The Effect Stubble Cutting Height on the Vegetative and Reproductive Phase of Rice Ratoon in a Tidal Swamp

Evriani Mareza (Corresponding author)
Department of Agronomy, Faculty of Agriculture, IBA University
Palembang, 30126, South Sumatera, Indonesia
Tel: +62-8127118027 Fax: +62-711322217 E-mail: *evriani_mareza@yahoo.co.id*

Zainal Ridho Djafar
Department of Agronomy, Faculty of Agriculture, Sriwijaya University
Palembang, 30662, South Sumatera, Indonesia
Tel: +62-711310756 Fax: +62-711580279 E-mail: *zainalridhodjafar@yahoo.com*

Rujito Agus Suwignyo
Department of Agronomy, Faculty of Agriculture, Sriwijaya University
Palembang, 30662, South Sumatera, Indonesia
Tel: +62-811786186 Fax: +62-711580279 E-mail: *rujito62@yahoo.com*

Andi Wijaya
Department of Agronomy, Faculty of Agriculture, Sriwijaya University
Palembang, 30662, South Sumatera, Indonesia
Tel: +62-8127139113 Fax: +62-711580279 E-mail: *andiwijayadani@yahoo.com*

Abstract: Rice ratoon technology has a great potential to be developped in a tidal swamp because it can resolve various obstacles such as limited of production factor and labor, the time of planting which is depends on the season. The objective of this paper is to analyse the effect of the stubble cutting height after harvesting of first crop on the vegetative and reproductive phase of ratoon rice. The rice was planted in a tidal swamp using a direct seedling system. A randomized block design with five replicates was used. The treatment was the stubble cutting height ranged from 10, 20, 30, 40 and 50 cm from the surface of the soil. The results showed that the height of stubble cutting has significant effect on the vegetative and reproductive phases of rice ratoon. The plant height, number of tillers and number of productive tillers of ratoon was lower than first crop. The flowering of rice ratoon was faster than the first crop. Stubble cutting up to 50 cm from the surface of the soil increases plant height, number of tillers and number of productive tillers and accelerate flowering of rice ratoon. It can be known the impact of the height of stubble cutting to the vegetative and reproductive phase on rice ratoon. Future studies on effect of the height of stubble cutting for rice yield prodcution should be focussed after the ripening phase.

Keywords: Vegetative phase; reproductive phase; rice ratoon; rice stubble; tidal swamp

1. Introduction

Agricultural development in Indonesia recently leads to using of sub-optimal land such as tidal swamp to replace the fertile lands that have been converted to non-agricultural purposes. The areal extent of the tidal swamp in Indonesia is estimated to be 20.19 mil ha of which about 9.5 mil ha has potential for agriculture conversion. A total of 4.2 mil ha have been reclaimed for agriculture (Ananto, 2002).

In order to meet the increasing demand of the nation's demand for rice, its production must be increased. One of the efforts is to intensify the rice ratoon system. Ratoon system could provide additional rice production per growing season, and also able to suppress production facilities, labor costs, and the time of planting (Ambili and Rosamma, 2002; Santos *et al.,* 2003; Nakano and Morita, 2007). Despite many advantages, the cultivation of rice ratoon is still hardly applied because the production is too low (IRRI, 1996; Nair and Rosamma, 2002; Noor, 2006; Islam *et al.,* 2008). Currently, information about ratoon rice begins to evolve. Many studies on rice ratoon have been conducted in the Philippines, India, China and Japan while in Indonesia, limited studies on rice ratoon is evident.

In areas where they were characterized by limited and expensive labor and a limited planting time as in the tidal swamp of South Sumatra Province, direct seeding system become an alternative for farmers in reducing the use of labour cost (Pane, 2003; Mareza and Kesmayanti, 2013). Due to limited manpower, the farmers used the stubble after the first crop of rice ratoon was harvested with a new tillage for the next planting. Generally, the farmers let the stubble grow as it is in the fallow without intensive cultivation, so the production of ratoon is low. The ratoon production was less than 30% of first crop depending on the varieties of first crops and soil conditions (Nair and Rosamma, 2002; Noor, 2006; Islam *et al.,* 2008; Susilawati *et al*., 2010; Susilawati *et al*., 2012).

