Comparison of Vegetative Growth and Some Yield traits of Perennial Rice Line 25

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Abstract

The world population continues to grow and it is required to increase the production of foods from fewer resources. Myanmar is one of the agricultural countries and rice is very important staple food for Myanmar peoples. For Myanmar, it is required to increase the current rice production and more modernized rice production technique. Nowadays perennial rice production is popular and it would not need to be planted annually. Perennial rice plantation can reduce soil erosion by providing permanent ground condition. In this study, comparative result on vegetative growth and yield related traits occurred in first growing season and second growing season of Perennial Rice line 25 were described. This research work was conducted in green house at University Research Center, University of Mandalay, Myanmar from July 2019 to May 2020. The plant height, panicles length and number of spikelets per panicles were higher in 1st growing season than 2nd growing season but the lower in the number of tillers, number of leaves per plant, and panicles per plant. The 1000 grains weight of 1st season and 2nd season were the same and quality of grains were also equal. PR 25 was adapted in Mandalay region, and vegetative growth and yield related traits were good observed in two growing seasons.

Key words: Perennial Rice, Panicles, Spikelets, Tillers

Introduction

Zhang *et al.* (2017) stated that global food security is under threat, due to rising global population, pressure on the resource base, and climate change. Significant improvements in genetics or new crop species, such as transformation from annuals to perennials, potentially provide efficient strategies to increase crop production in an environmentally sustainable way (Zhang *et al*., 2021; Wan, 2018; Glover *et al*., 2010; Hu *et al*., 2003).

Perennial plant communities can store more carbon, maintain better soil and water quality, and manage nutrients more conservatively than do annual plant communities, and therefore have greater biomass and resource management capacity. Annual cereal, legume and oilseed crops remain staples of the global food supply. Because most annual crops have less extensive, shorter-lived root systems than do perennial species, with a correspondingly lower capacity to manage nutrients and water, annual cropping systems tend to suffer higher levels of soil erosion and generate greater water contamination than do perennial systems (Cox *et al.*, 2006 & 2010). Zhang *et al.* (2021) stated that via a novel crop management scheme for perennial rice, use of less chemical N fertilizer and a higher planting density could enhance the sustainability of the grain yield and reduce fertilizer loss and also suggest that the potential benefits of producing other perennial grains should be further examined.

Rice is one of the most important crops grown worldwide, so the opportunity for the successful development of perennial rice has great potential. Viable progeny from the wide-hybrid segregating for perenniality also acquired nematode resistance and drought tolerance from the wild species, through linkage drag (Sacks *et al.*, 2003 & 2006; Huang, 2018). Huang *et al.*, (2018) proposed that the development of high-yielding perennial rice cultivars would address the environmental limitations of annual rice while helping to feed the rapidly increasing human population. Deployment of perennial rice could meet important needs, such as increased production per growing season, reduced risks for farmers, lower labour requirements, less water needed, and protecting soil from erosion (Sacks, 2013).

For the development of perennial rice to stabilize the fragile soils of rice-based farming systems, perennial rice breeding using derivatives of the original wide-hybrid and research on the genetic control of perenniality in rice have been continued (Batello *et al.,* 2014; Hu *et al.,* 2011; Sacks *et al.,* 2003 & 2006). These efforts offer the opportunity not only for the commercial use of perennial rice, but also for further understanding of the genetic architecture of perenniality in rice. A successful perennial rice breeding program has been established in the Yunnan Academy of Agricultural Sciences and Yunnan University, with the high-yielding and broadly-adapted experimental line PR23 recommended for pre-release testing under paddy conditions in southern China and Laos (Sacks *et al.*, 2003 & 2006). Huang *et al.,* (2018) reported the field evaluation of PR23 in comparison with the main conventional rice cultivars in pre-release testing under paddy conditions in nine ecological regions of Yunnan Province in China, between 2011 and 2017. To date, the perennial rice trail is on the way in China, Myanmar, Laos, Cambodia, Thailand, Vietnam, Indonesia, Uganda and Cote d'Ivoire via International Perennial Rice Collaboration organized by Yunnan University. In China, perennial rice has been tested in more than 10 provinces (Yunnan, Guangxi, Guangdong, Fujian, Hunan, Hubei, Henan, Zhejiang, Jiangxi and Guizhou) and over an area greater than 5000 ha as of 2019 (Zhang *et al.*, 2021).

