Comparison of agronomic characteristics protani rice in three different locations

Muhammad Rayhan[1*], *Totok* Agung Dwi Haryanto[2], *Risqa* Naila Khusna Syarifah[1], *Agus* Riyanto[2], and *Dyah* Susanti[2]

[1]Agronomy and Horticulture Department, Faculty of Agriculture Jenderal Soedirman University, Central Java, Indonesia 53122

[2]Plant Breeding Department, Faculty of Agriculture Jenderal Soedirman University, Central Java, Indonesia 53122

Abstract. Rice is a major food crop that produces rice, the staple food for the majority of Indonesia's population and more than half of the world's population, rice holds a special value for communities that consume it regularly, such as in Indonesia, but production in 2023 is estimated to decrease by 1.12 million tons. This study aims to assess the influence of location on the agronomic characteristics of the Protani rice in various locations, and to determine the stability of interrelation patern among characters as response to different locations. The research method used is a survey with observations of the surrounding environmental conditions and sampling of harvest-ready plants along with other supporting data. The conclusion it that different locations affect the agronomic characteristics of Protani rice, with the best results found in Purbalingga Regency. Additionally, the Interrelation patterns of Protani rice in response to varying environmental conditions remain unstable for most variables, with only the grain weight per panicle showing stability. The contribution gained from this research is that it can serve as a reference for developing plant varieties that are adaptive to various environmental conditions and helps in assessing the yield potential of Protani rice crops.

1 Introduction

Rice plants produce rice that contains various nutrients needed by the body, such as carbohydrates, proteins, fats, and others. Although there are various other staple foods that can replace rice, the rice produced by rice plants holds a special value for communities that regularly consume it, such as the Indonesian people [1] [2]. Based on data from the [3], rice production in Indonesia in 2022 was 54.74 million tons, and Indonesia's rice production in 2023 is estimated to decrease by 1.12 million tons. Many factors can affect rice production, one of which is environmental conditions. The environment is a very influential factor in farming activities in every location. If the environmental conditions in a location are not adequate for the crops to grow, then the plants will not be able to grow optimally, even if they are superior varieties [4].

* Corresponding author: muhammadrayhan695@gmail.com

Finding locations with optimal environmental conditions for crops can enhance harvest success and reduce the adverse impacts that the environment can cause [4]. Previous research on rice cultivation by [5] in different locations also yielded varying results. Therefore, this study hypothesizes that differences in planting locations affect the agronomic characteristics of Protani rice plants, and there is no consistent interrelation pattern between the characteristics of Protani rice across various locations since it's effected by the enviromental. Based on the description above, further research is needed to examine the impact of planting location on the agronomic characteristics of Protani rice that has been released by [6] that has been cultivated in various locations in Central Java and to determine the stability of the interrelation patterns among the characteristics of Protani rice in response to different locations.

2 Materials and Methods

The research was conducted on three rice fields located in Purbalingga Regency (35 meters above sea level), Brebes Regency (342 meters above sea level), and Purworejo Regency (85 meters above sea level), Central Java Province. Sample processing was carried out at the Agronomy and Horticulture Laboratory and the Plant Breeding Laboratory, Faculty of Agriculture, Jenderal Soedirman University, from August 2023 to April 2024. The materials used in this research were Protani variety rice plants, and the tools used to assist in data collection included a measuring tape, writing tools, a seed counter, a hand counter, an analytical balance (0.01), markers, a field measuring tape, a sickle, sacks, and scissors.

The method used is a survey, a survey is a quantitative research method used to obtain data about the characteristics and behavior of interrelation between variables, and the results produced by survey research are more oriented towards generalization, also added that the instruments used to obtain data in survey research include observation and interviews [7]. The survey was conducted by visiting predetermined locations to observe the surrounding environmental conditions and collect samples of crops that are ready for harvest, along with other necessary data to support the ongoing research which is obtained through interviews with farmers who directly take care of the plants and by requesting data from government agencies responsible for agriculture, such as the Agricultural Extension Center in each location.

The variables observed include Plant Height, Number of Productive Tillers, Total Number of Tillers, Panicle Length, Number of Grains per Panicle, Number of Grains per Plant, Grain Weight per Panicle, Grain Weight per Plant, Grain Weight per Plot, and Percentage of Filled Grains. Data analysis to determine differences in agronomic characteristics of Protani rice across different locations was performed using Analysis of Variance (ANOVA). If the ANOVA results show significant differences, a Least Significant Difference (LSD) test at a 5% significance level is conducted. Correlation analysis is used to assess the strength of relationships between variables for Protani rice at the three different locations, which is further clarified using Path Analysis to identify both direct and indirect relationships between independent and dependent variables for Protani rice at each of the three locations.

