

INVESTIGATION ON CULTIVATION OF FOUR PERENNIAL RICE CULTIVARS IN YEZIN, NAY PYI TAW UNION TERRITORY, MYANMAR

Thi Thi Htun¹, Swe Swe Linn², Thet Thet Zin³, Naw Alshar Phaw⁴, Yi Yi Naing⁵,
Soe Soe Aung⁶ & Nu Nu Yee⁷

Abstract

One of the activities for more food production in Myanmar was approached to perennial rice cultivation. The perennial rice (PR) cultivation for Myanmar section was conducted at Yezin, Nay Pyi Taw in 2020 to 2021. The seeds of four perennial rice cultivars (PR 23, PR 25, PR 101 and PR 107) were obtained from the Research Centre of Perennial Rice Engineering and Technology in Yunnan, School of Agriculture, Yunnan University, the People's Republic of China. The experimental design was carried out using Randomized Complete Block Design (RCBD). The plants of PR cultivars from the sample plots were measured for plant height, numbers of tillers, numbers of panicles, panicle lengths, numbers of spikelets, filled grains weight, unfilled grains weight, filled grain percentages, 1000 grains weight and grain yields (baskets per acre). The tallest plant height (136.0 cm) was found in PR 101. The numbers of tillers in PR 23 and PR 25 were higher than PR 101 and PR 107. The highest filled grain percentage (98.4%) was observed in PR 23, however, the highest 1000 grain weight (31.9 g) was obtained in PR 107. The highest grain yield (105 baskets per acre) was observed in PR 107. The physicochemical properties of the cultivated soil were also recorded. In conclusion the cultivation of perennial rice cultivars can provide the sustainable production capacities for food safety in Myanmar.

Keywords: perennial rice, PR 23, PR 25, PR 101, PR 107, panicles, spikelets, tillers

Introduction

The world's population is increasing year by year and the need for food safety and food production is increasing. Food safety initiatives are being implemented in most countries around the world. Myanmar is also focusing on food safety and more food productions. Therefore, it is necessary to improve modern technologies to produce more food.

In Myanmar, perennial rice cultivation research was initiated in 2018 according to the joint collaborative research agreements between the Yunnan University, China and University of Mandalay, Myanmar. The perennial rice (PR) cultivation researches for Myanmar Section were carried out at three different climates and altitudes of perennial rice (PR) research sites, namely, Mandalay site, Nay Pyi Taw site and Pyin Oo Lwin site, for the field experiments and at the greenhouse of University Research Center (URC) of University of Mandalay as the preliminary pot experiments from 2019 to 2022. The research works are carried out by members of perennial rice team from Department of Botany, University of Mandalay. In this paper, perennial rice cultivation of Nay Pyi Taw site was described.

¹ Department of Botany, University of Magway

² Department of Botany, University of Meiktila

³ Department of Botany, University of Mandalay

⁴ Department of Botany, University of Mandalay

⁵ Department of Botany, University of Yadanapon

⁶ Pro-Rector (Academic Affairs), Nay pyi taw State Academy

⁷ Curriculum Central Unit, Department of Education Research, Yangon

Zhang *et al.* (2022) stated that the agricultural systems are need to intensify sustainably, increasing crop productivity, farmer livelihoods and soil health while using fewer resources. Those can possible when crop perennialization, the conversion of especially annual grains to perennial forms. The author reported that the successful breeding of perennial rice and assess its performance and potential. Perennial rice can get domesticated, annual Asian rice (*Oryza sativa*) was hybridized with perennial African relative *Oryza longistaminata*. In 2021, perennial rice was grown on 15,333 ha by 44,752 smallholder farmers in southern China and growing them saves 58.1% of labour and 49.2% of input costs in each regrowth cycle.

Hu *et al.* (2022) reported that the perennial cultivars produce yields comparable to commercialized annual rice (AR) varieties and maintain them for 4-5 consecutive years from a single planting. The perennial rice exhibit robust regrowth, acceptable grain and milling quality, and are strongly preferred by farmers. The author also quantified the social-economic, ecological and soil benefits attributable to perennial rice cultivation and estimated the geographical areas potentially suitable for perennial rice cultivation worldwide, based on the correlation between regrowth rate and over-winter temperatures. The innovation would help maintain food security and ecological integrity, and also inspire research on other perennial grains.

