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Original article

Agronomic response of inbred and hybrid rice *(Oryza sativa L.)* varieties to methods of seeding preparation for transplanting

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ABSTRACT

The method of seedling preparation for transplanted rice is one of the most critical factors of producing healthy and vigorous growth of lowland rice seedlings. This study aimed to determine the growth, yield performance, and profitability of lowland rice hybrid and inbred varieties grown under different methods of seedling preparations for transplanting. The experiment was laid out in a Split-plot RCB design with three replications. The seedling preparations (conventional uprooting and *laplap* method) were designated as the main-plot while lowland rice varieties (hybrid and inbred rice varieties) as the subplot. The study revealed that uprooting management had no significant effects on plant height (cm), harvest index, herbage yield (tha^{-1}), and grain yield (tha^{-1}) in rice varieties. Inbred rice varieties produce a greater number of productive tillers hill^{-1} compared to hybrid rice regardless of seedling preparations (uprooting and *laplap* methods). However, hybrid rice varieties produced longer panicles and more filled grains than inbred varieties regardless of the methods of seedling preparations. As a result, hybrid rice produced a higher grain yield (tha^{-1}) compared to inbreed variety. This resulted in a higher net income of hybrid rice (PhP 57,090.72) than inbred rice, with PhP 54,530.72. *The laplap* method has a lower production cost than the conventional uprooting method. Hence, *laplap* method produced higher net income than conventional.

KEYWORDS: *Seedling preparations, conventional and laplap methods, rice farming, yield, profitability, net income*

1 INTRODUCTION

Rice (*Oryza sativa* L.) is the most important agricultural crop in the Philippines. It is an essential means of sustenance, as a basic staple food and source of income, for millions of Filipino farmers. With vegetables and fish, rice dominates the consumption choices of Filipinos, especially since it is the primary priority for food by the poor (FNRI, 2003). Given the weight of rice's social and economic implications, it has always been the top priority of the governments' food security policies (Bordey, 2010). However, its production is labor-intensive. According to the Philippine Statistics Authority (PSA, 2015), the average labor utilization in *palay* farming across the country was 61.6 man-days per hectare. Eastern Visayas posted the highest labor input at 86.8 man-days per hectare.

Crop establishment can either be direct-seeded or transplanted. In direct seeding, seeds are sown directly in the field. While in transplanting, seedlings are first raised in seed beds and pulled at the right age, depending on the season and characteristics of the plot before they are planted in the field. However, the transplanting method is more popular than direct seeding, with 70.1% adoption among farmers nationwide due to higher yield and low weed growth (Verma, 2010). Rice seedlings can be raised in different methods *viz.* wet-bed, dry-bed, *dapog*, and modified mat nursery followed by seedling pulling either by uprooting or through *laplap*. Pulling of rice seedlings is a delicate operation using the transplanting method. It is too critical to be handled without care by paid laborers who always wanted to finish the job quickly, resulting in damaged roots that may lead to missing hills and may ultimately cause substantial yield loss (Kassam et al. 2011). On the other hand, the number of tillers per plant varied significantly due to different raising the seedlings for transplanting.

In seedling pulling by uprooting, two or three rice seedlings will be held close to the root and between the thumb and index finger, positioning the index almost perpendicular and the thumb parallel to the seedlings (Wopereis *et al.*, 2009). A low pressure must be exerted downwards before slowly pulling the seedling toward oneself. While in the *laplap* method, seedlings are cut into mats 12-15 cm^2 with 0.5-0.7 cm thick soil instead of pulling and bundling. One hand holds a seedling mat, and the other holds plants during transplanting (IRRI, 1986). This is a faster method requiring less labor to gather the rice seedlings as the roots are cut, and less force is needed to pick the seedlings. Thus, the cost is minimal.