3 Results and Discussion

In this research, the average results from the agronomic characteristics of Protani rice plants across three distinct locations were collected. Each location offered unique data that reflected the specific environmental conditions and treatments applied at each site. Below are the tables of average results, along with the ANOVA table, LSD, and also others.

Table 1. Results of protani rice in three different locations

No	Observation Tables	Purbalingga	Brebes	Purworejo
1	Plant Height (Cm)	102,70	86,60	87,57
2	Number of Productive Tillers (Stem)	22,00	11,93	19,80
3	Total Number of Tillers (Stem)	24,93	14,00	24,40
4	Panicle Length (Cm)	22,67	22,02	21,07
5	Number of Grains per Panicle (Grains)	141,28	145,05	117,04
6	Number of Grains per Plant (Grains)	3167,13	1742,87	2324,87
7	Grain Weight per Panicle (g)	2,76	2,60	2,08
8	Grain Weight per Plant (g)	62,26	31,18	41,27
9	Grain Weight per Plot (1,5 m x 1 m) (g)	2179,03	1091,32	990,45
10	Percentage of Filled Grains (%)	83,04	72,07	69,71

Table 2. Result of analisis of varians (anova)

No	Observation Variables	Treatment (Location Differences)
1	Plant Height (Cm)	hs
2	Number of Productive Tillers (Stem)	s
3	Total Number of Tillers (Stem)	s
4	Panicle Length (Cm)	ns
5	Number of Grains per Panicle (Grains)	s
6	Number of Grains per Plant (Grains)	s
7	Grain Weight per Panicle (g)	s
8	Grain Weight per Plant (g)	s
9	Grain Weight per Plot (g)	hs
10	Percentage of Filled Grains (%)	hs

Note: hs = Highly Significant, s = Significant, ns = Not Significant

https://doi.org/10.1051/bioconf/202415803018

Table 3. Least significant difference (lsd) test

Treatment	PH (Cm)	NPT (Stem)	TNT (Stem)	NGP (Grains)	NGPL (Grains)	GWP (g)	GWPL (g)	GWPT (g)	PFG (%)
Purbalingga	102.70a	22a	24.93a	141.28a	3167.13a	2.76a	62.26a	2179.03a	83.04a
Brebes	86.60b	11.93b	14b	145.05a	1742.87b	2.60a	31.18b	1091.32b	72.01b
Purworejo	87.57b	19.80a	24.40a	117.04b	2324.87b	2.08b	41.27b	990.45b	69.71b
LSD 5%	7.30	5.39	7.30	19.01	838.95	0.43	16.37	545.35	4.82

Note: PH (Plant Height), NPT (Number of Productive Tillers), TNT (Total Number of Tillers), NGP (Number of Grains per Panicle), NGPL (Number of Grains per Plant), GWP (Grain Weight per Panicle), GWPL (Grain Weight per Plant), GWPT (Grain Weight per Plot), and PFG (Percentage of Filled Grains).

Table 4. Correlation of protani rice

Purbalingga	**PH**	**TNT**	**NPT**	**PL**	**NGPL**	**NGP**	**PFG**	**GWP**	**GWPL**
PH	1								
TNT	0.465	1							
NPT	0.524*	0.883**	1						
PL	0.583*	0.439	0.584*	1					
NGPL	0.697**	0.813**	0.891**	0.721**	1				
NGP	0.616*	0.318	0.364	0.692**	0.727**	1			
PFG	0.513	0.337	0.599*	0.639*	0.689**	0.613*	1		
GWP	0.604*	0.324	0.413	0.703**	0.753**	0.981**	0.711**	1	
GWPL	0.696**	0.778**	0.874**	0.722**	0.996**	0.745**	0.729**	0.784**	1
Brebes									
PH	1								
TNT	-0.160	1							
NPT	-0.060	0.767**	1						
PL	-0.003	0.054	0.166	1					
NGPL	0.023	0.743**	0.837**	0.514*	1				
NGP	0.073	0.377	0.310	0.766**	0.774**	1			
PFG	0.165	-0.297	-0.250	0.446	-0.067	0.179	1		
GWP	0.042	0.234	0.207	0.798**	0.661**	0.916**	0.505	1	
GWPL	0.003	0.692**	0.812**	0.556*	0.977**	0.761**	0.108	0.734**	1
Purworejo									
PH	1								
TNT	-0.054	1							
NPT	-0.134	0.777**	1						
PL	0.121	-0.186	0.124	1					
NGPL	0.081	0.425	0.792**	0.357	1				
NGP	0.329	-0.219	0.094	0.477	0.676**	1			
PFG	0.214	0.028	0.057	0.538*	-0.135	-0.251	1		
GWP	0.447	-0.240	0.052	0.823**	0.478	0.761**	0.415	1	
GWPL	0.160	0.444	0.805**	0.558*	0.916**	0.552*	0.251	0.630*	1

