DOI :https://doi.org/ 10.36378/juatika.v4i1.1884
JUATIKA
JURNAL AGRONOMI TANAMAN TROPIKA
VOL.4 NO. 1 January 2022
eissn 2656-1727
pissn 2684-785X
Hal : 234 – 241

Lodging Rice Resistant : Identification on MorphoPhysiological Paddy Stems Falling Factor in Different Planting Methods

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ABSTRACT

Due to the extreme weather that hit throughout the year resulted in the threat of rice plants falling down. It was known that the fall of rice plants was a limiting factor for obtaining high yields and quality of grain. Therefore, it was considered important to evaluate the resistance to fall in the general methods of planting rice in the area. Those were transplanting planting (TP) and direct seed planting (TBL). Based on this objective, we identified the morphophysiology of rice stems in the laying factor of 2 planting methods commonly used by farming communities, namely transplanting planting and direct seed planting. Identification was carried out by observing the morphology and physiology of the rice stalks, the laying index and the level of fall of rice plants in each planting method (TP and TBL). The result of the research was that the direct seed planting method (TBL) tends to show morphophysiological identification results that were not resistant to falling compared to the transplanting method (TP). The laying rate shown by TBL was accounting for 75.5% while transplanting (TP) was only 5.7% of the experimental unit area. Significant differences were observed in plant height, stem length, center of gravity height, laying index, laying level, stem internode length, stem internode width, bending moment and bending stress of the stem. In the experiment, it was also found that the grain was damaged due to the fall of the rice plant when the rice fields were flooded. Therefore, it is important to carry out agronomic management as part of sustainable mitigation of the risk of falling rice plants to support national food security.

Keywords*: morphophysiology, rice, planting method, resistance to fall, stem*

1. INTRODUCTION

In 2018 Indonesia's rice consumption was 33,470,000 tons while rice production reached 46,500,000 tons. There is a rice surplus of 13.03 million tons. However, Indonesia still imports rice from other countries, especially from Thailand and Pakistan in 2018 amounting to 305,247.6 tons. This rice import policy has always caused public debate (Rahayu & Febriaty, 2019).

Various public responsed when the government imported rice. Various comments, both pro and con, were made in various media. One of the reasons why rice istill imported was for rice reserves due to weather factors. The government continued to promote food security programs to achieve self-sufficiency in food (rice).

However, due to conditions and conditions on the ground, it seemed that food self-sufficiency was still difficult to achieve. In a period of 10 years (2003-2013) there was an average land conversion of 100,000 ha per year (Agriculture, 2013), while it was concluded that the fertility of paddy fields was currently very concerning due to a production system that ignores the principles of plant ecology (Gea K. et al, 2020; Tuhuteru et al., 2021). Apart from that, one of the causes of the impact of the difficulty of self-sufficiency was the extreme weather. Extreme weather such as strong winds and heavy rains was a natural phenomenon that often affected rice production.

Lodging of rice plants in Indonesia is the most common and has an impact on production results and farmer psychology. According to the results of the study (Edi Santosa et al., 2018) which stated that extreme weather events in the form of strong winds and high rainfall had an impact on falling rice plants, in general, the loss of rice yields due to strong winds and high rainfall was at 11.89%.

The value of rice yield loss due to extreme weather tends to be *underestimated*. Based on reports every year there are about 400-800 ha experiencing crop failure due to extreme weather. On the other hand, (E Santosa et al., 2016) noted that the occurrence of extreme climate and weather conditions was almost evenly distributed in all rice production centers in Indonesia, but escaped the monitoring of weather loggers and tended not to be reported. The value of the loss each year was estimated at Rp. 3.16 Trillion.

Research on the fall phenomenon has long been studied (Salassi et al., 2013; Zhang et al., 2014), in Indonesia (Destieka Ahyuni and Dulbari, 2019; Dulbari, Edi Santosa, Yonny Koesmaryono, 2019; Dulbari et al., 2018; E Santosa et al., 2016; Edi Santosa et al., 2018). However, research related to the fall of rice plants, factors of the cropping system or planting method studied in terms of morphological and physiological identification was still lacking in data. Therefore, this study aims to identify and obtain scientific data on morphology and physiology of rice stems related to the laying factor, in two ways of planting rice, direct seed planting and transplanting.

