EFFECT OF SEEDLING AGE ON PERFORMANCE OF THE 3—MONTH RICE VARIETY BG 276—5

K. D. S. M. JOSEPH, P. V. HEMACHANDRA[1] and S. D. G. JAYAWARDENA[1]

Central Agricultural Research Institute, Gannoruwa

ABSTRACT

The performance of a short duration rice variety (Bg 276—5; 3 months) was studied in relation to seedling age and plant density during yala 1986 and maha 1986/87 seasons. Grain yield and yield components, especially spikelets per panicle and grain weight, were adversely affected by increased seedling age. Delayed transplanting resulted in shifting of stress due to uprooting towards reproductive growth and thus affected yield parameters. It appears that seedlings of short-duration (3 month) varieties should be transplanted at least 10—12 days prior to expected date of panicle initiation. Delayed transplanting also seems to cause irregular and longer flowering periods. Yield reduction due to increased seedling age cannot be compensated by increased plant populations but a 15 cm × 10 cm spacing is the most appropriate plant density for this variety in the mid-country intermediate zone.

KEY WORDS: Plant density, Rice, Seedling age, Yield components

INTRODUCTION

Rainfed and semi-irrigated rice represent about 39,000 ha or 80% of the total rice lands in the mid-country region. The success of rice cultivation in these lands depends more or less on total rainfall received in the area and its distribution. In areas where rainfall is inadequate and poorly distributed short-aged varieties are recommended. Total growth duration of short-aged varieties (3 months) is approximately 90—95 days under normal environmental conditions. When broadcast sown, the vegetative growth period of these varieties is about 25—30 days during which time rice plants have to produce an adequate number of tillers and sufficient leaf area for maximum production. Transplanting is not recommended for short-aged varieties mainly because the seedlings will have to remain in the nursery for 14—21 days leaving only a very short period for plants to complete their vegetative growth. The short vegetative period will result in tiller reduction and a low leaf area index leading eventually to a reduced number of panicles per unit area and fewer spikelets per panicle.

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[1]Present address : Plant Genetic Resources Centre, Gannoruwa

It has been reported that when 3—month varieties are transplanted it is important to use seedlings which are 21 day-old or less to raise a successful crop (A. S. Vivekanandan, 1984, unpublished; G. A. Gunatilaka, 1981, unpublished). However if the onset of the monsoon is delayed farmers are compelled to postpone transplanting, and to retain seedlings in the nursery for a longer period of time. Thus when land is ready for transplanting, seedlings are older than 21 days and in some cases seedling age may be about 35 days. Establishment of new nurseries or broadcast sowing is not resorted to as the rice crop established late will suffer severe water stress at maturity stage.

Seedlings of long and medium duration varieties, can be kept in the nursery for a longer period of time without affecting grain yield (Balasubramaniyan, 1987; Maurya and Yadav, 1987). The longer vegetative period of these varieties give sufficient time for growth and development in overcoming transplanting stress whereas this is not so with short-duration varieties. When transplanting of short-duration varieties is delayed, the possibility of producing an adequate number of productive tillers is low. To compensate for this effect, farmers use close spacing and an increased number of seedlings per hill. Studies in India have indicated that yield reductions due to use of overaged seedlings can be compensated by increased plant densities (Ramasamy *et al.*, 1987). However, no study has been done with currently recommended varieties under local conditions to investigate this possibility.

The objectives of this study were to evaluate the effect of seedling age on performance of the 3—month rice variety, Bg 276—5 and to determine whether yield reduction due to planting older seedlings could be compensated by increased plant populations.

MATERIALS AND METHODS

A field experiment was conducted at Yatawatta, Matale (intermediate zone) during yala 1986 and maha 1986/87. Seedlings of rice variety Bg 276– 5 were transplanted at 21, 28 and 35 days after seeding at three plant densities (15×15 cm, 15×10 cm and 10×10 cm). The experimental design was a split-plot, with seedling age treatments as main plots and plant density treatments as sub plots. Individual plots measured $3m \times 4m$. Three to four seedlings were planted in each hill.

All treatments received fertilizers according to the recommendation of the Department of Agriculture (7 kg N, 59 kg P_2O_5 and 20 kg K_2O/ha as basal, 42 kg N/ha at 2 weeks after transplanting (WAT) and 30 kg N and 25 kg K_2O/ha at 6 WAT). Insecticides were applied at different stages as a routine measure to control insect damage.