Few studies, however, have sought to quantify the

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effects of this *laplap* method on the growth and productivity of both inbred and hybrid rice cultivars. This could help reduce the labor cost of the farmers. PSA (2015) also computed the average cost of producing hybrid *palay* of about PhP 56,885 per hectare and PhP 41,540 per hectare for inbred *palay*. Thus, it is also important to generate data on the production cost and returns for this method to serve as a basis to farmers and other entrepreneurs on the improvement of their efficiency and profitability. Hence, this study aimed to determine the effect of the seedling pulling or uprooting method on crop growth and productivity between inbred and hybrid rice cultivars. Also, it assessed the profitability of rice production per hectare between inbred and hybrid using two methods of pulling seedlings for planting.

2 MATERIALS AND METHOD

The experiment was conducted at the lowland irrigated field of the Department of Agronomy, Visayas State University, Baybay, Leyte. The field was flooded for one week to soften the soil. Then, plowing once and harrowing thrice at weekly intervals using a hand tractor were done. After the last harrowing, the field was leveled, and dikes were constructed. The experimental area was laid out in a split-plot arranged in randomized complete block design three replications. Methods of pulling or uprooting seedlings M_1 - Conventional uprooting, M_2 - *Laplap* (Cutting the roots) as the main plot and lowland rice varieties V_1 - Matatag 6 or NSIC Rc120 (Inbred), V_2 - NSIC Rc412H (Hybrid) as the subplot. Seedbeds with 1 m x 1 m dimensions were prepared for each method and variety. One kilogram of each variety was soaked in tap water for 24 hours and incubated for approximately 35 ^{0}C for another 24 hours before sowing the rice seeds to the wet bed seedbed. Pre-germinated seeds were sown thinly and uniformly in raised seedbeds. Ditches were constructed around the seedbed. The seedbeds were irrigated after three days with a 2-3 cm depth and maintained until the seedlings were ready for transplanting (Mohammed et al. 2016).

Thirteen-day-old seedlings of NSIC Rc120 (inbred) and NSIC Rc212H (hybrid) were transplanted in the designated plots at the rate of 1 seedling per hill at a planting distance of 20 cm x 20 cm. Replanting of missing hills was done seven days after transplanting. The fertilizer rate used was 120-60-60 kg ha^{-1} N, P_2O_5, and K_2O. Nitrogen was applied in 3 splits. The whole amount of P_2O_5 and K_2O were integrated into the first N application by broadcasting and incorporating into the soil before transplanting. The second and third N application was carried out during the mid tillering stage and panicle initiation by topdressing.

The rice field was flooded continuously with 2-3 cm water depth at the vegetative stage. During the reproductive stage, 3-5 cm water depth was maintained. The field was drained two weeks before harvesting. Handpicking of adults and egg masses of golden snails was done in the morning and afternoon. For weeds, rotary weeding was done 15 days after transplanting, while the second rotary weeding was done 25 days after transplanting. Spot weeding was also done after that. Black leaf folders (*Brachmia convolvuli* Wals), green leafhopper (*Herpetogramma hipponalis*, Walker), and brown leafhopper (*Ochyrotica concurs* Wals) were controlled by using insecticide. Guarding against birds as well as the use of scarecrows was employed. Harvesting was done when 85% of the grains had ripened and became firmed using a sharp sickle. All the sample plants were cut at the base, excluding two border rows on each side and two hills at both ends of each row. The samples were threshed, sun-dried for 2-3 days to attain a moisture content of about 14 %, and winnowed before gathering all the necessary data.

Data Gathered

Agronomic Characteristics

Plant height (cm) was recorded by measuring 10 sample hills from the ground level to the tip of the tallest part of the plant randomly selected in each treatment plot at maturity.

The number of productive tillers per hill- This was gathered by counting the number of tillers that produce panicles from the 10 sample hills in each treatment plot. This was done five days before harvesting the rice plants. Harvest Index (HI) – This was the ratio of economic to biological yield. This was obtained by dividing the grain weight by total dry matter at harvest. This was determined by harvesting at random the productive tillers of 3 sample hills from each treatment plot. The samples were cut close to the ground, and the grains and straw were oven-dried at 70 ^{0}C for three days or until the weights became constant. After drying, the grains were separated from the straw. HI was obtained using the formula:

$$HI = \frac{\text{Economic yield (dry grain weight in kg)}}{\text{Biological yield (grain and straw dry weight in kg)}}$$