1. RESEARCH METHOD

Genetic Material

This research was conducted in rice fields owned by farmers in the Wiringpalennae village, Tempe sub-district, Wajo district, South Sulawesi. The rice seed used was the Inpari 43 variety, which was a variety commonly used by local farmers. Soil chemical properties: pH 5.5 and organic matter 2.45%.

Design/Field Plan

The design was compiled based on the Completely Randomized Block Design (RAKL) method with 4 replications. Planting was done in two ways of planting, direct seed planting (TBL) and transplanting method (TP). Planted in plots that had been prepared and their positions were randomized. A plot size of 2.5 x 2.5m (12 plots) was used. The two treatments were separated by 2 mound beds to avoid water movement and fertilization. Germinated seeds used for direct seeding (TBL) were sown directly into the experimental plot, but transplanted seeds (TP) were sown -7 days before TBL scattering. Initial fertilization with fertilizer (N46%) at a dose of 100 ha-1 was carried out to stimulate the vegetative growth of young plants. Plant maintenance is carried out in accordance with the habits of local farmers.

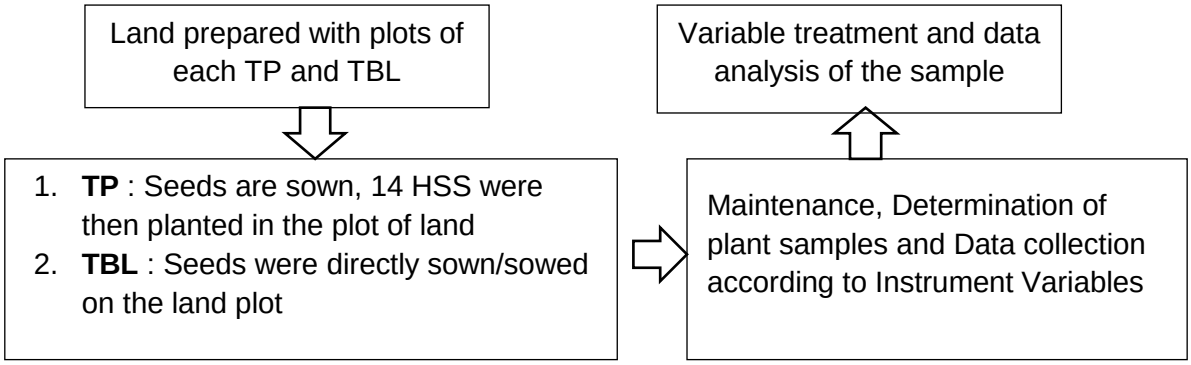

Figure 1. Flowchart of research implementation

Taking Sample and Observation

A sample of 10 clumps of plants in each experimental plot, was taken/determined when the rice plants were in full fruiting. The main stem was taken from the sample to be used as a morphological indicator related to the fall of rice plants. The observed morphological variables were plant height, stem length, center of gravity height, index of laying down, and bending moment at fracture.

The bending moment was calculated by the formula: Bending moment = PB(cm) x BS(cm), where PB is the length of the stem from the base of the stem to the tip of the panicle, BS is the fresh weight from the rank of the stem to the tip of the panicle. The bending pressure of the bar (TBB) was measured by testing the strength of the rod by applying pressure to a rod that was 5 cm long (between 2 support points). The fall index was measured based on the following formula: (Fallness Index (IK): Moment of Bending when bent/stressed) x 100. For rice before harvest, the rate of fall of the rice plant was measured and calculated from the area of the plant in a fallen condition divided by the area of the experimental plot.

Data analysis

The data were analyzed using the SPSS 24 application. The mean of each treatment was compared with the least significant difference test (BNT) at the probability level of p = 0.05.

3. RESULTS AND DISCUSSION

The results of the observations showed that all measured and observed variables had significant differences between the 2 rice planting methods.

Plant height, Center of Gravity Height, Lying Index, Stem Length and Lying Level.

