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Character Association and Path Analysis Studies for Grain Yield, its components and Gall Midge incidence in Rice (*Oryza sativa* L.)

B. Satish Chandra [1], Y. Hari [1], K. Rukmini Devi [2], V. Venkanna [3], K. Rajendra Prasad [4], R. Shravan Kumar [1], M. Akshay [5] and R. Uma Reddy [1]*

[1]Regional Agricultural Research Station, PJTSAU, Warangal (Telangana), India.
[2]Agricultural Research Station, PJTSAU, Madhira, Khammam (Telangana), India.
[3]Department of Genetics and Plant Breeding,
Agricultural College, PJTSAU, Aswaraopet (Telangana), India.
[4]Department of Genetics and Plant Breeding,
Agricultural College, PJTSAU, Warangal (Telangana), India.
[5]Research Scholar, Department of Genetics and Plant Breeding,
College of Agriculture, PJTSAU, Rajendranagar, Hyderabad (Telangana), India.

(Corresponding author: Satish Chandra B.)*
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ABSTRACT: The success of most crop improvement programs depends largely on understanding the relationship between traits and the magnitude of that relationship helps the breeder determine selection criteria for a breeding program. An investigation was carried out with 30 rice genotypes to study the character association and direct and indirect effects on yield parameters. The results on character associations revealed a positive and significant association of grain yield with days to 50 percent flowering, number of productive tillers per meter, panicle length, no. of grains per panicle indicating the scope for simultaneous improvement of yield by selections. All the above traits also recorded high and positive direct effects on grain yield per plant, indicating the effectiveness of these traits in improving grain yield per plant towards the development of high yielding genotypes.

Keywords: Correlations, Path effects, Rice, Yield, gall midge incidence.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important grain and staple food for more than 100 countries in the world and is referred to as the "global grain". It serves as the primary food source for about half of humanity, with a huge global impact. It is a vital source of nutrition and food security for many Asian countries. According to recent studies, there will be a 12% growth in the global population. Thus, an improvement in the productivity of crops by at least 13% and an increase in rice grain output of 500 million metric tonnes are required to satisfy the demand for rice from the growing population (Al-daej *et al.,* 2023). Genetic improvement through conventional breeding approaches mainly depends on the availability of diverse germplasm. In some parts of Telangana state, high incidence of gall midge is a major problem during the rainy season under both early and late planting conditions. Lately, the incidence of gall midge has increased and yield losses have been quite common. Breeding for high yielding rice varieties along with gall midge resistance is an essential and continuous process due to the rapid development of new gall midge biotypes and stagnant yield levels. In a breeding program, selection in available germplasm with wide variability in gall midge resistance and important traits contributing to yield would be a prospective approach to improve these particular traits. A comprehensive erudition of these 30 rice genotypes is essential for their successful improvement in yield through breeding. Selection of high-yielding varieties based on grain yield alone will not be very effective if sufficient information on genetic parameters is not available to construct a hybridization and selection program for further improvement, as the average estimate serves as a basis for eliminating undesirable genotypes. The knowledge of character associations can be utilized to identify some characters that may not have much value on their own but are helpful as indications of the more significant characters under examination, forecast the correlation of response to directed selection, and build selection indices (Singh *et al.,* 2022). Correlation studies would give reliable data on the nature, size, and direction of selection, especially when the breeder desires to combine high yield potentials with acceptable agronomic features and grain quality attributes (Krishnamurtha *et al.,* 2023).

Furthermore, since grain yield depends on different component characteristics, knowledge of the correlation between yield and yield components, in addition to identifying direct and indirect effects of yield, can help the breeder to design his selection strategies to effectively improve yield (Ekka *et al.,* 2011). Thus, information on the relationship between the trait and gall midge resistance, yield and other yield components could be useful in selecting the correct rice genotypes as parents in breeding programs. Considering the importance, this research was carried out in this context to elucidate information on trait associations and path coefficients in these genotypes to identify effective selection criteria for grain yield improvement with gall midge resistance.