Yield and Yield Components

The number of productive tillers $hill^{-1}$ - This was determined by counting the number of tillers $hill^{-1}$ that developed panicles from the five sample plants in each treatment plot at maturity. The number of filled and unfilled grains $panicle^{-1}$ - This was determined by counting all filled and unfilled grains of 5 selected panicles from each treatment plot manually. Weight of

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1000 grains (g) was determined by weighing 1,000 sample grains randomly taken from each treatment plot. Before measuring the weight, the moisture content was adjusted to 14%. Grain yield (t ha^{-1}) was determined by weighing the total harvested grains obtained from the harvestable area in each treatment plot. The grains were cleaned, sun-dried, and weighed. The weight of grains per plot at approximately 14% moisture content was converted into tons per hectare basis using the formula.

3 RESULTS AND DISCUSSION

This experiment explored how plant height (cm) and tillering ability as a measure of growth were affected by the seed pulling or uprooting method used for inbred and hybrid varieties at the maturity stage (Figure 1A and B). The rice plant's health and vigor can be indicated by its plant height as it is directly proportional to the development of the root system, availability and uptake of nutrients in the soil, and other critical factors controlling plant growth (Soriano *et al.*, 2016). Results showed that plants using the laplap method were higher than the conventional uprooting method with a plant height difference of 1.57 and 1.4 cm for hybrid and inbred rice, respectively. However, statistical analysis showed no significant differences.

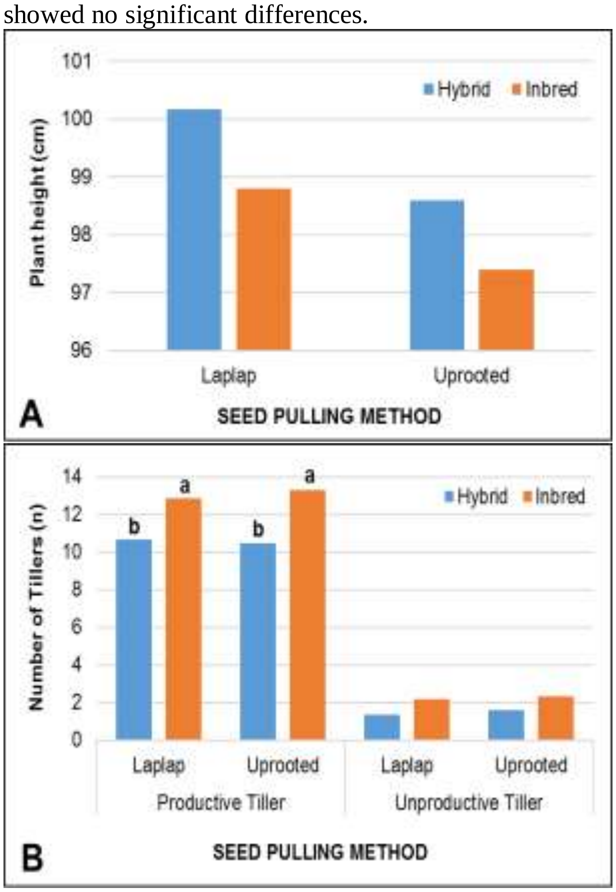

Figure 1. *Mean (**A**) plant height (cm) and (**B**) the total number of productive and unproductive tillers of inbred and hybrid rice as a response to two seed pulling methods used*

The panicle-bearing tiller rate influences the grain yield of rice (Wang *et al.*, 2007). The seed pulling methods used had no significant effect on the total number of productive and unproductive tillers in hybrid and inbred rice. It is noteworthy that the inbred variety has significantly more productive tillers than the hybrid rice. In contrast, hybrid rice has significantly longer panicle length than inbred rice (Figure 1C). However, comparing the two seed pulling methods, the 0.6 and 0.2 cm panicle length differences for hybrid and inbred rice, respectively, showed no significant differences.

