

Original Research Article

Exploring the Correlation between Morpho-Physiological Traits, Growth Attributes, and Yield Characteristics in Rice Genotypes

ABSTRACT

This study aimed to correlate morpho-physiological traits, growth patterns, and yield characteristics in rice genotypes. The experiment included 120 rice genotypes and 3 checks, conducted in an alpha lattice design with two replications at the Research Cum Instructional Farm of the Department of Plant Physiology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, during the *Kharif* seasons of 2021-22 and 2022-23. Conventional spacing of 15 x 20 cm and recommended cultural practices were employed. Results indicated that productive tillers (0.335**) and flag leaf area (0.213*) were positively correlated with higher yields. While leaf angles, specific leaf area, and days to panicle initiation showed negative correlations with yield. The leaf area index at flowering was positively correlated with specific leaf area (0.382***) but negatively with grain yield (-0.199*). Specific leaf weight was positively correlated with yield per hectare (0.178*). Understanding these relationships can guide the selection and breeding of rice genotypes with optimal traits for enhanced grain yield and crop performance.

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Keywords: Rice, flag leaf area, leaf angle, specific leaf weight, yield attributes

1. INTRODUCTION

Rice (*Oryza sativa* L.) is a semi-aquatic grass species cultivated globally. The crop is known as "dhanya" in India, where it represents "the subsistence of the human race". Panesar *et al.* (2016). It makes up about 30% of the land used for grain crops and 11% of all arable land on Earth. There is a projected 12% growth in the world's population, according to recent study. Therefore, in order to fulfill the growing demand for rice, 500 million metric tonnes more rice must be produced, and productivity must rise by at least 13%. Al-daej *et al.*, (2023). Yoshida (1981) states that one can increase rice yield by increasing biomass production, harvest index, or both. However, a growing body of research indicates that achieving higher rice yields mostly relies on biomass accumulation Zhang *et al.*, (2009). Biomass production is dependent on leaf physiology and the canopy's capacity to block incident radiation. This capacity is determined by the leaf area index (LAI) and canopy architecture. Ikawa *et al.*, (2018). It is well known that incident radiation is related to growth duration, while intercepted percent is dependent on canopy morphological characteristics such as leaf area, angle, and orientation. Lake and Sadras (2017). Yield is one of the most important and complex traits in rice. It is both regulated by genes known as quantitative trait loci and influenced by external environmental factors (Wang *et al.*, 2012; Zeng *et al.*, 2017; Zhang L. *et al.*, 2017). In addition to regulating plant architecture, leaf angle one of the agronomic characteristics strongly associated with grain output is also necessary for achieving moderate leaf erectness, which raises rice yield. Wang

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and Li, (2011). Leaf erectness increases CO₂ diffusion efficiency and light capture, which raises photosynthetic efficiency. The lamina joint, which joins the leaf blade and leaf sheath in rice, establishes the leaf angle. Sakamoto *et al.*, (2006). This requires a deep understanding of the factors influencing rice yield, particularly morpho-physiological traits, and growth attributes which play a crucial role in the plant's resource acquisition, growth efficiency, and grain production.

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2. EXPERIMENTAL DETAILS

The experiment uses a two-replication alpha lattice design. The first trial nursery was planted on June 24th, 2021, and seedlings were transplanted in the main field on July 22nd, with each plot measuring 3.30x1.40 m and 140 hills per plot. A conventional spacing of (15 x 20 cm) was used when combined with suggested cultural treatments to produce a healthy, productive stand. The second trial nursery was planted on 24th June 2022, and seedlings were transplanted on 15th July with the same plot size and spacing and harvested based on their respective growth durations. The plants were randomly selected from each genotype. Each selected plant was tagged for identification. The experimental plots were inspected daily, and data were collected regularly. After collecting data on the morpho-physiological, growth parameter, and yield traits data were summarized through arithmetic means. The data collected were morpho-physiological and growth attributes such as Plant height (PH), Number of tiller/plant (NT), Number of productive tiller/plant (NPT), Flag leaf area (FLA), Flag leaf angle (FLAn), Leaf area index (LAI), Leaf weight ratio (LWR), Specific leaf weight (SLW), Crop growth rate (CGR), Net assimilation rate (NAR), Spikelet fertility (SF), Unfilled spikelet/panicle (UFSP), Test weight (TW), Yield per hectare (YPH) and Harvest index (HI). Phenological characters were also evaluated which are days to panicle initiation, days to 50% flowering, days to maturity.

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3. RESULTS AND DISCUSSION

3.1 Association between morpho-physiological, growth, and yield attributes of rice genotypes under irrigated condition

The correlation analysis was done between morpho-physiological and growth traits with grain yield. It was observed that productive tiller (0.335**) was strongly and positively correlated with yield per hectare and (0.224*) with harvest index. The flag leaf area had a significant positive correlation with grain yield (0.213*). The leaf angle of the flag leaf showed a highly significant and negative correlation with grain yield (-0.93***, -0.264**, -0.181*) and with harvest index (-0.678***, -0.193**) for flag leaf angle. Leaf area index at the flowering stage was highly significant and positively associated correlation with specific leaf area (0.382***) however it negatively correlated with grain yield (-0.199*). The leaf area ratio was highly significant and negatively correlated with yield per hectare (-0.223*). Specific leaf area recorded a significant and negative association with grain yield (-0.232*). However, the specific leaf weight had a highly significant and positive correlation with yield per hectare (0.178*). Crop growth rate between flowering to grain filling stage was found highly significant and negatively correlated with grain yield per hectare (-0.241**) while highly significant and positive correlation with NAR (0.601***). (Table 1)

3.2 Association between phenological traits and yield attributes of rice genotypes under irrigated conditions

The association between phenological traits and yield attributes of rice genotypes is shown in (Table 2). Days to panicle initiation were strongly negatively correlated with harvest index (-0.356***) and grain yield per hectare (-0.309***). Similarly, days to 50% flowering were also

highly and positively correlated with unfilled spikelets panicle⁻¹ (0.327***), and days to physiological maturity were also strongly and positively correlated with grain yield per hectare (0.263***).

