Research article

Effects of Transplanting Methods on Yield of Different Rice Varieties under Sandy Soil Conditions

SOKORNTHEA PIN*
Institute of Environment Rehabilitation and Conservation, Cambodia branch
Email: sokornthea.pin@gmail.com

SOPHAL CHUONG
Faculty of Agronomy, Royal University of Agriculture, Phnom Penh, Cambodia

VANTHORN SOK
Royal University of Agriculture, Phnom Penh, Cambodia

THYDA LEN
Faculty of Agronomy, Royal University of Agriculture, Phnom Penh, Cambodia

Received 16 December 2011 Accepted 18 April 2012 (*: Corresponding Author)

Abstract Rice is a staple food for Cambodians and it is also a main source of income for farmers' livelihood in rural areas. However, rice yield is low so it is vitally important to increase rice yield through promoting new rice varieties and cultivation methods. To promote new knowledge for famers, an experiment regarding the effect of transplanting methods on rice yield of different varieties was conducted in experimental station. The experiment investigated the interaction of different transplanting methods on rice varieties and identified the best variety and transplanting methods for rice cultivation. The experimental design was based on Randomize Complete Block Design (RCBD) which had six treatments: Riang Chey variety with straight-row transplanting, Riang Chey variety with conventional transplanting, Phkar Rumduol variety with straight-row transplanting, Phkar Rumduol variety with conventional transplanting, IR66 variety with straight-row transplanting, IR66 variety with conventional transplanting and three replications. Hill spaces were 25 cm x 25 cm for straight-row transplanting method, and 15 cm to 25 cm for conventional transplanting method. The result of the experiment showed that yield component, panicle number per hill, percent of filled grains per panicle and total yield of three varieties transplanted straight–row transplanting method had significant difference with conventional transplanting method. However, the yield components, panicle length and 1000-grain weight of three varieties transplanted by using straight–row transplanting method had no significant difference from conventional transplanting. Also, the rice yield components had no interaction with the three varieties and the transplanting methods. IR 66 variety with straight–row transplanting method had the highest yield with 6.145 t/ha in average compared to conventional transplanting method with only 5.630 t/ha in average. In conclusion, among three varieties and two transplanting methods, the potential and highest yield was IR66 variety transplanted by using straight-row transplanting method.

Keywords cultivated method, conventional transplanting, straight-row transplanting, yield component

INTRODUCTION

Cambodian agriculture sector has played a vital role in increasing national economy as it has provided many jobs for 85% of people in rural areas, and contributed with 34.4% of GDP (Sarun, 2007; MAFF, 2009). Rice is a main stable crop which ensures food security and is a main source of income for Cambodian people in rural areas (Helmer, 1997).

In rainfed lowland rice, 70% of farmers cultivate rice with traditional methods and use traditional varieties. They also transplant rice seedlings that were 40 to 80 day olds and 4 to 5 seedlings per hill, and transplant too much of rice seedling hills in paddy field that reached 800,000 hill/h (Rickman et al., 1997). Rice yield is low comparing to other Asian countries because 91% of total rice productivity depends on rainfall, damage from pests, and decreasing soil fertility (Javier, 1997).

Makara et al. (2001) reported that to increase rice yield, it is necessary to develop new varieties which produce high yield, are resistant to climate stress and pests along with new cultivation techniques which are suitable for each rice agro-ecosystem. More importantly, the new varieties and the new cultivated techniques should be promoted and taught to local farmers. In 2000, system of rice intensification (SRI) was introduced to farmers by CEDAC, Cambodian NGO, and in 2005 SRI technique was promoted widely to local farmers by MAFF and other NGOs. However, some principles of SRI were not applied by farmers, and there are few farmers who have applied SRI techniques (Sarun, 2007; Sothy and Rattana, 2008).

The objectives of this research are to determine the interaction of different transplanting methods on rice varieties and to identify the best variety and transplanting methods for rice cultivation.

MATERIALS AND METHODS

Site description

Soil condition: This study was carried out at the crop experimental station of the Royal University of Agriculture, Cambodia. The soil condition of experimental site is Prateash Lang soil type (85% is sandy soil). Prateash Lang soil has low fertility so it needs be applied with organic fertilizer combined with chemical fertilizer. The properties of this soil are detailed in Table 1.