Yunnan Crop Variety Approval committee approved on Perennial rice 23(PR 23) and the certification was obtained in 2018. Therefore PR 23 is not only the first perennial rice variety approved in Yunnan Province, but also the first one in country and even all over the world. Yun Da 25 (PR 25) and Yun Da 107 (PR 107) were also approved for release already in 2020. In 2018, FAO selected perennial rice technology as International Agriculture Innovation Technology (Hu *et al.* 2022). Zhang *et al.* (2021) stated that the trials of perennial rice technology has started in Laos, Myanmar, Cambodia, Vietnam, Thailand, Bangladesh, Uganda, Cote d'Ivoire in Africa and other south and southeast Asian countries since 2018.

The aim of this research is to provide information needed for Myanmar's food security strategy and the objectives are to examine growth and yield characters of the perennial rice cultivars, to investigate the adaptation of rice cultivars on paddy fields of Myanmar.

Materials and Methods

Research site

The Nay Pyi Taw site is located near the Sein Sar Pin village, Zayarthiri Township, Nay Pyi Taw, Mandalay Region, Myanmar. It is situated at latitude 19°49'04.6"N, longitude 96°15'51.4"E and altitude 115 m.

Experimental Designs

The field experiments were carried out using Randomized Complete Block Design (RCBD) in 2020 - 2021. The field area of Nay Pyi Taw site was 918 m² and the area of each plot for each PR cultivar was 288.1 m² (8.4 m width × 34.3 m length) including 28 rows. There were 81 plants in each row. The total 2268 plants were grown in each plot.

Field Preparation and Cultivation

The cultivation of four PR cultivars (PR 23, PR 25, PR 101 and PR 107) in the first growing season at Nay Pyi Taw site were initiated and the seeds were sown in the nursery beds

on 18th January, 2020. At the same time, the soil preparation, ploughing, harrowing and irrigation were performed in the fields of PR research site. Twenty days after sowing (DAS), the seedlings were transplanted into each plot as designated (Figure 1).

All designated plots were irrigated after sowing and the subsequent irrigation was then carried out two to five times per month until the flowering stage according to the water contents of field soils. The compound fertilizers, N: P: K (15: 15:15), were treated three times to the paddy fields. For the first time of fertilizer treatment, the compound fertilizer, 100 kg ha⁻¹ was applied at the transplanting time. For the second time, the mixture of compound fertilizer, 100 kg ha⁻¹ and urea 25 kg ha⁻¹, was applied on the paddy fields during tillering. For the third time, the mixture of compound fertilizer, 100 kg ha⁻¹ and urea 50 kg ha⁻¹, was applied at the time of flowering. The methods for the fertilizer treatments were recommended by Department of Agriculture (MOAI 2015). In the regrowth seasons, fertilizer treatments were carried out two times. First time fertilizer was applied within 5 days after harvesting and the second time was applied during the initial heading stages.