Note: PH (Plant Height), TNT (Total Number of Tillers), NPT (Number of Productive Tillers), PL (Panicle Lenght), NGPL (Number of Grains per Plant), NGP (Number of Grains per Panicle), PFG (Percentage of Filled Grains), GWP (Grain Weight per Panicle), GWPL (Grain Weight per Plant), * (Significant), and ** (Highly Significant).

https://doi.org/10.1051/bioconf/202415803018

Table 5. Path analysis of protani rice

Purbalingga	Direct Effect	Indirect Effect								Overal Impact
		PH	TNT	NPT	PL	NGPL	NGP	PFG	GWP	
PH	0.00006		-0.00012	-0.00010	-0.00007	0.00560	-0.00180	-0.00002	0.00200	0.00556
TNT	0.00109	-0.00012		0.00067	0.00020	-0.02694	0.00383	0.00004	-0.00443	-0.02565
NPT	0.00053	-0.00010	0.00067		0.00019	-0.02058	0.00306	0.00006	-0.00393	-0.02011
PL	0.00020	-0.00007	0.00020	0.00019		-0.01013	0.00354	0.00004	-0.00407	-0.01012
NGPL	**1.00802**	**0.00560**	**-0.02694**	**-0.02058**	**-0.01013**		**-0.26642**	**-0.00277**	**0.31299**	**0.99977**
NGP	**0.13323**	**-0.00180**	**0.00383**	**0.00306**	**0.00354**	**-0.26642**		**0.00090**	**-0.14824**	**-0.27191**
PFG	0.00002	-0.00002	0.00004	0.00006	0.00004	-0.00277	0.00090		-0.00118	-0.00291
GWP	**0.17140**	0.00200	**-0.00443**	**-0.00393**	**-0.00407**	**0.31299**	**-0.14824**	**-0.00118**		**0.32454**
Brebes										
PH	0.00005		0.00000	0.00000	0.00000	-0.00017	0.00026	-0.00001	-0.00015	-0.00002
TNT	0.00000	0.00000		0.00000	0.00000	-0.00077	0.00019	0.00000	-0.00012	-0.00069
NPT	0.00001	0.00000	0.00000		0.00000	-0.00261	0.00048	0.00001	-0.00032	-0.00243
PL	0.00003	0.00000	0.00000	0.00000		0.00267	-0.00196	0.00002	0.00203	0.00278
NGPL	**1.08160**	**-0.00017**	**-0.00077**	**-0.00261**	**0.00267**		**-0.41294**	**-0.00070**	**0.34922**	**1.01630**
NGP	**0.26317**	**0.00026**	**0.00019**	**0.00048**	**-0.00196**	**-0.41294**		**-0.00092**	**-0.23871**	**-0.39044**
PFG	0.00010	-0.00001	0.00000	0.00001	0.00002	-0.00070	-0.00092		0.00257	0.00107
GWP	**0.25806**	**-0.00015**	**-0.00012**	**-0.00032**	**0.00203**	**0.34922**	**-0.23871**	**0.00257**		**0.37258**
Purworejo										
PH	0.00010		-0.00002	0.00096	0.00008	-0.00010	-0.00003	-0.00007	-0.00252	-0.00161
TNT	0.00176	-0.00002		-0.02337	-0.00052	-0.00218	0.00008	-0.00004	0.00569	-0.01860
NPT	**0.51266**	**0.00096**	**-0.02337**		**-0.00595**	**0.06918**	**0.00061**	**0.00143**	**0.02100**	**0.57652**
PL	0.00449	0.00008	-0.00052	-0.00595		-0.00292	-0.00029	-0.00126	-0.03110	-0.03747
NGPL	0.01488	-0.00010	-0.00218	0.06918	-0.00292		0.00074	-0.00058	0.03289	0.11193
NGP	0.00008	-0.00003	0.00008	0.00061	-0.00029	0.00074		-0.00008	0.00386	0.00498
PFG	0.00123	-0.00007	-0.00004	0.00143	-0.00126	-0.00058	-0.00008		0.00819	0.00881
GWP	**0.31810**	**-0.00252**	**0.00569**	**0.02100**	**-0.03110**	**0.03289**	**0.00386**	**0.00819**		**0.35610**

Note: PH (Plant Height), TNT (Total Number of Tillers), NPT (Number of Productive Tillers), PL (Panicle Lenght), NGPL (Number of Grains per Plant), NGP (Number of Grains per Panicle), PFG (Percentage of Filled Grains), GWP (Grain Weight per Panicle), and Bold Result = Significant.