Climatic conditions: In 2009 annual average temperature at experimental site was 28.40 ^{o}C. Minimum average temperature was 26 ^{o}C in December and maximum average temperature was 30.50 ^{o}C in May. For rainfall, 2009 annual average rainfall was 137.06 mm, and higher average rainfalls were recorded in August and September, 290 mm and 289.60 mm respectively (Fig. 1)

Table 1 Soil properties in experimental site

Soil property	Prateah Lang soil (Red yellow podzol)
Organic matter (OM) %	0.26
C %	0.156
N %	0.035
P (ppm)	113
K (meq/100g soil)	0.12
Mg (meq/100g soil)	1.25
Ca (meq/100g soil)	2.5
Na (meq/100g soil)	0.86
pH	5.5-7.5
C:N Ratio	5

Source: Soil result analysis, department of Agronomy and soil improvement, 2005

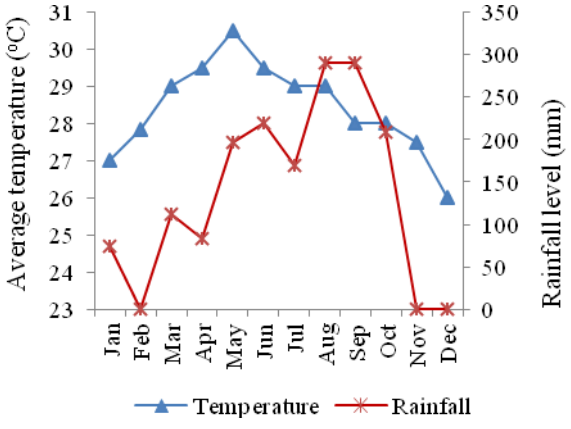


Fig. 1 Average temperature and rainfall level during 2009

Experimental design

Three common rice varieties including Riang Chey, Phkar Rumduol and IR6 developed by CARDI were selected to conduct the experiment in the station in 2009, and these rice varieties were cultivated with two different transplanting methods: straight-row transplanting method with hill

space of 25 cm x 25 cm and conventional transplanting method with variable hill space from 15 cm to 25 cm. The experimental plots (9 m^2) were organized based on randomized complete block design (RCBD) with 6 treatments and 3 replications set up at the crop station. Each plot was applied with 10 t/ha of compost manure before transplanting.

Data analysis

Parameters for data collection of rice yield components including panicle, panicle length, filled grain, 1,000-grain weight and grain yield were calculated for means and significant difference determined between treatments by analysis of variance (ANOVA) at 5% and 1% of significant level. In addition, multiple comparison of the treatment was tested for high significant difference by Muncan's Multiple Range Test (DMRT) at 5% of significant level. Also, simple linear regression was performed to determine relationships of yield component and grain yield by using Microsoft Excel.

RESULTS AND DISCUSSION

The result of statistical analysis indicated that the yield components of three rice varieties had significant difference at 1%. Also, the two transplanting methods had effect on panicle per hill, filled grain and grain yield of the three varieties. However, panicle length and 1,000 - grain weight of each variety had no significant difference between the two transplanting methods; and there was no interaction between three varieties and two transplanting methods on rice yield component (Table 2).

Table 2 Summary of statistical analysis of rice yield component

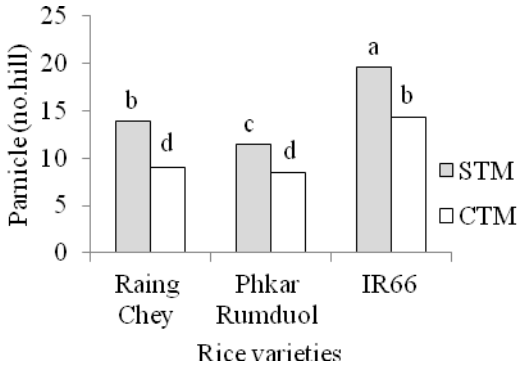
Rice Varieties	Transplanting methods	Yield components				
		Panicle (no./hill)	Panicle length(cm)	Filled grain (no./panicle)	1,000-grain weight(g)	Grain yield (t/ha)
Raing Chey	STM	13.84^{b}	23.83^{b}	164.80^{a}	23.37^{b}	4.872^{c}
	CTM	8.95^{d}	23.73^{b}	134.60^{b}	22.99^{b}	4.427^{d}
Phkar Rumduol	STM	11.48^{c}	24.90^{a}	110.86^{c}	27.22^{a}	3.654^{e}
	CTM	8.49^{d}	24.43^{a}	82.27^{d}	26.86^{a}	3.347^{f}
IR66	STM	19.51^{a}	23.01^{c}	118.40^{c}	21.59^{c}	6.145^{a}
	CTM	14.25^{b}	22.88^{c}	93.03^{d}	21.42^{c}	5.630^{b}
F-test	Variety	**	**	**	**	**
	Method	*	ns	*	ns	*
	Variety* Method	ns	ns	ns	ns	ns
C.V (%)		6.92	2.18	5.64	1.70	5.60

