Effect of mechanical harvesting for germination capability of rice seeds

D.M.C. Champathi Gunathilake[1*], Chandrajith Gamage[2]

(1. *Assistant Professor, Department of Soil Science & Agricultural Engineering, College of Agriculture, Fisheries and Forestry, Fiji National University, PO. BOX 1544 Nausori, Fiji*;
2. *Research Officer, Institute of Post- Harvest Technology, Jayanthi Mawatha, Anuradhapura, Sri Lanka*)

Abstract: At present, mechanical harvesters called combine harvesters of which cutting, threshing and cleaning performed in one machine are highly popular among local farmers as a solution for labor scarcity during harvesting season. However, most of the farmers interpret without proper evidence that germination of rice seeds can be lost due to mechanical harvesting by combine harvester. Therefore, this study was conducted for scientific evaluation of mechanical harvester for seed damage and germination. Four types of available commercial combine harvester machine brands namely Kubota, Mubota, Agrotech and Class were used for this experiment. During the experiment, machines were operated under standard operating conditions as mentioned in the machine manufactures. The 40 m^2 area that 2 m wide and 20 m strip was harvested by each mechanical harvesters. Same size strip was harvested manually in same field as a control. Seed mechanical damage was analyzed by seed damage detector and standard germination test, 100 paddy seeds allowing to germinate on cotton wool media with adequate amount of water for 10 days was performed. The results revealed that mechanical damage to seed was not significant when machine was new and operated under standard operation condition. Results were also clearly pointed out that new or well-maintained mechanical harvesters were not significantly affected for reducing seed germination compare to control. However, the mechanical damaged occurred to the seeds during mechanical harvesting caused to reduced seed germination capabilities. Furthermore, experiment has shown that mechanical damage of seeds would be increased due to the use of worn out mechanical parts in the harvesting machines for long run without replacing.

Keywords: combine harvester, paddy seed, harvesting, seed damage, germination

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1 Introduction

Rice (*Oryza Sativa*) is the most important and extensively grown food crop in the world. It is the staple food of more than 60 percent of the world population. Rice is mainly produced and consumed in the Asian region. It is also staple food and extensively grown food crop in Sri Lanka. Harvesting, threshing and cleaning play significant roles in realizing the full benefit of raised crop by reducing post-harvest losses as well as improving quality of paddy. Further, these operations play a vital role in protecting seed viability/germination. Improper harvesting, threshing and cleaning may cause to seed damage and loss of seed germination/viability. Harvesting is traditionally carried out using sickles. Four-wheel tractors or low capacity mechanical threshers are generally used for threshing of harvested paddy. Cleaning of threshed paddy is done by fan attached to two wheel tractors or through manual winnowing. At present, high capacity combined thresher apart from other methods is used for threshing and cleaning of paddy. However, all these methods require considerable amount of labor. Labor scarcity during peak harvesting season of paddy (rough rice) has become a challenge for paddy growers in Sri Lanka and also the cost of labour is about 45%-55% of the total cost of production of paddy out of

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***Corresponding author: Champathi Gunathilake, D. M. C.,** Assistant Professor, Department of Soil Science & Agricultural Engineering, College of Agriculture, Fisheries and Forestry, Fiji National University, Fiji. Tel: +6799911870. Email: champathi@hotmail.com.

which about 50% is used for harvesting, threshing and winnowing operations (Maharouf and Rafeek, 2004). Combine harvester for harvesting, threshing and cleaning of paddy is a very good solution to overcome labor scarcity and high labor cost. Hence, combine harvesters are highly popular among local farmers. However, most of the farmers' judge without proper evidence that, combine harvesting caused to high seed damage and loss of germination, hence combine harvester was not suitable for harvesting seed paddy. Therefore, this research study was conducted to study the effect of paddy harvesting by different combine harvesters for seed damage and germination (viability).

2 Methodology

Study was conducted in government seed paddy (rough rice) production farm at Pollonnaruwa, Sri Lanka. Combine harvesters, cutting, threshing and cleaning performed in one machine are popular among local farmers as a solution of labor shortage during harvesting season. Several types of combine harvester brands were available in Sri Lanka, while following four types of commercial combine harvester machine brands namely Kubota (Mode DC-68G), Mubota (Mode 4LZ-2.0), Agrotech (Model 4R1040) and Class (Model CropTiger 40 Terra Trac) famous among local farmers were used for this experiment. Equal size machines in terms of power and capacity from these four different brands were selected and machines were operated under standard operating conditions in terms of speed and crop harvesting moisture content according to the machine manufactures standards. Harvesting moisture content of paddy was maintained around 18%-20% wet basis (WB) as recommended by machine manufactures. The 40 square meter area that 20 m long and 2 m wide strip of paddy was harvested by each selected (above mentioned) combine harvester to collect experimental paddy samples. Harvesting width 2 m was maintained according to the cutting blade width of the machines. Paddy samples for control treatment were collected by manual harvesting followed by manual threshing and cleaning of same size strip in same filed. Both experimental and control paddy samples were dried at equilibrium moisture content 14% WB and kept for three months under ambient condition before testing germination. All treatments replicated three times in order to minimize errors. Mechanical damages to the seeds occurred during harvesting was analyzed by seed damage detector (model AS28015). Seed mechanical damage percentage was calculated by identifying number of cracked seeds from 100 seeds of working sample of obtained each treatment by precision sample divider. Equation (1) was adopted to calculate mechanical damage percentage of seeds.

$$\text{Mechnical damage } \% = \frac{\text{Number of damaged seed}}{\text{Total number of seeds}} \times 100 \quad (1)$$

Paddy seed germination test was done according to the standard procedure of germination (IRRI 2007) that 100 paddy seeds allow to germinate on cotton wool media with adequate amount of water for 10 days. Equation (2) was used for calculation of germination percentage of seeds. Each germination test was replicated for three times (each replicate 100 seeds).

$$\text{Germination } \% = \frac{\text{Number of germinated seed}}{\text{Total number of seeds}} \times 100 \quad (2)$$

Analysis of variance (ANOVA) of treatments on complete randomized design (CRD) by general liner model (GLM) procedure was performed and also treatment means were separated by the Duncan's multiple range test (DMTR) at $\alpha = 0.05$ level of significance.