Zhang *et al.* (2019) described that the successful hybridization between *Oryza sativa* and *Oryza longistaminata* (Tao and Sripichitt, 2000), efforts to develop perennial rice commenced (Hu *et al.,* 2003; Sacks *et al.*, 2006; Zhang *et al.*, 2014), with the long-term goal of breeding perennial rice to stabilize the fragile soils in rainfed lowland and rainfed upland rice- based farming systems. Three papers have specifically reported on performance of perennial rice in the field (Huang *et al.*, 2018; Samson *et al.,* 2018), and perennial rice may have promise in a number of rice-based systems, and this requires further investigation (Zhang *et al.,* 2017).

The objectives of this research are to compare the vegetative growth and yield characters of PR 25 growing in two seasons, to examine the regrowth and adaptation of PR 25 in Mandalay region. The perennial rice lines are not testing and releasing in Myanmar that is why to do this research work.

Materials and methods

Planting location and experimental design

The experiments were conducted in greenhouse, University Research Center (URC), University of Mandalay, Myanmar. URC is situated 21°57′29″ North latitude and 96°05′38″ East longitude. The average annual temperature of Mandalay Region is 27.0°C and about 32 inches of precipitation falls annually (https://en.climate-data.org, 2019). The perennial rice grains, PR 25 were collected from research center of Perennial rice engineering and technology in Yunnan, School of agriculture, Yunnan University, China. In this experiment, complete randomised design was used, comprising 5 perennial rice lines with 10 replications. The soils were collected from paddy field of Patheingyi Township, Mandalay Region.

Experiment for first season

The seeds were soaking with water for 12 hours and then placed on cloths, wrapped with it and watering. After 3 days, the germinated seeds were sowing in nursery tray (Figure 1. A, B). Twenty days after sowing, the seedlings were transplanted to 1.5 ft in diameter x 1.5 ft length plastid pot which contained the soil (Figure 1. C, D). The rows were at 45 cm apart from each pot. For soil fertility, N,P,K (22: 27: 11 kg/Ha) ratio is applied for each pot when transplanting time and before flowering time. Thirty days after transplanting, the plants height, number of leaves and number of tillers were measured. After that, these data were collected every 15 days until the flowering time. The number of panicles, panicles length, number of spikelets per panicle and thousand grains weight were also measured.