Base Based on observations of rice stems, all variables were almost significantly different except for plant height as shown in table 1. Plant height in transplanting method and direct seed planting method looked significantly different due to differences in the treatment of the planting system. In this experiment, direct seed planting method did tend to look ecologically too dense in population in this experiment. Clump units, competition between plant stems for more sunlight makes the plants appear taller (Utami et al., 2020). Several studies had reported that plant height greatly influenced the rate of laying down (Ahadiyat et al., 2020; Liu et al., 2015; Zhang et al., 2014). And in this study, between transplanting and direct seed planting method, if you look at the indicators or instruments, the plant height and the level of laying down had data that were directly proportional, meaning that plant height had an effect on the level of laying down. The same thing with the instrument of center of gravity height, stem length and laying index in the 2 planting methods or methods (TP and TBL) in table 1 also showed significant differences.

Table 1. The results of the analysis on the morphological variables of rice plants in the method of transplanting (TP) and Direct Seed Planting (TBL).

Cultivation Method	Variable Component				
	Plant height (cm)	Stem Length (cm)	Height Center of gravity (cm)	Lying Index (%)	Lying Level (%)
TP	89,7b	84,6b	43,5a	110,7a	5,7a
TBL	117,8a	96,8a	56,9b	121,9b	75,5b

Note: Numbers followed by the same letter in the same column are not significantly different based on the SPSS application test at level = 5%

In table 1, it was identified that morphophysiologically, stem length and center of gravity were closely related to the level of laying down (Liu et al., 2018), meaning that the longer the stem of the rice plant and the higher the center of gravity, the more susceptible it is to falling rice plants. Therefore, it can be considered that the method or method of planting with the direct seeding system (TBL) is more likely to have a higher laying rate than the transplanting method (TP).

Trunk Length

The in-depth identification of factors related to the fall of rice, an indicator of stem quality, can be seen from the length of the stem segment instrument (table 2). It has been stated that there are 5 samples of the average length of stem internodes as a result of field experiments. It can be seen that the direct seed planting method or system (TBL) has a higher/longer stem internode length indicator than the transplanting method (TP).

Table 2. The results of the analysis on the morphological variables of rice plants in the method of transplanting (TP) and Direct Seed Planting (TBL).

Cultivation Method	Trunk Length				
	R1 (cm)	R2 (cm)	R3 (cm)	R4 (cm)	R5 (cm)
TP	15,6b	11,6b	9,7b	7,9b	5,7b
TBL	16,8a	13,7a	10,6a	9,2a	7,8a

Note: Numbers followed by the same letter in the same column are not significantly different based on the SPSS application test at level = 5%

This can be indicated that the higher the length of the trunk segment, the more susceptible it will be to a higher level of falling (Wu et al., 2011). The same thing with plant height. Internode length is usually influenced by the existence of population competition that occupies the same habitat or plant clump units, because the transplanting planting method tends to be divided and neatly arranged in clumps in the cropping unit (Utami et al., 2020). Analysis shows that transplanting provides more internode length for optimal fall resistance.

Trunk Width

A significant difference was also seen in the morphophysiological instrument of the width of the stem segment. In table 3, it can be seen that the average stem width/stem width in the transplanting system (TP) is higher than TBL, the highest is at R5 the width of the rice stem segment is 7.50 mm for transplanting method while for TBL

it is only 4.6mm. The width of the stem internodes correlated with the resistance to fall of rice plants. In this study, it is possible that the resistance to fall of rice plants in extreme weather climates can be mitigated by means or methods of planting rice with a transplanting system. In line with the research of Dulbari, et al.(2019) stated that there are differences in the resistance of the fall index in extreme weather.

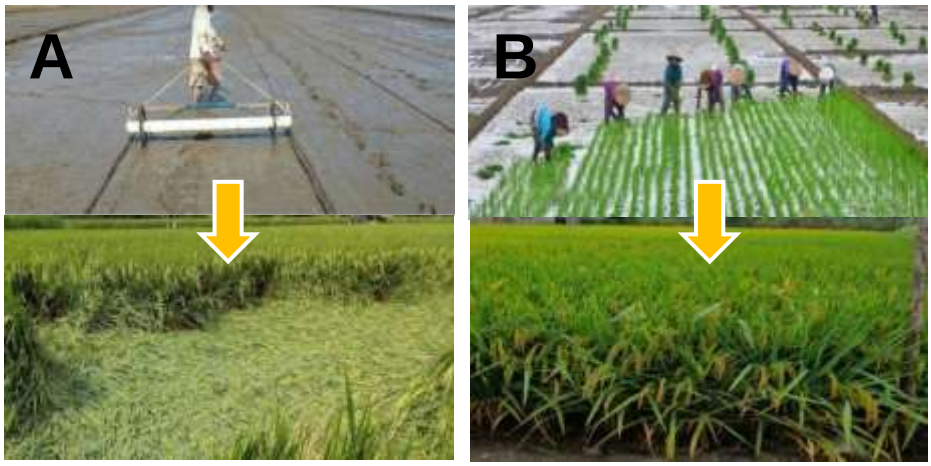

Figure 2. (A) TBL method with field results, (B) TP method with field results.