** = Significant at 5%, **= Significant at 1%, ns = Non significant difference*
Different letters were DMRT test by significant difference at 5%
STM: Straight-transplanting method, CTM: Conventional transplanting method

The results of the experiment showed that IR 66 variety had more panicles per hill than Raing Chey and Phkar Rumduol varieties, and for straight-transplanting method IR 66 had more panicles per hill than when it is transplanted by using conventional transplanting method (Fig. 2). Raing Chey variety had more filled grain per panicle than Phkar Rumduol and IR 66 variety, and with straight-transplanting method, Raing Chey variety got more filled grain than when it is transplanted by using conventional transplanting method (Fig. 3).

Fig. 4 shows that IR 66 variety (average grain yield was 6.145 t/ha) cultivated by using straight-transplanting method got higher grain yield than Raing Chey and Phkar Rumduol variety, by using conventional transplanting method which was only 5.630 t/ha in average.

Straight-transplanting method made rice to produce more panicles per hill than rice transplanted by using conventional method. The relationship between panicles per hill and grain yield showed that increasing IR 66 yield was correlated highly with panicle per hill. Furthermore, grain yield of Raing Chey and Phkar Rumdoul variety did not only depend on panicle per hill but also on filled grain (Fig. 5 and Fig. 6).



*STM: Straight- transplanting method,
CTM: Conventional transplanting method

Fig. 2 Panicle number per hill of each variety with different methods of transplanting

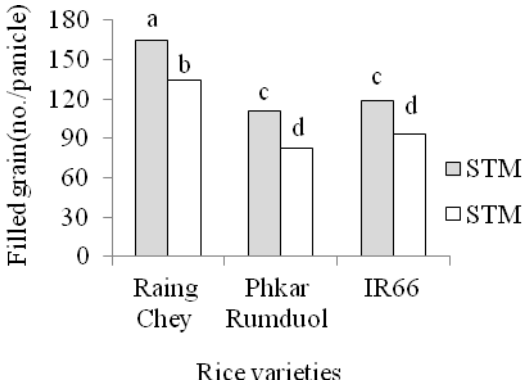


Fig. 3 Number of filled grain per panicle of each variety with different methods of transplanting