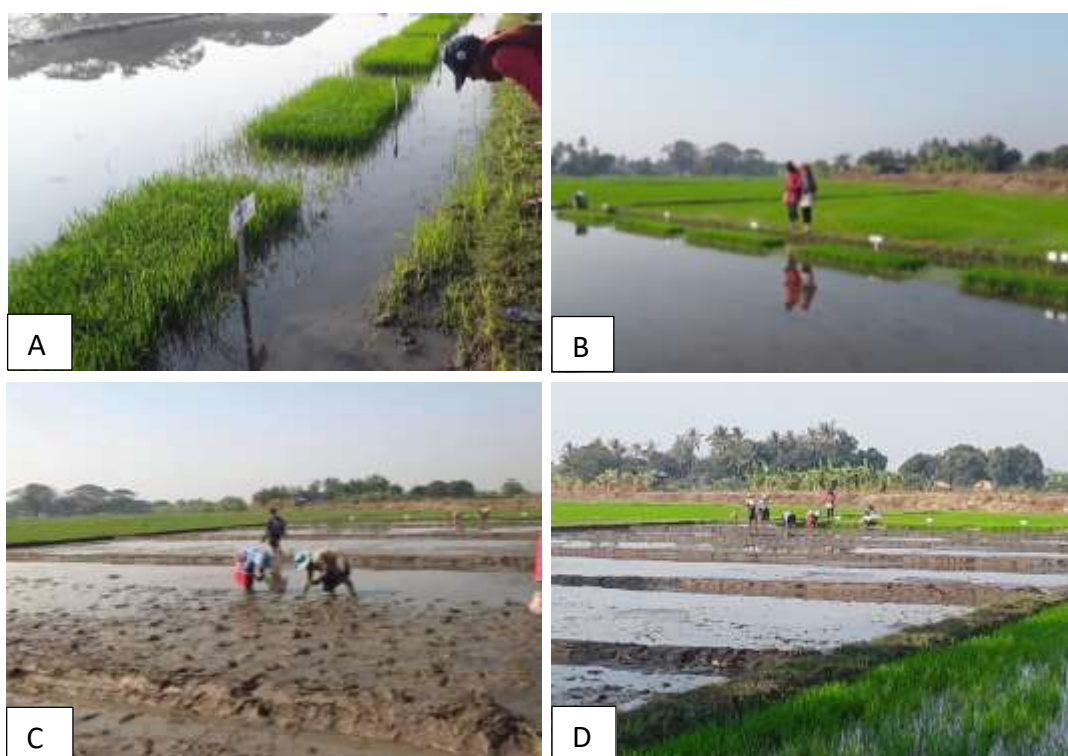


Figure 1. The cultivation of four perennial rice cultivars at Nay Pyi Taw site
(A, B) The nursery plots 20 days after sowing
(C, D) Planting of the perennial rice cultivars after field preparation

Harvesting

Harvesting was done at maturity stage when 85% of grains were changed into golden color. At harvesting time, the straw was cut off at 10 cm above the ground to maintain the consistency of new tillers arising from the rhizomes for the regrowth of rice plants to the next growing seasons.

Soil Analysis

The soil samples were randomly collected from the experimental sites before initiating the experiments. The soil samples from Nay Pyi Taw site were analyzed at the Department of Agricultural Research (DAR), Yezin, Nay Pyi Taw, Mandalay Region.

Determination of agronomic characters and yield Components

The plant height and numbers of tillers per plant were measured at every 15-days intervals after transplanting. The numbers of panicles per plant, panicle lengths, numbers of spikelets per panicle, the filled and unfilled grains weights per panicle, filled grains percentages and 1000 grains weight per plant and yields per acre were recorded at the harvesting time. The yield sampling area for each variety was randomly selected 2 plots and each plot was 6.6 ft width x 6.6 ft length. Forty-nine plants from each plot were measured for the parameters of their agronomic characters and yield components (Figure 2).



Figure 2. Sample plot (6.6 ft width x 6.6 ft length) in PR field after harvesting

Results and Discussions

The agronomic and yield characters of perennial rice (PR) cultivation were recorded and described. The research for Nay Pyi Taw site was carried out by the cultivation of four perennial rice cultivars: PR 23, PR 25, PR 101 and PR 107. Each of the PR cultivars was measured and described for plant height, numbers of tillers, numbers of panicles, panicle lengths, filled grains weight, unfilled grains weight, filled grain percentages, 1000 grains weight (Table 1) and grain yields (baskets per acre) (Table 2). The field experiments for two growth seasons were conducted according to the designated plots and experimental designs. The physicochemical properties of the cultivated soil was also described (Table 3).

Agronomic characters

The total 9072 plants of four kinds of PR cultivars were grown at Nay Pyi Taw PR Site. Among four PR cultivars, the earliest flowering time was observed at 50 days after transplanting (DAT) in PR 107 cultivar and the latest flowering time was found in PR 101 cultivar. The tallest plant height (136.0 cm) was found in PR 101. The numbers of tillers in PR 23 and PR 25 were

higher than those in PR 101 and PR 107. The highest filled grain percentage (98.4%) was observed in PR 23, however, the highest 1000 grain weight (31.9 g) was obtained in PR 107. The lowest filled grain percentage (91.7%) and the lowest 1000 grains weight (22.6 g) were observed in PR 101. PR 23, PR 25 and PR 107 for the first growing season were harvested at 91 days after transplanting (DAT) and PR101 was 125 DAT (Table 1- 2). The conditions of four PR cultivars for first growing seasons were shown in Figure 3 – 7.

Table 1. Agronomic and yield characters of four PR cultivars at Nay Pyi Taw Site

PR Cultivars	Plant height (cm)	No. of tillers	Panicle length (cm)	Filled grains weight (g)	Unfilled grains weight (g)	Filled grains (%)	1000 grains weight (g)
PR 23	104.0	14.0	23.1	158.0	3.0	98.4	26.8
PR 25	103.0	14.0	22.1	147.0	3.0	97.8	26.7
PR 101	136.0	12.0	28.3	142.0	12.8	91.7	22.6
PR 107	109.0p	12.0	27.9	144.0	5.0	96.8	31.9

In the second growing season, the vegetative growth of PR 101 was rapidly developed and all PR cultivars were harvested at 126 days after harvesting of first growing season. Due to the limitation in travelling in COVID-19 pandemic period, the data could not be recorded in the second growing seasons.