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3.4 DISCUSSION

The present study evaluated the correlation between morpho-physiological, growth, and yield attributes. Mohanan & Pavithran (2007) reported that the optimum number of tillers was more productive in economic yield. They also suggested the new plant type to replace conventional high tillering varieties for high yield. They also emphasized optimizing tillering, which is crucial for increasing yield. Jennings (2003) reported that the angle of the flag leaf was a significant factor in rice grain production. The products of photosynthesis determine the yield of grains, and crops may produce biomass more efficiently if leaves are distributed and arranged optimally. Mahesh *et al.*, (2022) reported that the flag leaf and its penultimate leaves characters mostly contribute to catching high light intensity, directly influencing the grain yield. Although early flowering genotypes have a short period of vegetative growth, the reproductive and grain-filling stages have been reported to be similar for rice (Kropff, Van Laar & Matthews, 1994). Specific leaf weight is an important characteristic in plant physiological processes. Bowes *et al.*, (1972) reported that SLW, a measure of leaf thickness, had a high positive connection with leaf photosynthesis in numerous crops. The findings of the research showed that three factors affected grain yield intercepted light, the capacity of the plant to convert it to dry matter, and the partitioning and reallocation of photosynthate to grains.

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4. CONCLUSION

The importance of traits such as tiller number, leaf area, and leaf angles in determining yield potential. However, the relationships between these traits and yield can vary significantly across different genotypes and environments. Therefore, elucidating these correlations in specific contexts can provide valuable insights for breeding programs aimed at improving rice yield. This study focuses on correlating morpho-physiological traits, growth patterns, and yield characteristics in various rice genotypes. By identifying the traits that significantly influence yield, we aim to provide a foundation for developing high-yielding rice varieties adapted to specific growing conditions. The findings of this study will contribute to the strategic selection and breeding of rice genotypes with enhanced yield potential and overall crop performance.

Table 1 Correlation analysis of morpho-physiological, growth parameters and yield attributes

	PH	NT	NPT	FLA	FLAn	LAI	LWR	SLW	CGR	NAR	SF	UFSP	TW	YPH	HI
PH	1														
NT	-0.111	1													
NPT	-0.082	0.733***	1												
FLA	0.092	-0.109	-0.017	1											
FLAn	0.015	-0.066	-0.294**	-0.163	1										
LAI	0.284**	0.049	-0.033	-	0.221*	1									
				0.268**											
LWR	0.021	0.023	-0.027	-0.144	0.003	0.03	1								
SLW	0	-0.155	0.055	0.144	-0.349***	-0.23*	0.296**	1							
CGR	-0.026	0.108	-0.046	-0.022	0.311***	0.127	0.059	0.006	1						
NAR	0.008	0.075	0.021	0.008	0.202*	0.168	0.046	0.013	0.606***	1					
SF	-0.071	0.035	0.338***	0.17	-0.82***	-0.191*	0.035	0.395***	-0.244**	-	1				
										0.181*					
UFSP	-0.02	0.035	-0.171	0.108	0.16	-0.022	-0.062	-0.209*	-0.086	-0.039	-	1			
											0.377***				
TW	0.096	-0.007	-0.096	-0.067	-0.076	0.074	-0.027	0.09	0.059	-0.092	-0.046	0.047	1		
YPH	0.028	0.022	0.335***	0.213*	-0.93***	-0.184*	0.022	0.454***	-0.266**	-0.171	0.857***	-0.289**	0.064	1	
HI	0.015	0.135	0.316***	0.192*	-0.769***	-0.085	0.087	0.31***	-0.128	-0.036	0.75***	-0.261**	0.078	0.803***	1

* Significant at 0.05; ** significant at 0.01 level of probability; plant height, NT- number of tiller/plant, NPT- number of productive tiller/plant, FLA- flag leaf area, FLAn- flag leaf angle, 2nd LAN- second leaf angle, 3rd LAN- third leaf angle, TDM flw- total dry matter at flowering, TDM- total dry matter at maturity, LAI- leaf area index, LAR-leaf area ratio, LWR-leaf weight ratio, SLA-specific leaf area, SLW- specific leaf weight, CGR-crop growth rate, NAR-net assimilation rate, SF- spikelet fertility, FSP- filled spikelet/panicle, UFSP-unfilled spikelet/panicle, TW-test weight, YPH-yield per hectare, HI-harvest index.

Table 2 Correlation analysis between Phenological behavior and yield parameters

	DPI	D50%F	DM	FSP	UFSP	YPH	HI
DPI	1						
D50%F	0.281**	1					
DM	0.225*	0.837***	1				
FSP	0.006	0.044	0.172	1			
UFSP	0.152	0.327***	0.265	0.144	1		
YPH	-0.309***	0.064	0.263**	0.217*	-0.201*	1	
HI	-0.356***	-0.039	0.033	0.243**	-0.164	0.712***	1

* Significant at 0.05; ** significant at 0.01 level of probability *DPI*- days to panicle initiation, *D50%F*- days to 50% flowering, *DM*- days to maturity, *FSP*- filled spikelet/panicle, *UFSP*- unfilled spikelet/panicle, *YPH*- yield per hectare, *HI*- harvest index

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