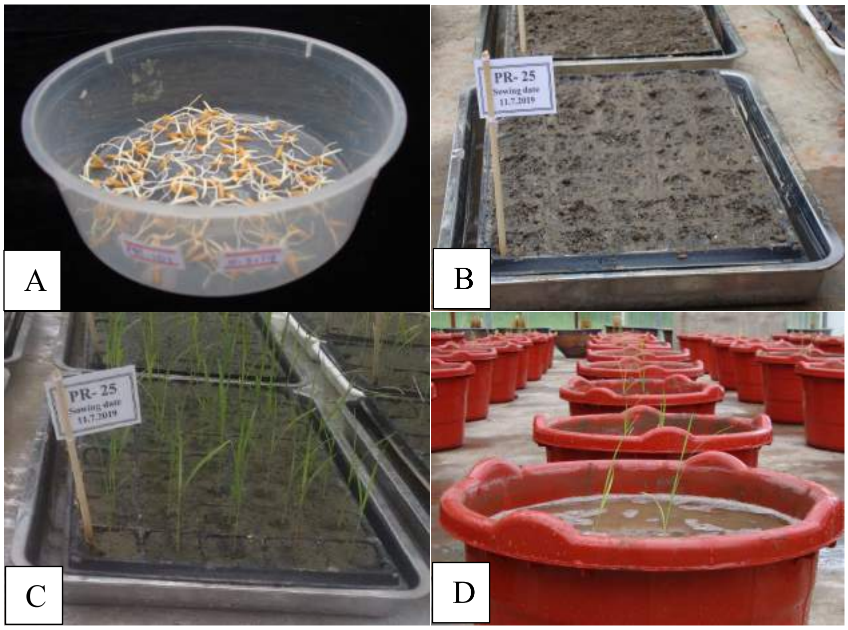

Figure 1. (A) Three days old germinated seeds of PR 25 rice line (B) Germinated seeds sowing in nursery tray (C) Seedling of 20 days after sowing (D) Transplant in pot (20 DAS)

Experiment for second season

After first season harvesting, the stubble was cut into 15cm and the plants were allowed to regrow and regrowth was consistent. The growth duration was calculated from the date of transplanting and stubble cut-off and maturation. The plant height (cm), ratoon tiller number (tillers per plant), number of leaves per plant, panicle number (panicles per plant), panicle length (cm), number of spikelets per panicle and thousand grains weight were recorded. The data of 2nd season were collected and compared with the results of first season experiment.

Statistical analysis

The growth and some parameters of PR 25 in first growing season and second growing season were examined and mean numbers were compared using student 't' test (Steel and Torrie, 1960; Singh, 2001).

Results and Discussion

In this study, the data of first season and second season of perennial rice (PR 25) were collected and described. The plants height (cm), number of tillers, number of leaves per plant, panicles per plant, panicle length (cm), number of spikelets per panicle and 1000 grains weight (g) were measured, calculated and described in Table (1), (2) and (3).

Table (1) Measurements of plant height(cm), number of tillers and number of leaves per plant in 2 seasons

Parameter	Season	30 DAT /DAH	45 DAT /DAH	60 DAT /DAH	75 DAT /DAH	90 DAT /DAH	105 DAT /DAH
Plant Height (cm)	1	83.5	110.25	113.3	137.2	139.2	139.2
	2	68.6	78.85	89.7	100.43	105.7	112.3
Number of Tillers	1	4.4	16.1	22.3	27.5	30.4	32.5
	2	32.1	45.4	60	85.7	92.4	83.8
Number of leaves per plant	1	21.9	66.4	100.6	113.6	-	-
	2	124	186.3	238	376.3	-	-

DAT- Day after transplanting (for 1st season).
DAH- Day after 1st season harvesting (for 2nd season)

Table (2) Measurements of plant height(cm), number of tillers and number of leaves per plant, panicles per plant, panicle length (cm), number of spikelet per panicle and 1000 grains weight (g) of PR 25 in 2 seasons

Parameters	Season	Pot 1	Pot 2	Pot 3	Pot 4	Pot 5	Pot 6	Pot 7	Pot 8	Pot 9	Pot 10
Plant Height (cm)	1	145	139	145	146	131	137	137	138	137	137
	2	119	107	106	106	118	118	118	120	112	99
Number of tillers	1	32	26	31	33	24	34	34	36	37	38
	2	98	79	75	83	75	89	80	103	79	77
Number of leaves per plant	1	104	84	88	100	96	134	132	128	140	130
	2	400	419	324	414	321	401	309	453	382	340
Number of panicles per plant	1	31	24	31	33	24	33	34	36	37	38
	2	87	78	75	69	68	75	61	88	75	73
Panicle length (cm)	1	21.97	23.23	21.27	21.81	23.93	22.49	22.33	22.48	22.82	21.81
	2	17.21	17.46	18.69	16.19	18.01	15.87	15.07	14.85	16.31	19.42
Number of spikelets per panicle	1	15.66	14.33	11.00	13.66	10.66	11.66	13.33	14.00	11.66	15.00
	2	8.60	9.10	8.10	7.60	7.70	9.00	8.90	8.90	9.40	8.10
1000 grains weight (g)	1	24.80	23.28	22.78	22.60	22.21	21.88	22.92	22.73	22.61	23.98
	2	20.92	20.25	20.88	22.47	20.11	19.27	30.77	21.42	21.12	21.63