Grain Yield

At Nay Pyi Taw site, the yield of first growing season was recorded. The highest yield (105 baskets per acre) was obtained in PR 107 and the lowest yield (60 baskets) was obtained in PR 101. The seasonal yield of PR cultivars was listed in Table 2.

Table 2. Grain yield of four PR cultivars at three sites during their growing seasons

PR Cultivars	first growing season (baskets per acre)
PR 23	98
PR 25	98
PR 101	60
PR 107	105

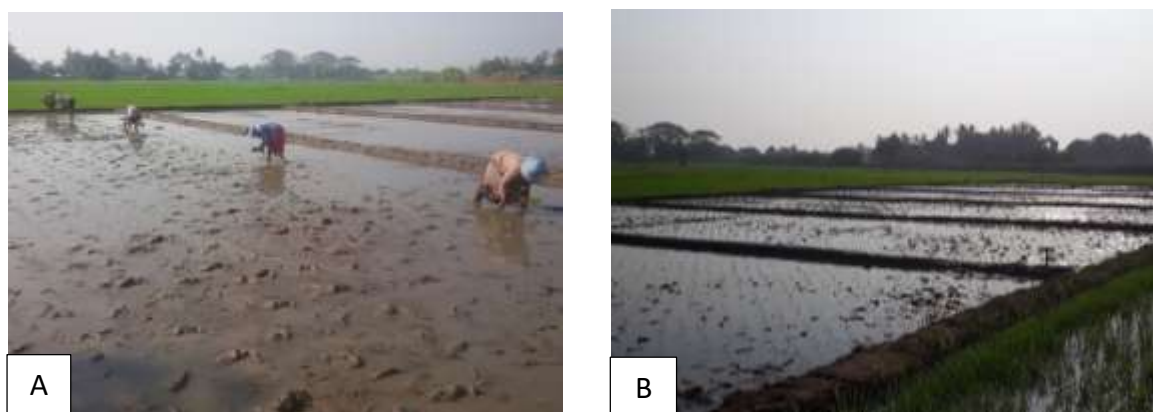


Figure 3. PR cultivation in 1st growing season at 0 DAT in Nay Pyi Taw site
(8.2.2020) (A) Transplanting to designated plots (B) After transplanting