Critical success factor for ratoon is a stubble vigor after the first crop being harvested. It is closely related to the results of photosynthesis. One of the factors related to carbohydrate status of the plants that affect the growth of ratoon is the height of stubble cutting. In addition to dealing with food reserves in stubble, the height of stubble cutting is also associated with the nodes amount remaining on stubble, and in each node there is a lateral shoots that will produce the number of shoots and tillers (Jichao and Xiaohui, 1996). The height of stubble cutting can also stimulate dormant buds to grow and influence the grain yield (Harrell *et al*., 2009).

Information of the height of stubble cutting on rice ratoon still showed inconsistent results, ranging from low to high cutting height. According Huossainzade *et al.* (2011) and Susilawati (2011), a cutting of 20-30 cm from the surface of the soil is the optimum cut to optimize the production of seeds in the panicle ratoon. While Santos *et al.* (2003) and Petroudi *et al.* (2011), low cutting stubble (0-15 cm) gave a higher ratoon production. However, Harrell *et al.* (2009) and Nassiri *et al.* (2011) reported that the higher cutting stubble (40-50 cm) gave higher ratoon production of 10-20 cm. This suggests that the effective height of stubble cutting can be influenced by the location,

season and rice varieties. Therefore, the objective of this study is to evaluate the effect of the stubble cutting height on the vegetative and reproductive phase of rice ratoon in a tidal swamp planted by direct seeding system.

2. Materials and Methods

Research was conducted from November 2013 to April 2014 in the tidal swamp Telang Sari village (land overflow type B), District of Tanjung Lago, Banyuasin Regency, South Sumatera Province, Indonesia. The plant material is Ciherang variety which is one of the rice varieties commonly grown by farmers in the study site. Urea, SP 36, insecticides and herbicides were used for the crop fertilization.

The research was applied randomize block design (RBD) with five replicates. The treatment was the height of stubble cutting 10, 20, 30, 40 and 50 cm from the surface of the soil level. Rice is grown on plots of 4 x 5 m in size with 1 m spacing between plots.

Fertilizer was given in accordance with the recommendation of farmers in the study site. The dose for the main crop is urea 300 kg/ha and SP36 100 kg/ha. Half dose of urea and the whole SP-36 was given as basal fertilizer at planting time, and half dose of urea was given 40 days after planting. Urea and SP-36 for stubble given simultaneously (all at once) three days after harvest (DAH) of the first crop as many as half of the first crop fertilizer dose (150 kg urea/ha and SP-36 50 kg/ha).

The data in this paper is limited to the data during the vegetative and reproductive phases of rice ratoon. Plant height, number of tillers and number of productive tillers were observed in ripening stadia or before harvesting, and days to flowering (days when number of flowering plants 50%). Data were statistically analysed using the analysis of variance (ANOVA), followed by HSD test at 5% significant level.

3. Results and Discussion

Table 1 illustrated the height of stubble cutting which significantly influenced some parameters during vegetative and reproductive phase of rice ratoon.

Table 1. Analysis of variance of plant height, number of tillers, number of productive tillers, and days to flowering of rice ratoon

Parameters observed during the vegetative and reproductive phase	F calculated	
Height cropp	11.65	sn
Number of tillers	16.93	sn
Number of productive tillers	10.68	sn
Days to Flowering	33.32	sn

Remarks: sn = highly significant

Ratoon height ranged from 63.15-71.65 cm which is lower than the first crop which ranged from 96.08-99.08 cm (Table 2). In a ratoon system, after the first crop was harvested, the plant experienced a very short vegetative phase, sometimes even directly into the reproductive phase, increasing the plant height but not the overall growth.