Table (3) Comparisons on plant heights (cm), number of tillers, number of leaves per plant, panicles per plant, panicle length (cm) and 1000 grains weight (g) of PR 25 in 2 seasons

Parameters of PR 25	Season	Mean ± S.D.	"t" value
Plant height (cm)	1st season	139.2 ± 4.73	8.65*
	2nd season	112.3 ± 7.35	
number of tillers	1st season	32.5 ± 4.52	-17.20*
	2nd season	83.8 ± 9.77	

number of leaves per plant	1st season	113.6 ± 21.2	-15.59*
	2nd season	376.3 ± 49.4	
panicles per plant	1st season	32.1 ±4.86	-14.65*
	2nd season	74.9 ± 8.21	
panicle length (cm)	1st season	22.41 ±0.77	9.71*
	2nd season	16.9 ± 1.51	
Number of spikelets per panicle	1st season	13.09±1.74	8.03*
	2nd season	8.54 ± 0.62	
1000 grains weight (g)	1st season	22.97 ± 0.85	1.04ns
	2nd season	21.88 ± 3.24	

*= significantly different at 5% level, ns= non-significant

In two seasons of PR 25 rice line, the results show that the plant height of perennial rice (PR) in 1st season were higher than 2nd season. The highest plant height of PR in 1st season was 139 cm and 2nd season was 120 cm. According to the results, the calculated 't' value (8.65) of plant height is higher than table value (2.262) at 5% level and significant. Hence the plant height in the two growing seasons differ significantly.

But the number of tillers, number of leaves per plant and panicles per plant of 1st season and 2nd season PR were differed significantly. Number of tillers and number of leaves per plant and panicles per plant found in 1st season were lower than 2nd season. In the number of tillers, the calculated 't' value (17.20) is higher than table value and hence the number of tillers in the two growing seasons differ significantly. In the number of leaves per plant, the calculated value of 't' (15.59), being greater than table value at is significant in two growing seasons. The two growing seasons differ significantly for panicles per plant because the calculated 't' value (14.65) was greater than table value.

The panicles length of PR in 2nd season was shorter than 1st season. Panicle length and number of spikelets per panicle were also differed significant. The number of spikelets per panicle were differ significant because the value of 't' (8.03) being greater than table value. In 1000 grains weight, the 't' value (1.04), being smaller than table value and is non-significant. Hence 1st season and 2nd season do not differ significantly for 1000 grains weight.

The 50% flowering time of 1st season PR was started at 68 days after transplanting (DAT) and 2nd season PR was 83 days after 1st season harvesting (DAH). The harvesting time for 1st season PR was 129 DAT and the 2nd season was 140 DAH.The harvesting time in 1st season PR is more earlier than 2nd season PR.

Conclusion

According to these results, the PR 25 in 1st season is higher in plant height, panicles length and number of spikelets per panicles than 2nd season but the lower in the number of tillers, number of leaves per plant, and panicles per plant. Although these parameters were different, the 1000 grains weight were the same and grain quality was also equal in 2 seasons. It was concluded that PR 25 was adapted in Mandalay region and will continue in field experiment for further information.