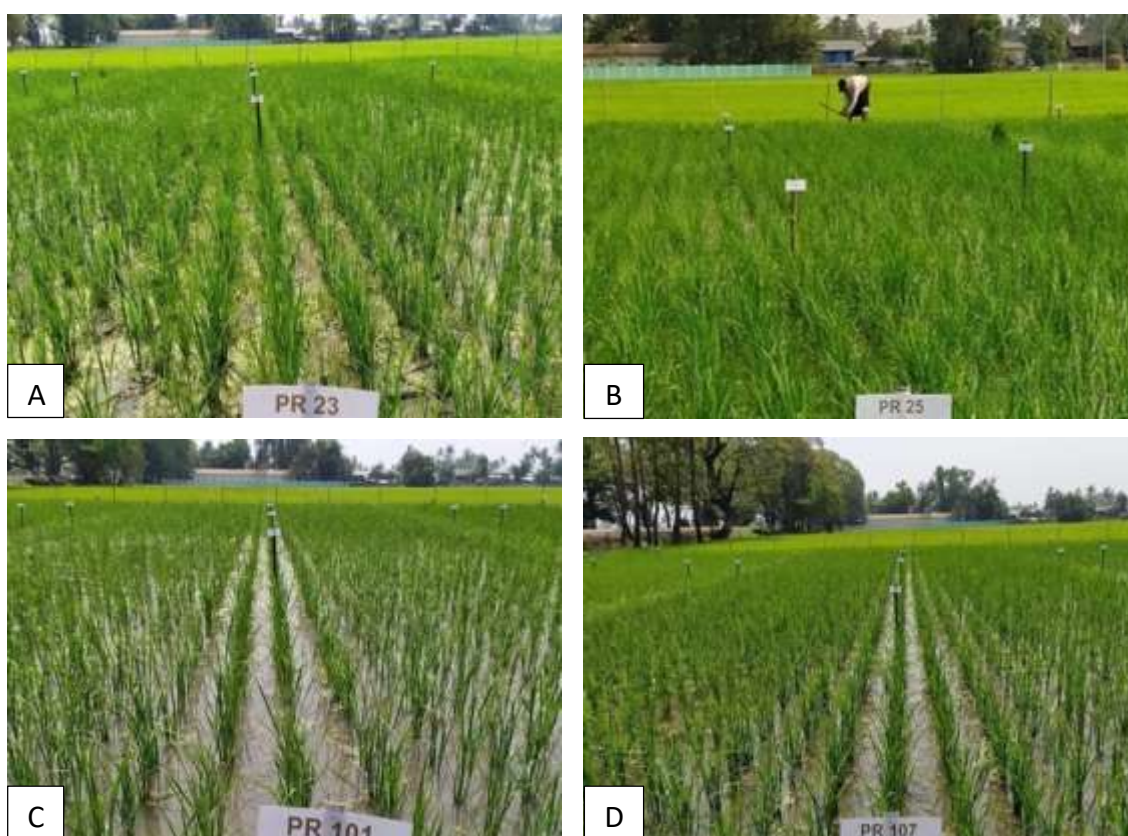


Figure 4. PR cultivation in 1st growing season at 30 DAT in Nay Pyi Taw site
(A) PR 23 (B) PR 25 (C) PR 101 (D) PR 107

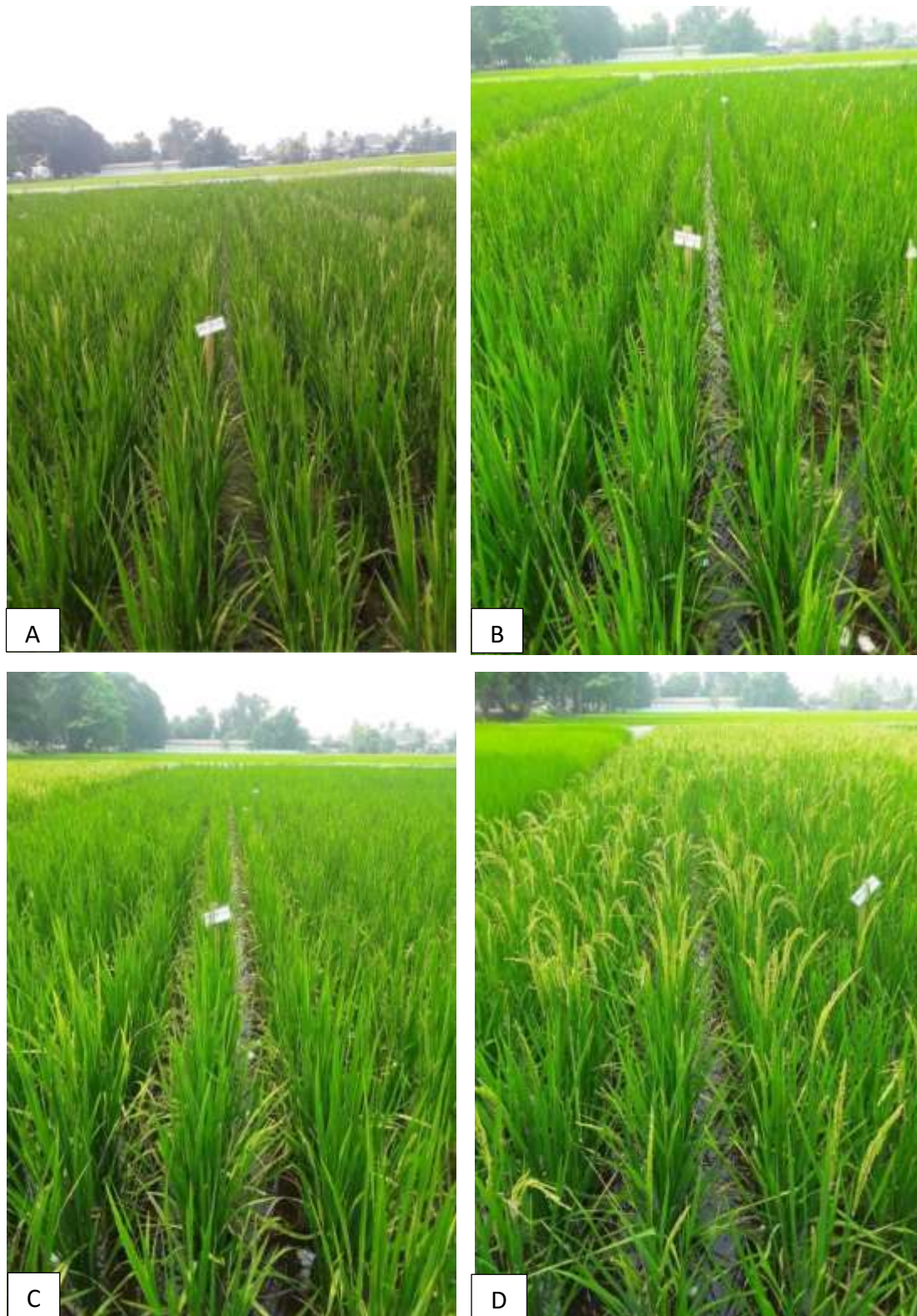


Figure 5. PR cultivation in 1st growing season at 60 DAT in Nay Pyi Taw site
(A) PR 23 (B) PR 25 (C) PR 101 (D) PR 107