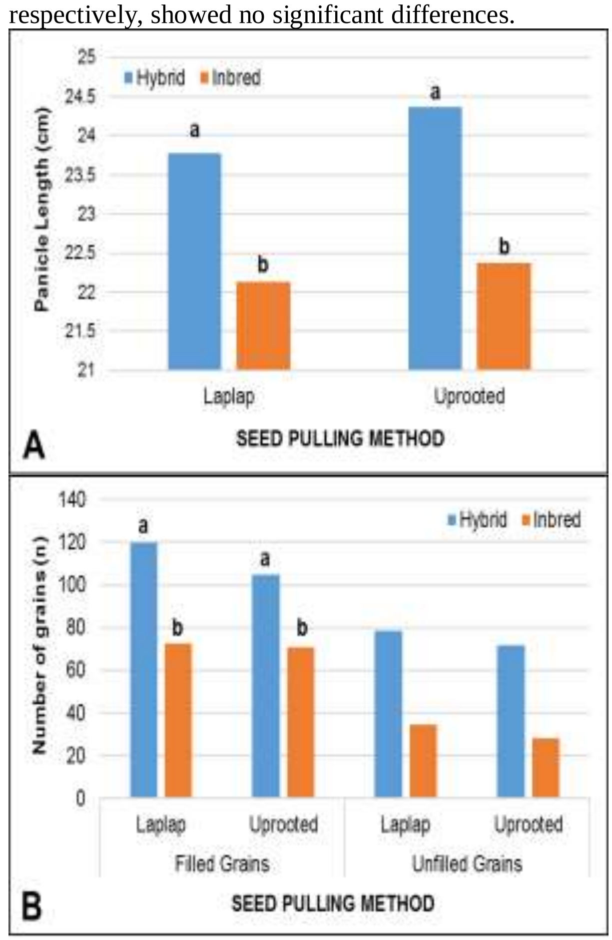

Figure 2. *Mean (**A**) panicle length (cm) and (**B**) number of filled and unfilled grains of inbred and hybrid rice as a response to two seed pulling methods used*

The grain yield (tha^{-1}), the total number of filled and unfilled grains per panicle, herbage yield (tha^{-1}), and harvest index showed no significant variation in respect to seed pulling techniques (Figure 2B and 3A-C). But the number of days to heading and maturity was significantly longer in the *laplap* method than the conventional uprooting method for hybrid rice only (Figure 3D). Knowing the heading and maturity date of rice is important for elucidating its adaptation to different

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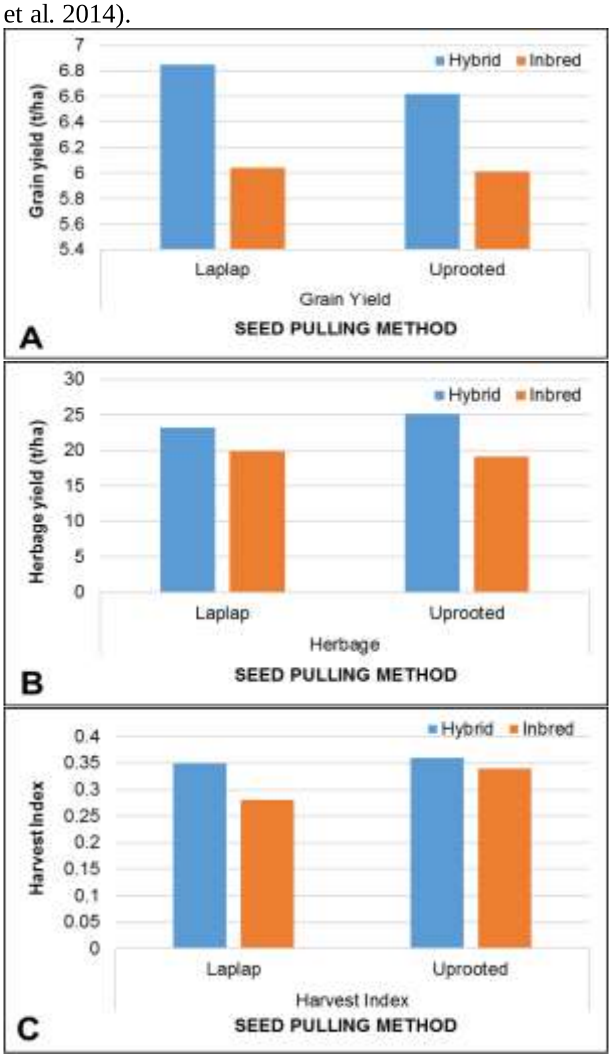
cultivation areas and crop seasons and crucial determinant for diversification and domestication (Izawa, 2007; Meyer and Purugganan, 2013 as cited by Jing *et al*., 2018). Moreover, hybrid rice varieties showed delays in maturity when subjected to the laplap method than the conventional uprooting method. The result can be attributed to the delay in root development when the roots were cut during seedling. However, this result did not cause any variation in the total grain yield of rice (Rana et al. 2014).