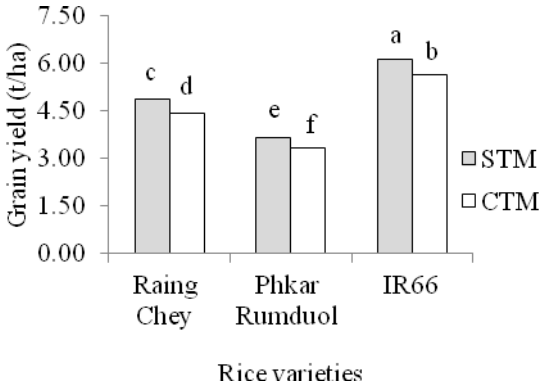


Fig. 4 Grain yield of each variety with different methods of transplanting

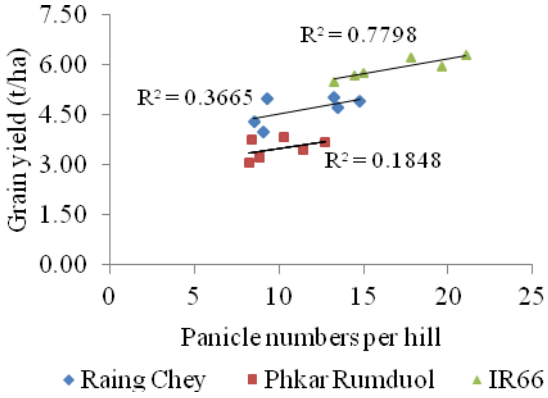


Fig. 5 Relationship between panicle number perhill and grain yield

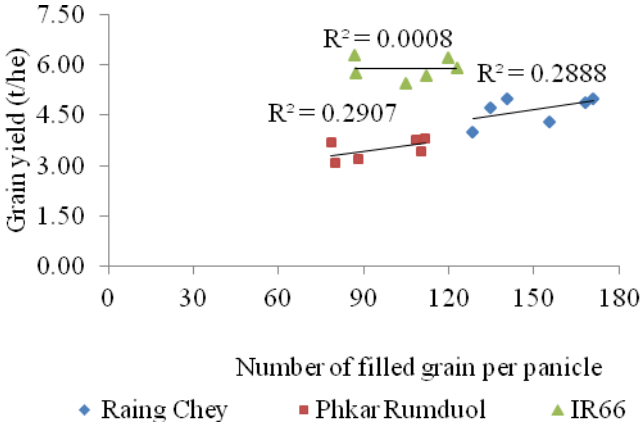


Fig. 6 Relationship between filled grain per hill and grain yield

Cultivation of rice by using straight-transplanting method provides the potential for rice to absorb nutrients from the soil, and sunlight to make photosynthesis higher; it also increased rice

yields from 25% to 39%, higher than conventional transplanting. Contrastingly, conventional transplanting can cause rice yield to decrease from 20% to 30% (IRRI, 1987; Men Sarom, 2007). Takan and Kiyochika (1993) reported that shade affects filled grain and weight of grain, and yield component will decrease if sunlight intensity decreased. Shouichi (1981) also reported that sunlight intensity is vitally important in dough grain stage and mature grain stage. Rice will grow well when intensity of sunlight is higher than 250 cal/cm^2, and if light intensities reached 300 cal/cm^{2,} rice yields will increase to 5 t/ha.

CONCLUSION

This study has indicated that the yield component of each variety is significantly different. Panicle per hill, filled grain and grain yield of the three varieties were significantly different between straight-transplanting and conventional transplanting. However, panicle length and 1,000- grain weight were not significantly different between the two transplanting methods. Also, there was no interaction between these varieties and two transplanting methods. Therefore, IR66 variety transplanted by using straight-transplanting method got yields in average 6.145 t/ha higher than those of IR66 transplanted by using conventional transplanting method. As a result, among the three varieties, IR66 variety has the potential for producing higher yields than Raing Chey and Phkar Rumdoul variety. The best method for transplanting rice is straight-transplanting methods.

ACKNOWLEDGEMENTS

I would like to thank Faculty of Agronomy, Royal University of Agriculture (RUA) for supporting and providing experimental site, and special thanks to ERECON, especially to Prof. Machito MIHARA for his support.

REFERENCES

Helmer, K. 1997. Rice in the Cambodian economy: past and present. Rice Production in Cambodia, Cambodian-IRIRI-Australia Project. IRIR, Philippines.

IRRI .1987. Method of planting rice (http://www.knowledgebank.irri.org/plantingrice/ plantingrice.pdf).

Javier, E.L. 1997. Rice ecosystems and varieties. Rice Production in Cambodia, Cambodian-IRIRI-Australia Project. IRIR, Philippines.

Ministry of Agriculture, Forestry and Fishery, Cambodia. 2009. Annual report of activities and achievement 2008-2009 and plan 2009-2010 of agriculture, forestry and fishery.

Makara, O., Sarom, M. and Nesbitt, H.J 2001. Rice production systems in Cambodia. Increased lowland rice production in the Mekong region. Proceeding of International Workshop, Vietnamese, Laos, ACIAR Proceeding, 101.

Makara, O. et al. 2001. Rice varieties released by the varietal recommendation committee of Cambodia (1990-2000), CARDI, Phnom Penh, Cambodia.

Rickman, J.F., Pyseth, M. and Sothy, O. 1997. Farm mechanization. Rice Production in Cambodia, Cambodian-IRIRI-Australia Project. IRIR, Philippines.

Sarun C. 2007 Guideline of System of Rice Intensification, Khmer version, Phnom Penh, Cambodia.

Sothy, I. and Rattana, H. 2008. Annual Report of SRI Secretariat in February 2007 to January 2008, Phnom Penh, Cambodia.

Shouichi, Y. 1981. Foundation of the rice crop science, the international rice institute, Los Banos, Laguna, Philippines.

Takan, M. and Kiyochika, H. 1993. Science of the rice plant, Food and Agriculture Policy Research Center, Tokyo.