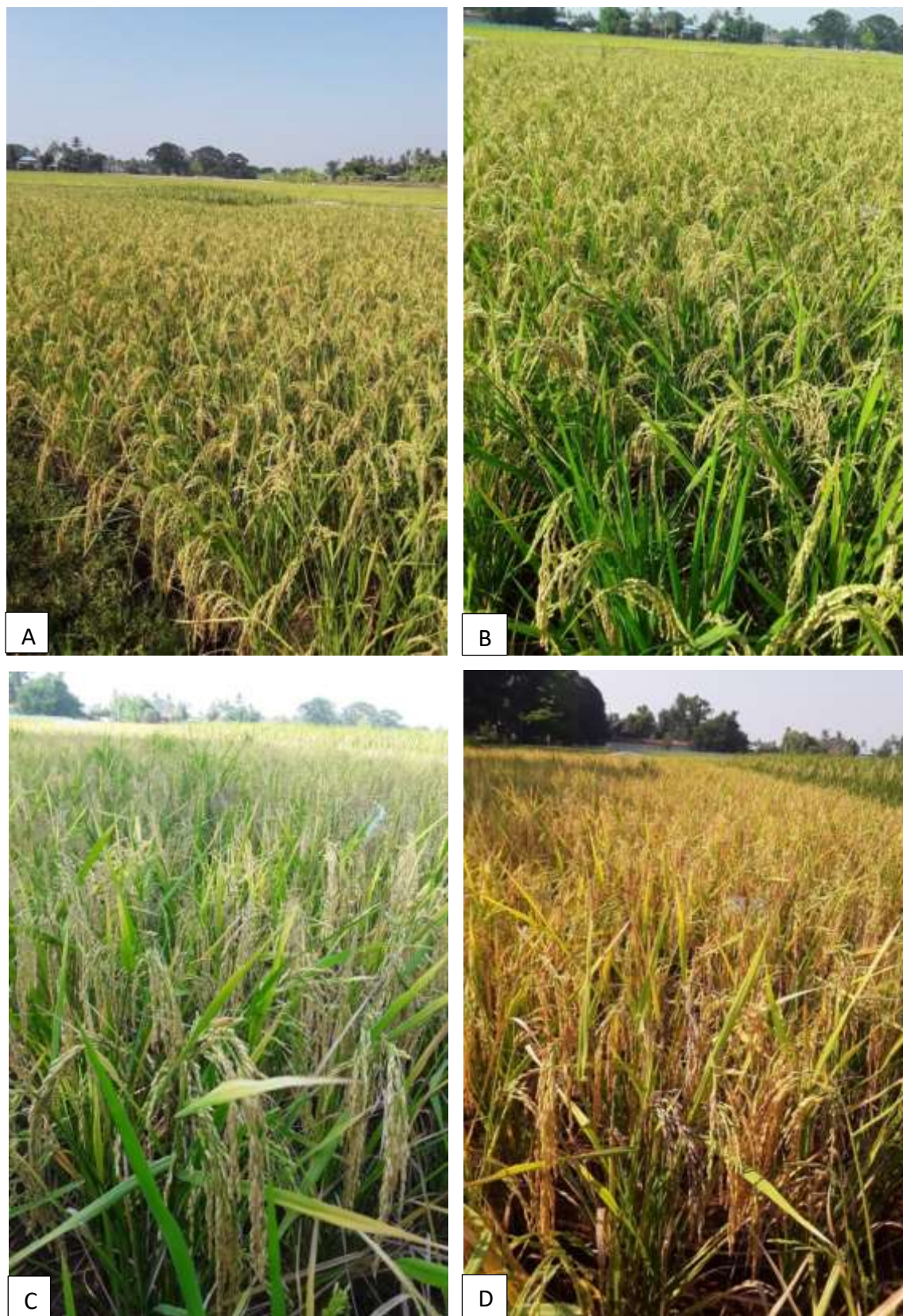


Figure 6. PR cultivation in 1st growing season at 90 DAT in Nay Pyi Taw site
(A) PR 23 (B) PR 25 (C) PR 101 (D) PR 107