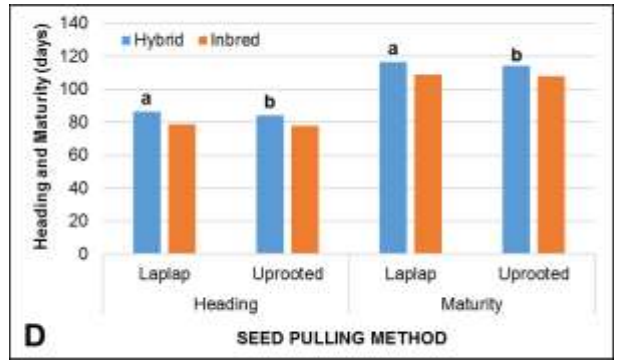


Figure 3. *Mean (A) grain yield (t/ha), (B) herbage yield (t/ha), (C) harvest index, and (D) the number of days to heading and maturity of inbred and hybrid rice as response to two seed pulling methods*

Production Cost and Return Analysis

The cost and return analysis of lowland rice varieties under different methods of uprooting seedlings is presented in Table 1. Hybrid rice (NSIC Rc412h) obtained a higher net income of PhP 57,090.72 compared to inbred rice variety PhP 38,530.72 (Matatag 6). The difference in net income was due to the higher grain yield of hybrid rice than inbreed that obtained higher gross income per hectare. For methods of seedling preparations, *laplap* method produced higher net income than the conventional uprooting method. This advantage was due to the low labor requirement of the laplap method compared to traditional uprooting. In effect, it obtained a lower cost of production per hectare (Younas et al. 2016).

4 CONCLUSIONS

It was demonstrated that there were no significant differences in the growth performance of hybrid and inbred rice varieties between the two seedling preparations used, namely, uprooting and *laplap* method, except for the number of days to heading and maturity of hybrid rice and the total grain yield (tha^{-1}). The results provide a certain level of confidence that the *laplap* method can be used as an alternative to the manual

Table 1. Cost and return analysis of lowland rice varieties under different methods of seedling preparations (conventional uprooting and *laplap* methods)

Treatments	Grain Yield (t ha^{-1})	Gross Income (PhP ha^{-1})	Production Cost (PhP ha^{-1})	Net Income (PhP ha^{-1})
A. Rice Varieties				
Inbreed Rice (Matatag 6)	5.02	80,320.00	41,789.28	38,530.72
Hybrid Rice (NSIC 214H)	6.73	107,680.00	50,589.28	57,090.72
B. Methods of Pulling Seedlings				
Uprooting	6.31	100,960.00	47,814.28	53,145.72
Laplap	6.44	103,040.00	45,564.28	57,475.72

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uprooting of seedlings. Therefore, farmers can reduce time and labor costs during seed pulling and bundling as slicing the seedling mats requires less time and transporting is much easier than bundled seedlings. However, the *laplap* method can lengthen the maturity of hybrid rice but obtain a significantly higher grain yield (tha^{-1}) compared to inbred rice varieties. This must be adequately accounted for to make necessary adjustments in the planting calendar. This will be validated with a further study using more inbred and hybrid genotypes with varying root system development.

RECOMMENDATIONS

1. To reduce the cost of pulling seedlings, farmers now can use the laplap method in uprooting seedlings for both inbred and hybrid rice varieties.
2. It is recommended to use other inbred and hybrid rice varieties to verify further the results of this study.

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