During yala 1986 at the time of panicle initiation stage, plant samples were taken from all treatments for determination of panicle development. Plants were dissected, and longitudinal sections taken from the basal part of the main stem were observed under the microscope to determine panicle development stages. The panicle development stages were determined according to the description of Matsushima (1970) (Table 1). The dates of flowering (15% and 85%) and maturity were recorded. At maturity all plots were harvested leaving two border rows and yields expressed at 14% moisture. During yala 1986 ten hills from each treatment were harvested separately for yield component determination.

RESULTS AND DISCUSSION

Panicle development: The time taken by different treatments to reach specific panicle development stages as determined microscopically is presented in Table 1. The first observation on panicle initiation was taken 35 days after sowing nursery (16 June, 1986) which was also the date of transplanting for 35 day-old seedling treatments. On this day the other two seedling age treatments (21 and 28 days) were already in the field for 14 and 7 days after transplanting, respectively. No differences were observed in panicle initiation and development among plant density treatments within a seedling age. However, differences in panicle initiation were observed between different seedling age treatments.

Twenty-one day-old seedling reached stage 1 of panicle development (PD) on June 16 i.e. 35 days after sowing nursery and 14 days after transplanting (Table 1). On this date, 28 day-old seedlings (transplanted only 7 days before) were still in the vegetative stage. The 35 day-old seedlings which were in the nursery up to this date had reached panicle development stage 3 (Table 1) which is a more advanced stage than that observed in 21 day-old seedlings. This clearly indicates that stress due to uprooting definitely affects the time taken to reach stage 1 of panicle development. Since 21 day-old seedlings were in the field for 14 days after transplanting, plants would have had sufficient time to recover after transplanting before reaching the expected panicle initiation stage. On the contrary, 28 day-old seedlings had only 7 days after transplanting to reach the expected stage of PD. This time period has not been sufficient to allow full recovery of the plants to enter the reproductive stage. On the other hand, the 35 day-old seedlings which were in the nursery up to the date of first observation did not undergo any stress due to uprooting and thus reached PD early.

Flowering dates also varied with seedling age (Table 1). Thirty five day-old seedling treatments started heading early but continued for a longer period of time (about 26 days). Twenty one day-old seedlings started flowering about 12 days later than 35 day-old seedlings but completed flowering 2 days before them taking a total of only 12 days to complete flowering. Therefore 21 day-old seedlings had a longer reproductive growth period and a shorter flowering period when compared with 35 day-old seedlings. Flowering of 28 day-old seedlings started about 5 days later (compared to 21 day-old seedlings) but was completed within 16 days. In 35 day-old seedling treatments several late tillers emerged after transplanting even though main culms had reached the PD stage at the time of transplanting. These late tillers continued growth for sometime resulting in a very long flowering period. Any stress caused at or near the reproductive stage will have a marked effect on the number of spikelets and thus on grain yield. Also irregular flowering and longer flowering periods can result in higher percentage of unfilled grains and lower seed weights.

Grain yield and yield components: Grain yield decreased with increasing seedling age in both seasons (Table 2). The yield reductions in 28 and 35 day-old seedlings over 21 day-old seedlings during yala 1986 season were 14% and 33% respectively. This clearly indicates that late transplanting of short-aged rice varieties will result is low grain yields.

During both seasons 15 cm × 10 cm spacing produced the highest yield compared to 15 cm × 15 cm and 10 cm × 10 cm spacings (Table 2). When plant spacing treatments of different seedling ages were compared, the results showed consistency regardless of seedling age. The closer spacing

(10 cm × 10 cm) did not produce higher yields in older seedling treatments. Therefore, increasing grain yield of older seedlings, by increasing the plant population is not possible. However, for any seedling age a 15 cm × 10 cm spacing is better than 15 cm × 15 cm spacing, which is the presently recommended spacing for all 3—month varieties. As transplanting is preferred to broadcast sowing by some mid-country farmers the spacing used is crucial for realizing the yield potential of short-aged rice varieties.

Yield component data for yala 1986 are given in Table 3. Seedling age did not influence the number of panicles per m^2 and production of late tillers by older seedlings could be the reason for this. However, plant spacing directly influenced the panicle number per unit area in all seedling ages, and panicle number increased with closer spacing. Higher number of panicles per unit area is mainly due to higher initial plant densities in closer spacing. Higher yields recorded in the 15 cm × 10 cm spacing were mainly due to increased number of panicles per m^2. However, very high panicle number in the 10 cm × 10 cm spacing had a negative effect on the spikelet numbers and this factor was responsible for lower yields recorded in some situations with 10 cm × 10 cm spacing.