The height of stubble cutting significantly affect ratoon shoots height. The higher the cutting stubble, the higher the growth of shoots ratoon. The condition is influenced by the amount remaining assimilate on stubble as food reserves which can be utilized for growth of ratoon (Jichao and Xiaohui, 1996). The height of ratoon shoots is also associated with the remaining sections in stubble, because ratoon shoots grow from lateral buds that grow on each node that will produce shoots ratoon.

The higher the stubble cutting from the surface of the soil, the more the number of ratoon shoots because they grow from the higher nodes (2nd and 3rd segments) from the surface of the soil (Table 3). According to Harell *et al.* (2009), seedlings growing from the rice ratoon differ among varieties. In some varieties, ratoon shoots growing from higher nodes.

Table 2. The influence of the height of the first crop stubble cutting to plant height, number of tillers, number of productive tillers and days to flowering of first crop and rice ratoon

The height of stubble cutting	Plant height (cm)		number of tillers		Number of productive tillers		Flowering	
	FC	R	FC	R	FC	R	FC (DAP)	R (DAH)
10 cm	96.08	63.15 a	6.25	5.05 a	5.83	4.35 a	79.50	37.50 c
20 cm	97.88	65.55 ab	7.75	5.85 ab	7.09	5.37 ab	81.25	28.75 b
30 cm	97.53	69.65 bc	7.25	6.57 bc	6.50	6.50 bc	80.25	16.75 a
40 cm	99.08	71.65 c	7.58	7.20 c	7.08	6.95 bc	80.50	15.00 a
50 cm	98.66	71.95 c	7.58	7.53 c	7.18	7.01 c	80.05	15.00 a
HSD		5.30		1.23		1.64		8.63

Remarks: FC = first crop, R = ratoon, DAP = days after planting, DAH = days after harvesting of first crop. Figures (number) in the same column followed by the same letter are not significantly different means at 5% HSD test.

Table 3. The number of nodes remaining on the stubble after cutting the first crop

Cutting Height	Percentage of nodes on stubble above the surface of soil (%)			
	1 node	2 nodes	3 nodes	4 nodes
10 cm	100 .00	-	-	-
20 cm	38.33	61.67	-	-
30 cm	-	91.66	8.34	-
40 cm	-	-	90.00	10.00
50 cm	-	-	91.67	8.33

The number of tillers and number of productive tillers produced on the first crops and rice ratoon grown in a tidal swamp with the direct seedling system is low (5.05-7.58 tillers). This is lower than the potential rice tillers owned Ciherang of 14-17 tillers (Badan Penelitian dan Pengembangan Pertanian, 2014). This results is in accordance with Pane (2003), Makarim and Suhartatik (2006) who reported that the direct seeding will result in a smaller number of chicks. This is due to the spacing among others, radiation and mineral nutrients.

The higher stubble cutting resulted in the higher numbers of productive ratoon tillers. A 30-50 cm height of stubble cutting from the surface of the soil increased the number of tillers and the number of productive tillers ratoon compared to cutting at 10-20 cm. Tiller ratoon buds have the ability to grow very dependently on the stubble conditions of first crop. The high cuts also stimulate dormant buds to grow so as to affect the number of tillers (Harrell *et al.*, 2009). This condition may be due to differences in the amount of assimilates remaining on stubble after the first crop harvested as food reserves. If high assimilate reserves and stubble harvested remains vigor, the shoots will emerge into a seedling ratoon. Conversely, when there is a low assimilate reserves, the seedling growth will be stunted. Establishment of the number of tillers was also determined by the amount of the remaining segments.

In the high cutting (30-50 cm from the surface of the soil), about 90-91.65% stubble were in 2-3 nodes (Table 3), so it is likely that the number of tillers grow much more, because tillers grow from lateral buds contained in each nodes. At the low stubble cutting (10 cm from the surface of the soil) also causes frequent decay because of the flooded lands or damaged by being walked during harvest time so that will inhibit the growth of rice ratoon .