Figure 7. Seeds and grains of PR produced from 1st growing season
(A) PR 23 (B) PR 25 (C) PR 101 (D) PR 107

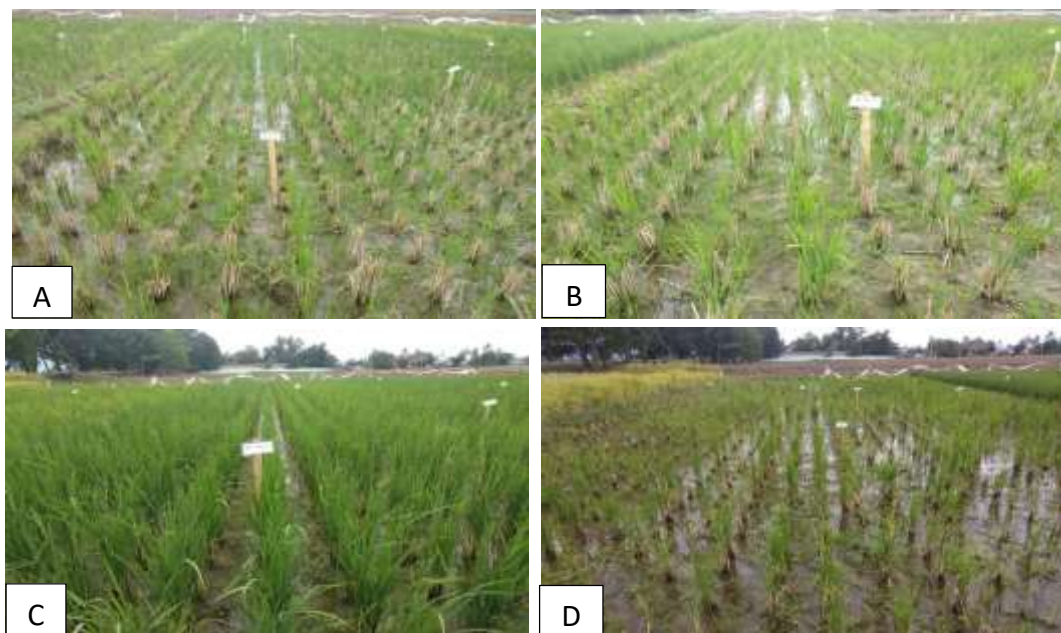


Figure 8. PR cultivation in 2nd growing season at 100 DAT in Nay Pyi Taw site
 (A) PR 23 (B) PR 25 (C) PR 101 (D) PR 107