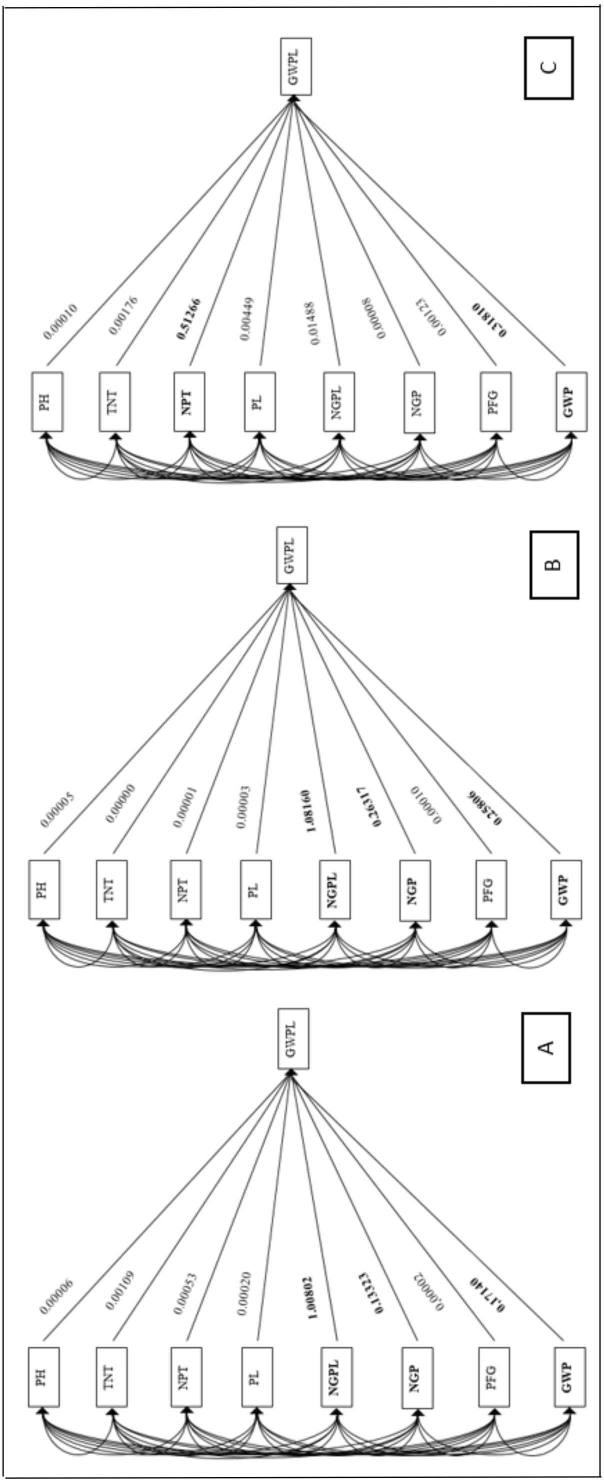

Fig. 1. Path analysis result: a. Purbalingga, b. Brebes, c. Purworejo, and bold variabels (significant)

The variation in results at each location indicates that environmental factors influence the agronomic characteristics of Protani rice. This is evident from the average results obtained (Table 1), which are supported by the ANOVA (Table 2) analysis showing the environmental impact on the observed variables. This is further clarified by the LSD test (Table 3), which identifies Purbalingga Regency as the location with the best results. This finding aligns with the opinions of [8], who state that the growth and yield of rice plants are influenced by the environmental conditions in which they are cultivated. It is also in line with the opinions expressed by [4,9–12] that environmental conditions consisting of agro-climate conditions, planting techniques, and plant care, affect plant growth.