At the age ranged from 79.50-81.25 DAP the first crop flowering, while days to flowering for ratoon ranged from 15.00-37.50 DAH. The shorter phase on the ratoon due to the ratoon has very short or not undergo the vegetative phase. The shorter phase on the ratoon due to the ratoon not undergo the vegetative phase and the emergence of tillers ratoon often followed or concurrent with the release of panicles or flowers (Makarim and Suhartatik, 2006; Mareza *et al.,* 2013). The age for flowering on ratoon shorter than the first crop, due to ratoon have different growth phase. In plants, there are three main phases, namely phase of vegetative growth, reproductive and ripening, while rice ratoon only has two phases namely the reproductive phase of growth and ripening.

The higher stubble cutting resulted in the faster ratoon rice flowering. Cutting stubble at 30 up to 50 cm resulted in a flowering at 15.00-16.75 DAH. This will significantly affect the stubble cutting at 20 cm (28.75 DAH) and 10 cm (37.50 DAH). Makarim and Hartatik (2006) and Mareza *et al.* (2013) stated that ratoon age is 65 days, where the first 35 days is the productive and the next 30 days is for the ripening phase.

4. Conclusion

The height of stubble cutting has significant effect on the vegetative and reproductive phases of rice ratoon. Plant height, number of tillers and number of productive tillers of ratoon is lower than first

crop and day to ratoon flowering faster than the first crop. Stubble cutting up to 50 cm from the surface of the soil increases plant height, number of tillers and number of productive tillers and accelerate flowering of rice ratoon. It depends on the condition of the stubble and the amount remaining nodes on stubble above the soil after the first crop harvested. Future work suggests that the best time to determine the height of stubble cutting of rice ratoon yield is after its ripening phase.

References

1. Ambili, S. N., and C. A. Rosamma. (2002). Character Association in Ratoon Crop of Rice (*Oryza sativa* L.). Journal of Tropical Agriculture, 40 (1): 1-3.
2. Ananto, E. E. 2002. Pengembangan Pertanian Lahan Rawa Pasang Surut Mendukung Peningkatan Produksi Pangan. Makalah disampaikan pada Seminar IPTEK pada Pekan Padi Nasional di Sukamandi 22 Maret 2002 (*in Indonesian*).
3. Badan Penelitian dan Pengembangan Pertanian. (2014). Deskripsi Varietas Padi 2010. Pusat Penelitian dan Pengembangan Tanaman Pangan, Bogor (*in Indonesian*).
4. Harrel, D. L., A. B. Jason., and B. Sterling. (2009). Evaluation of Main-Crop Stubble Height on Ratoon Rice Growth and Development. Field Crops Research Journal, 114: 396-403.
5. Huossainzade, A. E. Azarpour, H. Z. Doustan M. Moraditochaee, and H. R. Bozorgi. (2011). Management of Cutting Height and Nitrogen Fertilizer Rates on Grain Yield and Several Attributes of Ratoon Rice (*Oryza sativa* L.) In Iran. World Applied Sciences Journal, 15(8): 1089-1094.
6. Islam M. S., M. Hasannuzzaman, Md. Rukonuzzaman. (2008). Ratoon Rice Response to Different Fertilizer Doses in Irrigated Condition. Agriculture Conspect Science Journal, 73: 197-202.
7. IRRI. 1996. Standard Evaluation System for Rice (SES). IRRI, Los Banos, the Philippines.
8. Jichao, Y. and S. Xiaohui. (1996). Effect of Cutting Node and Leaves Retained on the Mother Stem on Rice Ratooning. Journal of Sichuan Agricultural University. 4(7): 42-53.
9. Makarim, A. K. dan E. Suhartatik. 2006. Morfologi dan Fisiologi Tanaman Padi. Balai Besar Penelitian Tanaman Padi (*in Indonesian*).
10. Mareza, E., F. Podesta, dan R. Ratibayati. (2009). Respon Perkecambahan Lima Varietas Padi Rawa Lebak terhadap Pemberian Zat Pengatur Tumbuh 2,4-D pada Fase Vegetatif di Lapangan. Jurnal Akta Agrosia. 12(2): 177-183 (*in Indonesian*).
11. Mareza, E., Z. R. Djafar, R. A. Suwignyo, dan A. Wijaya. (2013). Respon Pertumbuhan Fase Reproduktif Ratun Tanaman Padi di Lahan Pasang Surut terhadap Tinggi Pemotongan Singgang. Dalam Prosiding Seminar Nasional Lahan Suboptimal, Pusat Unggulan Riset Lahan Sub Optimal. Palembang, 20-21 September 2013, hal. 528-534 (*in Indonesian*).
12. Mareza, E. dan N. Kesmayanti. (2014). Identifikasi Karakter Agro-Morfologi Varietas Padi (*Oryza sativa* L.) Potensial