In the comparison of seedlings of different ages, it is clear that fewer spikelet number per panicle was the factor responsible for lower yields recorded in older seedlings (Table 3). Spikelets per panicle decreased with increasing age of seedlings, With increase in seedling age, the period from time of uprooting of seedling to panicle primordia initiation decreased, and in fact 35 day-old seedlings had reached panicle initiation stage at the time of transplanting. Stress at or near the reproductive stage can affect spikelet numbers per panicle accounting for the greater setback in 35 day-old seedlings. Seed weight decreased with increasing seedling age but plant density did not affect the 1000 grain weight. The lower 1000 grain weight recorded in the 35 day-old seedling treatment was mainly due to partly filled grains produced by the late tillers.

CONCLUSIONS

Grain yield and yield parameters, especially number of spikelets per panicle and 1000 grain weight, in the short-aged rice variety Bg 276—5 were adversely affected by planting overage seedlings. Shorter vegetative period of this variety did not allow sufficient time for plants to fully recover before the expected time of panicle development. This stress at or near reproductive stage resulted in fewer grains per panicle. It is essential that seedlings of short-duration varieties be transplanted at least 10—12 days prior to the expected date of panicle initiation. Increased plant densities would not compensate for yield reduction in older seedlings. For the rice variety Bg 276—5, a 15 cm × 10 cm spacing can be recommended when grown in the mid–country intermediate zone.

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Table 1. Influence of seedling age on panicle development and flowering of rice variety Bg 276-5 during yala 1986

Seedling age (days)	*Panicle development stage ***					*Flowering date*	
	16 June	*1 July*	*9 July*	*15 July*	*21 July*	*5%*	*85%*
21	1	7	8-9	10–12	13–15	30 July	11 Aug.
						(12 days) *	
28	-	2–3	6–7	9–10	11–12	4 Aug.	20 Aug.
						(16 days)*	
35	3	8–9	9–10	12–18	FL	18 July	13 Aug.
						(26 days)*	

FL = Flowering

* = Duration of flowering

** = Panicle development stages identified as described by Matsushima (1970) are given below:-

Stage		*Description*
1	—	Primodium of the flag-leaf protrudes and upper part of protuberance will develop into a panicle.
2	—	Differentiating stage of the neck node.
3	—	Increasing of bracts stage.
4	—	Early differentiation stage of primary rachis branches.
6	—	Late differentiating stage of primary rachis branches.
7	—	Early differentiating stage of secondary rachis branches.
8	—	Late differentiating stage of secondary rachis branches
10	—	Early differentiating stage of spikelets.
13	—	Differentiating stage of pollen mother cells.
14–17	—	Reduction division stage.

Table 2. Effect of seedling age and plant density on grain yield of rice variety Bg 276-5 during yala 86 and maha 86/87

Seedling	*Yala 1986*				*maha 1986/87*			
age	*15x15 cm*	*15x10 cm*	*10x10 cm*	*Mean*	*15x15 cm*	*15x10 cm*	*10x10 cm*	*Mean*
(*days*)	(*t/ha*)				(*t/ha*)			
21	4.19	4.74	4.08	4.34	4.35	5.07	4.72	4.71
28	3.61	3.94	3.66	3.74	2.72	3.50	3.32	3.18
35	2.80	3.16	2.78	2.91	2.38	3.10	2.86	2.78
Mean	3.53	3.95	3.51		3.15	3.89	3.63	

LSD (0.05) to compare:	Yala 1986	maha 1986/87
Seedling age	0.54	0.88
Spacing	0.24	0.25
Spacing within seedling age	0.42	0.44
Spacing between seedling age	0.52	0.97

Note: Interactions were not significant

Table 3. Effect of seedling age and plant density on yield components of rice variety Bg 276-5 during yala 1986

seedling age (days)	*Number of panicles/m²*				*Number of spiklets/Panicle*				*1000 grain wt. (g)*			
	15×15 cm	*15×10 cm*	*10×10 cm*	*Mean*	*15×15 cm*	*15×10 cm*	*10×10cm*	*Mean*	*15×15 cm*	*15×10 cm*	*10×10 cm*	*Mean*
21	344	449	540	440	45	41	30	39	26.9	26.9	26.5	26.5
28	367	418	500	428	37	34	29	33	26.4	25.0	25.9	25.8
35	429	543	507	470	27	29	21	26	24.3	24.0	25.0	24.4
Mean	380	440	522		36	34	26		25.9	25.1	25.8	
LSD (0.05) to compare:												
Seedling age			NS			6				1.4		
Plant spacing			44			3				NS		
Spacing within seedling age			76			5				NS		
Spacing between seedling age			114			7				NS		

Note: Interactions were not significant; NS: Not significant