The research continued with conducting a correlation analysis to the observed variables of protani rice in respective location. The results of the correlation test are presented in Table 4 to facilitate data interpretation. The analysis results in Table 4 show different outcomes, which may be due to varying environmental conditions where the rice was planted. This finding is also supported by [13], who obtained correlation results in their study on Japanese taro plants that varied between locations, caused by the different environmental conditions. From this, we can also observe the interellation pattern of protani rice in strenght relation between its variables, we can see that in across 3 locations variables that are stable with the yield variable (grain weight per plant) are number of productive tillers, panicle lenght, number of grains per plant, number of grains per panicle, and grain weight per panicle. Since correlation only shows the strength of the relation, path analysis needs to be conducted to clearly see the direct and indirect effects to the yield, and we can also determine the interrelation pattern among the variables that affect the yield variable. Based on that, path analysis was then carried out to determine which variables have a significant impact on the yield (grain weight per plant) in the form of direct and indirect effects as shown in Table 5 and Figure 1 above. It should be noted that the variable of grain weight per plot cannot be included in the correlation and path analysis due to having a smaller sample count compared to other variables, which would interfere with the results of the correlation and path analysis.

From the path analysis above, the variables number of grains per plant, number of grains per panicle, and grain weight per panicle significantly affected yields at the first and second locations. However, at the third location, only number of productive tillers and grain weight per panicle had a significant impact. These differences can be attributed to varying environmental factors, consistent with [14], which found that path analysis results are influenced by environmental conditions, variations in these methods can cause differences in path analysis outcomes, and thus, varying plant locations may produce even more diverse influence since they have more factors that influence them. Notably, only grain weight per panicle consistently showed a stable interrelation pattern and significant influence on both corelation and path analysis across all three locations.

4 Conclusion

Different locations influence the agronomic characteristics of Protani rice, with the best outcomes observed in Purbalingga Regency. Additionally, the interrelation patterns of Protani rice in response to varying environmental conditions are unstable for the variabels that give significant value on both analysis (corelation and path analysis), except for the grain weight per panicle which remains stable. To gain a better understanding of the location's impact on Protani rice, it is advisable to conduct trials in more variety of locations. This approach will help identify how different environmental conditions affect agronomic characteristics and assist in developing new more adaptive varieties.

We extend our deepest gratitude to the Ministry of Research, Technology and Higher Education Indonesia for the financial support provided for this research. We also thank our team members and friends who have offered valuable assistance in the preparation and execution of this research. The data underlying this research is included in a thesis that has not yet been published. The thesis and associated data will be available in the institutional repository of Universitas Jenderal Soedirman following the completion of the evaluation and graduation process, and will only be accessible offline at the Universitas Jenderal Soedirman library. All authors significantly contributed to designing the research, collecting and analyzing data, and preparing the final report.

References

1. A. Monika, Research Gate 1 (2021)
2. I Nyoman Yogi Supartha, Gede Wijana and G. M. Adnyana, E-Jurnal Agroekoteknologi Tropika **1**, 98 (2012)
3. Central Statistics Agency, *Harvest Area and Rice Production in Indonesia 2023 (Preliminary Figures)* (2023)
4. S. Femmy Marsitha B, Jurnal Meteorologi Klimatologi Dan Geofisika **4**, 32 (2017)
5. I. W. Risqa Naila Khusna Syarifah, Agus Suroto, Dina Istiqomah, in *Sains Dan Teknologi Pertanian Modern* (NST Proceedings, 2021), pp. 6–10
6. Ministry of Agriculture of the Republic of Indonesia, *Decree of the Minister of Agriculture of the Republic of Indonesia Number 980/HK.540/C/10/2020 Regarding the Release of the Candidate Variety of Gogo Rice Unsoed-PDK-G82-11 as a Superior Variety Named Inpago Unsoed Protani* (Ministry of Agriculture of the Republic of Indonesia, Jakarta, 2020)
7. Sugiyono, in *Quantitative, Qualitative, and R&D Research Methods* (ALFABETA, Bandung, 2013), pp. 2–27
8. S. J. K. Serafina Laka Neonbotaa, Agrimor **1**, 32 (2016)
9. E. Dia Novita Sari, Sumardi, Akta Agrosia **17**, 115 (2014)
10. H. G. Eliasyb P Sitanggang, Erwin Masrul Harahap, Agroekoteknologi FP USU **6**, 508 (2018)
11. I. A. Harfresen, Rustam Baraq Noor, ZIRAA'AH **46**, 251 (2021)
12. U. M. Nur Magfiroh, Iskandar M. Lapanjang, Jurnal Agrotekbis **5**, 212 (2017)
13. E. S. Delvi Maretta, Sobir, Is Helianti, Purwono, Buletin Palawija **19**, 82 (2021)
14. and Y. R. K. Paul Benyamin Timotiwu, Yayuk Nurmiaty, Eko Pramono, Jurnal Penelitian Pertanian Terapan **18**, 87 (2018)