement of photosynthetic rate. With regard to sca, the crosses Sona x Gowrisanna, Sona x Halubbalu, and Mahsuri x Rasi were found to be good specific combinations. In all these superior crosses, one of the parents was a good general combiner and the other was poor.

As is evident from the present study, photosynthetic rate in rice is governed by both additive and nonadditive types of gene action. Hence the breeding methods which enable to fix both additive and nonadditive genes could be followed to improve this trait. Further, within the limitations of the present study,it may be suggested that the cultivars Gowrisanna, Rasi and Halubbalu can be used in hybridization programme aiming at developing material with high photosynthetic rate which can further be used to isolate genotypes with higher biomass and grain yield.

**Table 3. Good general and specific combiners for photosynthetic rate**

| Parent | Gca effect | Cross | Sca effect |
|---|---|---|---|
| Gowrisanna | 0.059** | Sona x Gowrisanna | 0.208** |
| Rasi | 0.043** | Sona x Halubbalu | 0.182** |
| Halubbalu | 0.043** | Mahsuri x Rasi | 0.121** |

**Significant at 1% level.

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