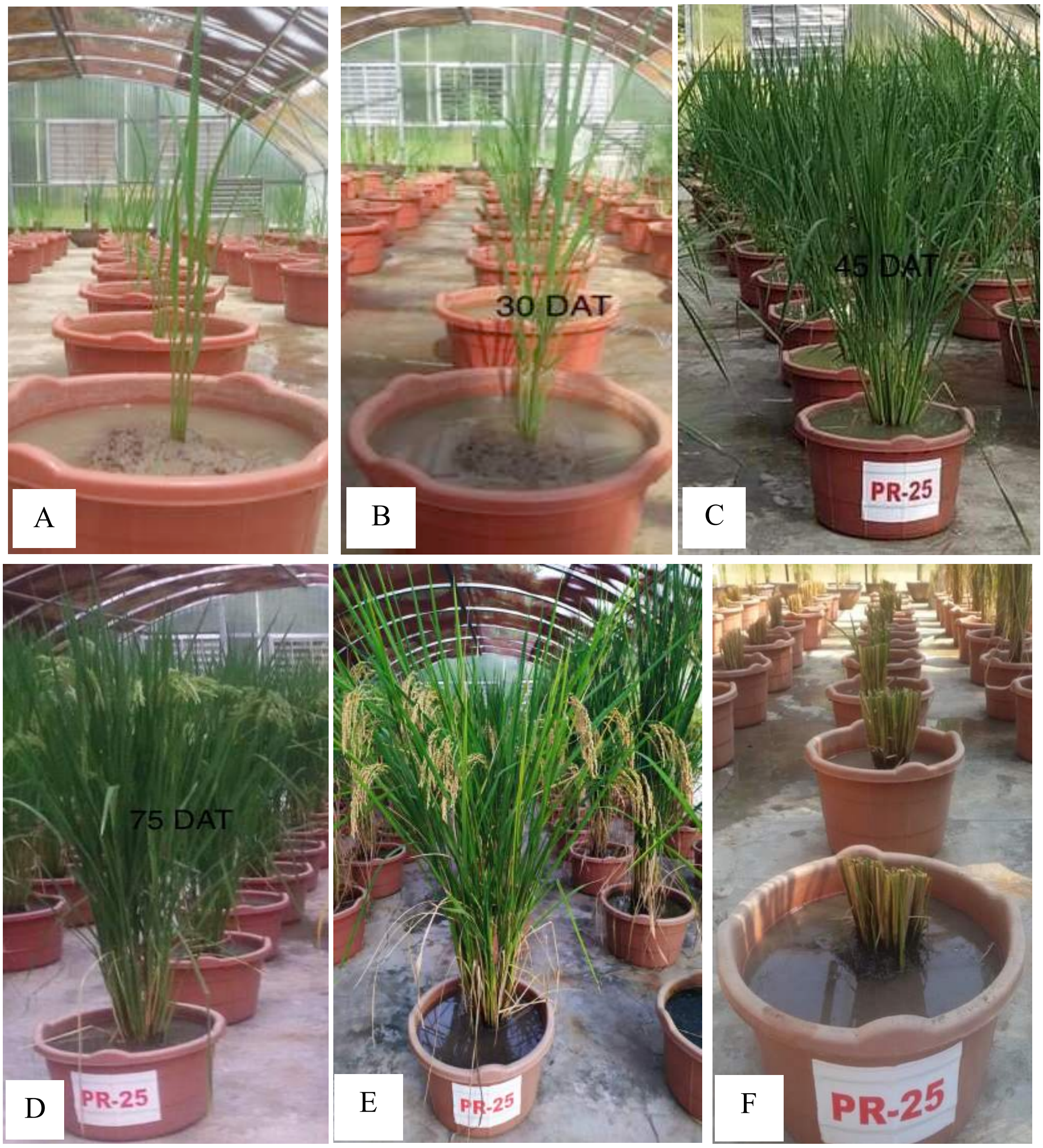

Figure 2. PR 25 in first growing season

(A) 15 DAT (B) 30 DAT (C) 45 DAT

(D) 75 DAT (E) 105 DAT (F) 129 DAT

(DAT=Day after transplanting)

Figure 3. PR 25 in second growing season

(A)30 DAH (B) 45 DAH (C) 75 DAH
(D) 105 DAH (E) 140 DAH

(DAH= Day after 1st season harvesting)

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