MATERIAL AND METHODS

The experimental material consisted of 30 rice genotypes. All thirty genotypes were sown at the Regional Agricultural Research Station, PJTSAU, Warangal, India, located at 18°01'N latitude, 79°60'E longitude and 270 m above mean sea level (MSL). All recommended practices for rearing a healthy nursery were adopted and thirty-day-old seedlings were transplanted into the main plot laid out in a Randomized Block Design (RBD) with three replications during kharif, 2021. Each genotype was transplanted separately in 3 rows of 4.5 m length, choosing a spacing of 20 cm between rows and 15 cm between plants. The entire recommended package of practices was adopted during the crop growing season and need-based plant protection measures were taken to grow a healthy crop. Observations were recorded on five randomly selected plants for grain yield per plant (g); yield component traits, namely days to 50% flowering, plant height (cm), no. of productive tillers/meter, panicle length (cm), no. of grains per panicle and 1000-grain weight (g), in addition to silver shoots (%) were recorded. However, days to 50% flowering were recorded on a plot basis. In contrast, observations for the test weight studied were obtained from a random sample of grain taken from each plot in each genotype and replicated using standard procedures. The collected data were subjected to standard statistical procedures according to Panse and Sukhatme (1967). Correlation was worked out using formulas suggested by Falconer (1964). The division of correlation coefficients into direct and indirect effects was carried out according to the procedure proposed by Wright (1921) and elaborated by Dewey and Lu (1959). Characterization of path coefficients was performed as suggested by Lenka and Mishra (1973).

RESULTS AND DISCUSSION

The results on trait associations between yield and yield components are presented in Table 1. Studies of association traits between yield and other traits and among the traits were studied for 30 genotypes and in most cases revealed a high magnitude of genotypic correlation coefficients compared to the corresponding phenotypic correlation coefficients indicating negligible influence of environmental factors. Similar results were reported by Ratna *et al.* (2015); Kalyan *et al.* (2017); Singh *et al.* (2022); Jasmin *et al.* (2023). By reviewing these results, a positive and significant association of grain yield with traits of the yield component was found, specifically no. of productive tillers/metre, no. of grains per panicle and days to 50% flowering, indicating scope for simultaneous improvement of yield and these traits through selection. This suggests that genotypes with long duration, greater panicle length, good number of productive tillers and grains per panicle contribute to higher grain yield. The results are consistent with the reports of Srilakshmi *et al.* (2021); Manasa *et al.* (2022); Singh *et al.* (2022); Jasmin *et al.* (2023) for no. of productive tillers/meter, Umarani *et al.* (2019); Manasa *et al.* (2022); Singh *et al.* (2022) for panicle length; Saha *et al.* (2019); Manivelan *et al.* (2022); Manasa *et al.* (2022); Singh *et al.* (2022) and Jasmin *et al.* (2023) for number of grains per panicle; Saha *et al.* (2019) for days to 50% flowering.

Positive and significant associations were also noted for days to 50% flowering with no. grains per panicle (Saha *et al.,* 2019; Saleh *et al.,* 2020) and number of productive tillers/meter (Saleh *et al.,* 2020); plant height had a significant positive correlation with panicle length (Umarani *et al.,* 2019) and no. grains per panicle (Devi *et al.,* 2019). However, the negative association for plant height with no. of productive tillers/metre and grains per panicle were obtained by Kumar and Nilanjaya (2014). The number of productive tillers/meter showed a positive correlation with the no. grains per panicle (Archana *et al.,* 2018; Singh *et al.,* 2022); panicle length showed a positive correlation with 1000-grain weight (Parimala *et al.,* 2020; Singh *et al.,* 2022); and a negative correlation with % silver shoots; The number of grains per panicle showed a significant positive correlation with grain yield and a negative correlation with 1000 grain weight, suggesting that the practice of selecting medium slender grain genotypes would increase yield levels. Similarly, a positive and significant association of number of grain per panicle with 1000 grain weight was previously reported, which contradicted the studies of Deepa *et al.* (2006); Kumar and Nilanjaya (2014). The results of the study thus indicated the scope for the simultaneous improvement of the above-mentioned characters. Gall midge incidence (% silver shoots) expressed by negative association with grain yield at both phenotypic and genotypic levels showed that genotypes with less silver shoots were high yielding.

Inter-correlation studies could help the breeder decide on the intensity of selection and the direction of selection pressure to be exerted on related traits for the simultaneous improvement of these traits. Gall midge incidence showed a significant negative correlation with no. of productive tillers/metre, plant height and 1000 grain weight at genotypic level indicating high yielding genotypes with short stature and medium slender grains with good number of productive tillers were relatively tolerant to gall midge infestation. Genotype selection in this direction could therefore help gall midge tolerance. These results contradict Thippaswamy *et al.* (2016) because test weight and effective bearing tillers were positively associated with gall midge incidence in their findings.