Table 3. The results of the analysis on the width of the rice stem segments in the transplanting method (TP) and direct seed planting (TBL).

Cultivation Method	Trunk Width (mm)				
	R1	R2	R3	R4	R5
TP	5.81a	6,78a	6,18a	6,3a	7,50a
TBL	3,57b	5,24b	5,84b	5,8b	4,6b

Note: Numbers followed by the same letter in the same column were not significantly different based on the SPSS application test at level = 5%

Improving in fall resistance with high yields can be achieved by appropriate internode widths with optimal internode configurations, i.e. shorter stems and longer peduncles, and by increasing stem stiffness, which is primarily associated with a higher proportion of structural carbohydrates (eg, cellulose and lignin) and greater elasticity of the leaf midrib (Zhang et al., 2014)

Bending Moment and Bending Pressure of the Bar

The results of an in-depth analysis using the bending moment instrument and the bending pressure of the stem were also observed in this study, because they are also the main factors of the fall resistance of rice plants (Liu et al., 2018; Wu et al., 2011; Zhang et al., 2014).) and the results are tentatively concluded that there is a correlation between the value of bending moment and bending stress of the stem with the resistance to fall of rice plants.

Table 4. The results of the analysis on bending pressure and bending moment of rice stems on the transplanting method (TP) and direct seed planting (TBL).

Cultivation Method	Bending Moment (cm g^{-1})				Stem Bend Pressure (g)			
	R1	R2	R3	R4	R1	R2	R3	R4
TP	503,7a	645,9a	765,7b	876,9a	467,6a	650,6a	876,7a	987,7a
TBL	478,9b	547,6b	723,5b	823,6b	365,5a	567,6b	765,8b	918,8b

Note: Numbers followed by the same letter in the same column are not significantly different based on the SPSS application test at level = 5%

Basically, a loose and optimal plant population density is very useful for increasing the light efficiency needed by plants for photosynthesis so that it has a positive impact on the quality of rice stems and then increases the fall resistance of rice plants (Yajie et al., 2015). On the other hand, a plant population that is too dense has an impact on stem diameter/stem width and thinner stem wall/bark (Liu et al., 2018). In this study, the TBL method was observed to tend to plant / sow too many seeds because the sowing equipment used was not controlled by the seeds coming out of the hole. This caused the seeds to grow more densely in the plant clump unit, in addition to irregular sowing and without a clear distance has an impact on the lack of light ventilation and shallow roots in the soil so that it may also be the main factor for rice downfall. In contrast to the transplanting system/method, the seeds planted tend to be well controlled so that the population of the plant clump unit is well organized and the root depth of the plants is deeper than the TBL.

4. CONCLUSION

Falling resistance of rice plants in two types of transplanting methods (TP) and direct seed planting (TBL). The decrease in falling resistance was mainly associated with an increase in internode length, decrease in internode width, bark thickness, dry weight per unit length, breaking stress, and basal internode bending moment. The resistance to fall of rice is closely related to the physical properties of the third and fourth segments from above. The fall of rice plants had an impact on the loss of production yields and grain quality which was mainly caused by the density of seeds during the direct seed planting method

Based on the study of stem morphophysiology of fallen rice, the practice of transplanting methods with appropriate agronomic management must be applied to reduce the risk of falling, because optimal plant population density is very useful for increasing the light efficiency needed by plants during photosynthesis. Therefore, it had a positive impact on rice stem quality and then improved the fall resistance of rice plants.

ACKNOWLEDGEMENT

The author would like to expresses deepest gratitude to Ministry of Education, Culture, Research and Technology which provided a Funding Grant for the Beginner Lecturer Research Scheme for the 2021 Financial Year. Therefore, this research can be conducted well and produce scientific publications.

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