3 Results and discussion

Table 1 showed the seed mechanical damage percentage and manufacturing years of the combine harvesters used for this experiment. According to the Table 1, it was clear that variation of damage seed percentage with type of machine brand mainly depended on machine life span that the number of year machine used. Agrotech combine harvester was relatively old in comparison to other machines so that highest damage seed percentage was reported from Agrotech. Additionally, lowest damage seed percentage was reported in relatively new Kubota machine. Hence, results clearly revealed that mechanical damage to the seed could be increased due to the wear and tear of the mechanical parts. Old machine must be replaced with

new one in order to minimize mechanical damage of seeds.

Figure 1 showed the variation of germination in paddy samples harvested by different combine harvesters. The results indicated that germination percentage of the paddy seed slightly varied with type of the combine harvester used for harvesting of paddy seeds. It can also be observed only slight germination difference of paddy seed in comparison to control treatment that performed manual harvesting, threshing and cleaning.

Table 1 Manufacturing years of the combine harvesters used for the experiment

Type of combine harvester use for experiment	Seed mechanical damage percentage	Manufacturing year of the machine
Class	14	2012
Kubota	13	2013
Agrotech	24	2010
Mubota	18	2011
Control	10	

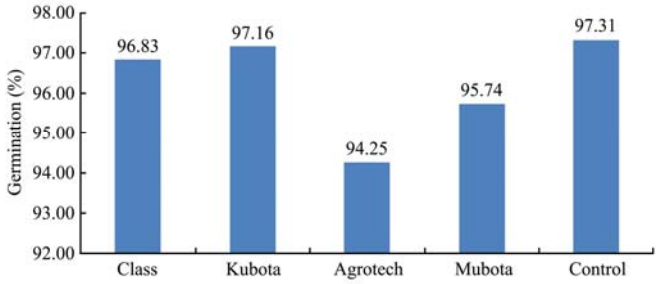

Figure 1 Variation of germination in paddy samples harvested by different combine harvesters and control

Paddy seeds harvested by Kubota combine harvester had reported highest germination percentage of 97.06% and lowest seed damage of 13% among four types of combine harvesters used for the experiment. Second highest germination percentage of 96.83% and second lowest seed damage of 14% were reported from sample obtained by Class combine harvesters. Mubota, and Agrotech combine harvesters were reported 95.31%, and 94.25% germination percentage and 18% and 24% seed damage percentage respectively. The lowest germination percentage of 94.25% and highest seed damage percentage of 24% were reported from Agrotech combine harvester.

Table 2 showed the results of multiple mean comparison of seed damage and germination of paddy seed for different harvesting method adopted in this study. It was clear from Table 2 that seed damage directly correlated with germination of paddy seed. Lowest damage seed samples have shown high germination. Paddy seed harvested by Kubota and Class combine harvesters were not shown significantly different in terms of seed damage and germination in comparison to control. Although, germination of Mubota sample was not shown significant difference in comparison to control sample, seed was damaged for Mubota significantly in comparison to the control. Seed damage and germination percentage of sample collect from Agrotech has been shown significant difference from control samples. It was clear from the results that seed damage caused reduce germination percentage. These results were proved by the previous study by Paulsen et al. (2015) that seed damage during harvesting caused loss of its viability. Table 1 was clearly pointed out that seed damage was directly proportional to the age of combine harvester. Agrotech combine harvester maintenance history has shown that machine was not maintained properly. It may cause to high mechanical damage to seed. Mechanical damage to the seed can be increased due to the wear and tear of the mechanical parts of relative old machine (Wei et al., 2012). Wear and tear mechanical parts must be replaced with new one in order to minimize mechanical damage to seeds. Therefore, combine harvester must be used as manufacture guide line. Periodical maintenance must be performed according to the manufacture guide line in order to high performance of the machine. However, paddy samples harvested by relatively new and well maintained three different combine harvesters were not shown significant difference in terms of germination percentage, in comparison to control sample except sample harvest by Agrotech combine harvester. The Agrotech combine harvester was relatively old and was not proper periodically maintained therefore seed damaged was relatively higher than other combine harvester as explaining above. Hence, it revealed that paddy harvesting by new and well maintained combine harvester had not shown significant effect for reducing germination percentage.

Table 2 Result of DMRT multiple mean comparisons of responses by treatments

Treatment (Different harvesting method)	Mean damage seed percentage	Mean germination percentage
Class	14.21 [a]	96.83[a]
Kubota	13.42 [a]	97.16[a]
Agrotech	24.74 [c]	94.25[b]
Mubota	18.46 [b]	95.74[a]
Control	10.56 [a]	97.31[a]

Note: [a] Columns having same letter are not significantly difference at $\alpha = 0.05$ by DMRT.

4 Conclusion

The results revealed that harvesting paddy seed by new or well-maintained combine harvester was not affected significantly for reducing seed germination and mechanical damage. Mechanical damaged occurred to the seeds due to machine harvesting reduced seed germination percentage. Mechanical damaged to the seed can increase due to wear and tear of mechanical parts of the machine with long time use without replacing.

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