The results of the path analysis of the yield components and the studied traits of grain yield per plant are shown in Table 2. Examination of the results revealed high and positive direct effects of no. of productive tillers/meter, days to 50% flowering, panicle length, no. of grains per panicle on grain yield per plant were noticed in present research, similar results were reported by Bagudam *et al.* (2018); Saha *et al.* (2019); Gupta *et al.* (2020); Shrestha *et al.* (2021); Manasa *et al.* (2022); Singh *et al.* (2022); Jasmin *et al.* (2023). These traits also showed a high positive and significant association with grain yield per plant, indicating the effectiveness of direct selection for these traits to improve grain yield per plant. However, moderate to negligible or negative direct effects were noted for plant height, 1000-grain weight, and % silver shoot along with non significant to significant associations with grain yield per plant, indicating indirect effects as the cause of the correlation. Therefore, consideration of indirect causal factors is suggested for these traits simultaneously.

For days up to 50 percent flowering, no. of productive tillers/ meter, panicle length, number of grains per panicle recorded high and positive direct effects, similar to the results of Saha *et al.* (2019). Furthermore, a non-significant association of panicle length with grain yield per plant in general was also noted, suggesting the need to use a constrained simultaneous selection model with constraints imposed to cancel out unwanted indirect effects in order to exploit the highly positive direct effects observed for these traits on grain yield per plant.

Table 1: Genotypic correlation coefficients between different traits in rice genotypes.

	Days to 50% flowering	No. of productive tillers/meter	Plant height (cm)	Panicle length(cm)	No. of grains/ panicle	1000 grain weight (g)	% Silver Shoots	Grain yield per plant (g)
Days to 50% flowering	**1.0000**	-0.0434	-0.2885	-0.3210*	0.3524*	-0.2163	-0.2208	0.3041*
No. of productive tillers/ meter		**1.0000**	-0.2258	-0.3063*	0.0672	-0.1029	-0.0198	1.2532**
Plant height (cm)			**1.0000**	0.6580**	0.1753	-0.2551	-0.0206	-0.0919
Panicle length(cm)				**1.0000**	-0.1134	0.2094	0.2413	0.1261
No. of grains/panicle					**1.0000**	-0.8048**	0.0040	0.3028*
1000 grain weight (g)						**1.0000**	-0.1319	-0.1411
% Silver Shoots							**1.0000**	-0.0001
Grain yield per plant (g)								**1.0000**
*Significant at 5 per cent level; **Significant at 1 per cent level								

Table 2: Estimates of direct and indirect effects between yield and its component traits in rice.

	Days to 50% flowering	No. of productive tillers/meter	Plant height (cm)	Panicle length(cm)	No. of grains/ panicle	1000 grain weight (g)	% Silver Shoots	Grain yield per plant
Days to 50% flowering	**0.5131**	-0.0223	-0.1480	-0.1647	0.1808	-0.1110	-0.1133	0.3041*
No. of productive tillers/meter	0.0649	**1.4959**	-0.3378	-0.4582	0.1006	-0.1540	-0.0296	1.2532**
Plant height (cm)	0.0974	0.0762	**-0.3376**	-0.2221	-0.0592	0.0861	0.0069	-0.0919
Panicle length(cm)	-0.3329	-0.3176	0.6822	**1.0369**	-0.1176	0.2171	0.2502	0.1261
No. of grains/panicle	0.0407	0.0078	0.0202	-0.0131	**0.1154**	-0.0929	0.0005	0.3028*
1000 grain weight (g)	0.0224	0.0107	0.0264	-0.0217	0.0833	**-0.1035**	0.0136	-0.1411
% Silver Shoots	0.0283	0.0025	0.0026	-0.0310	-0.0005	0.0169	**-0.1284**	-0.0001
*, ** significant at 5% and 1% level, respectively; Bold values are direct effects								

CONCLUSIONS

Based on the results summarized above, it was concluded that days to 50% flowering, no. of productive tillers/meter, panicle length and number of grains per panicle showed a positive contribution and % silver shoots, *i.e.* gall midge incidence showed a negative contribution to grain yield. Thus, these plant traits deserve more attention in further breeding programs for the development of high-yielding gall midge resistant rice varieties.

FUTURE SCOPE

Future research may focus on breeding high yielding rice varieties by important traits such as number of productive tillers/meter, days to 50% flowering, number of grains per panicle and panicle length. Further investigation of the background genes and genetic mechanisms responsible for the characters identified can provide valuable insights.

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Conflict of Interest. None.

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