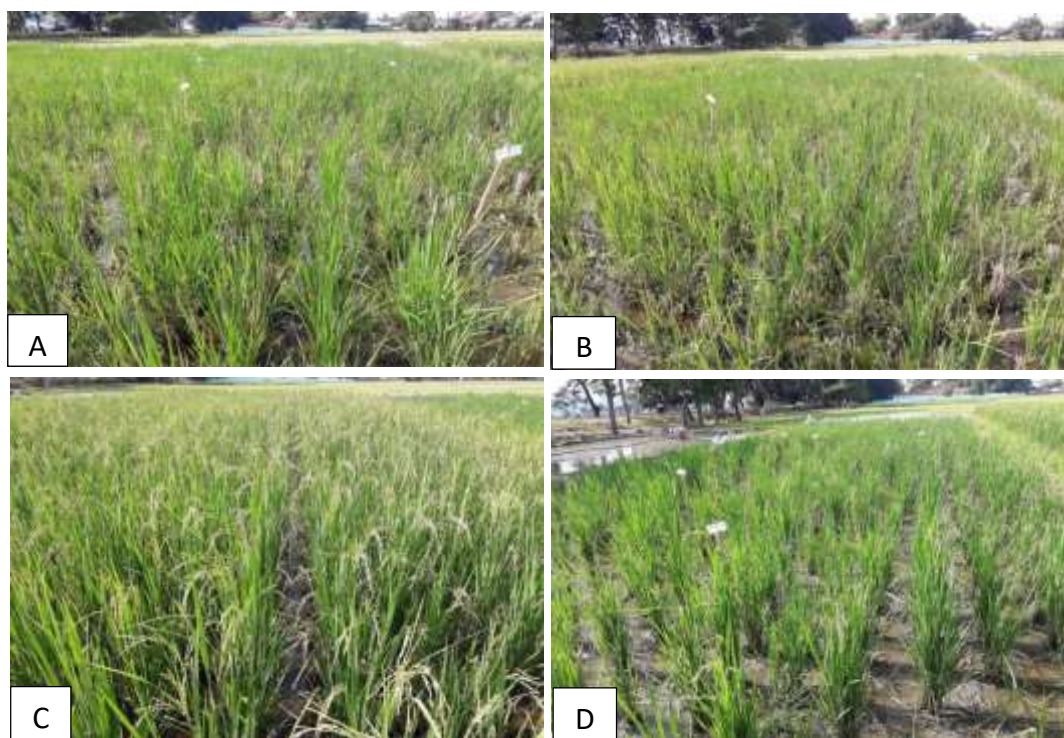


Figure 9. PR cultivation in 2nd growing season at 130 DAT in Nay Pyi Taw site
 (A) PR 23 (B) PR 25 (C) PR 101 (D) PR 107

Physicochemical Properties of the Cultivated Soil

Soil texture was found loamy sand and soil pH was 6 in Nay Pyi Taw site. The results of total nitrogen (N), available phosphorus (P), available potassium oxide (K₂O) and organic carbon contents were shown in Table 3.

Table 3. Physicochemical properties of the cultivated soil from Nay Pyi Taw Site

Location	pH	Organic matter (%)	Available N (mg/kg)	Available P (mg/kg)	Available K (mg/kg)	Calcium chloride extractable SO ₄ -S (mg/kg)	Texture (%)		
							Sand	Silt	Clay
Nay Pyi Taw Site	6	1.2	47	7	74	15	83.9	10.7	5.4

Source: Department of Agricultural Research (DAR), Yezin, Naypyitaw Union Territory, Mandalay Region. Note: N – Nitrogen; P – Phosphorus; K – Potassium; SO₄-S – Sulfate sulfur

Conclusions

According to results, perennial rice cultivars were very robust and can grow rapidly in short duration. Yield and yield characters were success in rice field. It was concluded that perennial rice should be planting in large scale for food safety in Myanmar.

Acknowledgements

We would like our deepest gratitude to Professor Dr. Fengyi Hu, Dean of the School of Agriculture, Yunnan University and PR team for giving the opportunities in the perennial rice research collaboration between Yunnan University (YNU), the Peoples' Republic of China and University of Mandalay (UM), the Republic of the Union of Myanmar. Our special appreciation and thanks are also extended to Minister, Ministry of Education, for achieve this perennial rice (PR) research project collaboration between China and Myanmar. We also would like to thank the Department of Agricultural Research (DAR), Land Use Laboratory of Department of Agriculture (DOA) from the Ministry of Agriculture, for their kind helps and technical suggestions in testing the cultivated soils of the PR research project. We would also thanks to Dr Khin Maung Oo, Rector, University of Magway for encouragement to submit research paper. At last, but not the least, we are very pleased to express our huge gratitude to the students and colleagues of Department of Botany and members of our perennial rice research team for actively and willingly participating in the perennial rice cultivation and data collection throughout this research project.

References

- Hu, F., S. Zhang, G. Huang, Y. Zhang, X. Lv, K. Wan, J. Liang, J. Dao, S. Wu, L. Zhang, X. Yang, X. Lian, L. Huang, L. Shao, J. Zhang, S. Qin, D. Tao, T. E. Crews, E. J. Sacks, J. Lyu, L. and J. Wade, (2022) "Perennial rice improves farmer livelihood and ecosystem security". *Research square*, ISSN 2693-5015(online). <https://doi.org/10.21203/rs.3.rs-1302277/v1>
- Zhang, S., G. Huang, Y. Zhang, X. Lv, K. Wan, J. Liang, J. Dao, S. Wu, L. Zhang, X. Yang, X. Lian, L. Huang, L. Shao, J. Zhang, S. Qin, D. Tao, T. E. Crews, E. J. Sacks, J. Lyu, L. J. Wade and F. Hu, (2022) "Sustained productivity and agronomic potential of perennial rice". *Nature Sustainability*, vol.6, pp. 28–38. <https://doi.org/10.1038/s41893-022-00997-3>
- Zhang, Y. J., G. Huang, S. Zhang, J. Zhang, S. Gan, M. Cheng, J. Hu, L. Huang, and F. Hu, (2021) "An innovated crop management scheme for perennial rice cropping system and its impacts on sustainable rice production". *Eur. J. Agron.* 122, 126186. <https://doi.org/10.1016/j.eja.2020.126186>