Lahan Pasang Surut. Jurnal Ilmiah AgrIBA, 2: 70-77 (*in Indonesian*).

13. Nair, A. S. and C. A. Rosamma. (2002). Character Association in Ratoon Crop of Rice (*Oryza sativa* L.). Journal of Tropical Agriculture, 40: 1-3.
14. Nakano, H. dan S. Morita. (2007). Effects of Twice Harvesting on Total Dry Matter Yield of Rice. Field Crops Research Journal, 101: 269-275.
15. Nassiri, M., H. Pirdashti and T. N. Nejad. (2011). Effect of Level and Time of Nitrogen Fertilizer Application and Cutting Height on Yield and Yield Component of Rice Ratooning. Proceedings of the Fourth International Iran and Russia Conference, pp: 602-606.
16. Noor, E. S. (2006). Pengaruh Sistem Ratunisasi dan Pemupukan Nitrogen terhadap Hasil Beberapa Varietas Padi di Lahan Sawah Irigasi. Jurnal Agrivigor. 5(3): 207-222 (*in Indonesian*).
17. Pane, H. (2003). Kendala dan Peluang Pengembangan Teknologi Padi Tanam Benih Langsung. Jurnal Litbang Pertanian, 22(4): 172-178 (*in Indonesian*).
18. Petroudi, E. R., G. Noormohammadi, M. J. Mirhadi, H. Madani, and H. R. Mobasser. (2011). Effects of Nitrogen Fertilization and Rice Harvest Height on Agronomic Yield Indices of Ratoon Rice-Berseem Clover Intercropping System. Australian Journal of Crop Science, 5(5): 566-574.
19. Santos, A. B., N. K. Fageria, and A. S. Prabhu. (2003). Rice Ratooning Management Practices for Higher Yields. Communications in Soil Science and Plant Analysis Journal. 34: 881-918.
20. Susilawati. (2011). Agronomi ratoon genotipe-genotipe padi potensial untuk lahan pasang surut, Disertasi Doktor, Institut Pertanian Bogor, Bogor (*in Indonesian*).
21. Susilawati, B. S. Purwoko, H. Aswidinnoor, dan E. Santosa. (2010). Keragaan Varietas dan Galur Padi Tipe Baru Indonesia dalam Sistem Ratun. Jurnal Agronomi Indonesia, 38(3): 177-184 (*in Indonesian*).
22. Susilawati, B. S. Purwoko, H. Aswidinnoor, dan E. Santosa. (2012). Peran Hara N, P dan K pada Pertumbuhan dan Perkembangan Ratun Lima Genotipe Padi. Jurnal Agronomi Indonesia, 40(3): 174-179 (*in Indonesian)*.
23. Wijaya, A. dan R. Soehendi. (2012). Peningkatan Produksi Padi Rawa Pasang Surut Melalui Penerapan Budidaya Ratoon dan Perakitan Varietas yang Spesifik. Laporan Penelitian Pusat Unggulan Riset Pengembangan Lahan Suboptimal, Universitas Sriwijaya, Palembang, Indonesia (*in Indonesian*).

***