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Postharvest seed dormancy in local rice varieties

(Tempoh rehat lepas tuai biji benih padi tempatan)

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Key words: dormancy period, varieties, heat treatment, germination

Abstrak

Kehadiran dan tempoh rehat beberapa varieti padi tempatan dari dua lokasi iaitu Alor Setar dan Parit telah dikaji. Varieti Masria mempunyai tempoh rehat yang terpendek (4.5 dan 13 hari) manakala Bahagia mempunyai tempoh rehat yang terpanjang (70.5 dan 83 hari). Tempoh rehat biji padi yang berbeza antara 1.7 hingga 65 hari antara dua lokasi tersebut mungkin disebabkan oleh faktor cuaca. Terdapat perbezaan dalam taburan hujan yang melebihi 300 mm antara kedua-dua lokasi itu pada peringkat biji matang dan penuaian. Kesan pendedahan pada haba (50 °C) untuk tiga tempoh terhadap percambahan biji rehat varieti Seberang telah juga dikaji. Pendedahan pada haba (50 °C) selama 96 jam boleh memendekkan tempoh rehat varieti ini sehingga 7 minggu.

Abstract

The presence and duration of dormancy in several local rice varieties from two locations namely Alor Setar and Parit were determined. Masria had the shortest dormancy period (4.5 and 13.0 days) while the longest dormancy period was found in Bahagia (70.5 and 83 days). The duration of dormancy differed between the two locations, ranging from 1.7 to 65 days for any one variety, possibly due to climatic factors. During seed maturation and harvest, there was a difference of more than 300 mm in total rainfall received between the two locations. The effects of heat treatment (50 °C) over three different durations on the germination of dormant seed of the variety Seberang were also studied. Exposure to heat (50 °C) for 96 h shortened the dormancy period in Seberang variety by 7 weeks.

Introduction

Seed dormancy in wild rice species, normally extends from 3 to 6 months. However, in the cultivated species this dormancy period can be totally absent or last as long as 4 months. Prolonged dormancy can be a problem when seeds from previous season are to be used for immediate sowing. Total absence of dormancy is equally disadvantageous as the seed will sprout on the plants in the field if the ripening stage occurs during the rainy season. Such seed will also germinate readily during wet weather if artificial drying facilities are not available. Thus, a certain degree of dormancy is advantageous for a variety.

In 1990, 24 recommended varieties of rice have been released by MARDI. These varieties have short maturation periods and therefore can be planted two or even three times a year though the latter is not commonly practised or recommended. As the interval between plantings can be short, for example, less than 3 months, information on the seed dormancy is critical to the

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growers to avoid the planting of still dormant seed. At present, such information on the released varieties is lacking although dormancy in the traditional varieties has already been ascertained (Dore 1955). This information will also be useful to the breeder in case the varieties are to be used as parents in the future breeding programme. This paper reports the results obtained from studies on dormancy and the effect of heat on seed germination in 27 rice varieties of which 24 varieties have been officially released.

Materials and methods

Determination of dormancy

The occurrence and duration of dormancy were determined in 27 rice varieties of which 18 varieties were tested at both Alor Setar and Parit research stations, two varieties at Alor Setar Station only and 7 varities at Parit Station only. The Alor Setar samples, consisted of 20 varieties, were harvested in February 1986. The second sample from Parit, consisted of 25 varieties, was harvested in March 1988. Seeds were harvested and threshed manually, and dried to a moisture content of 9–11% before storage. One hundred seed sub samples replicated four times, for each of the varieties, were withdrawn for germination test at a shorter interval (3 days) initially and finally at 2-week intervals to determine the trend of seed in germination.

The germination tests were carried out under ambient temperature using paper towel as the medium. The first test was done 6 days after harvest. Germination counts were made on the 14th day after sowing, and the computed germination percentage was based on normal seedling, following ISTA rules (Anon. 1985). Dormancy was considered terminated when germination reached 90%. This limit was chosen as non-dormant seeds normally give more than 90% germination in the normal routine tests carried out in our laboratory.

Effects of heat on germination

Seeds of variety Seberang, drawn from the seed lot from MARDI Research Station Parit, were used in this experiment. As this is one of the varieties with long dormancy period and easily available, it has been chosen for this treatment. After drying and cleaning, seed samples were heat treated in an oven at 50 °C for 48, 72 and 96 h. These time periods were chosen based on the results of preliminary observations. Germination tests were carried out at weekly intervals (up to 13 weeks from harvest) using the method described earlier. One hundred seeds were used in each of the four replications and Complete Randomized Design was adopted. Seed without the heat treatment was also included as control.

Results and discussions

Dormancy patterns

Results obtained show that all the varieties tested had some degree of dormancy (*Table 1*). Germination was low immediately after harvest and gradually increased to reach steady stage of 90% and above after some period of storage. The number of days to reach 90% germination differred significantly among the varieties in both locations (*Table 2*). This duration varied from 4.5 to 70.5 days for samples from Alor Setar, and 13 to 98.5 days for samples from Parit (*Table 1*) depending on the varieties. Seed germination at 6 days after harvest ranged from 5% to 79% for samples from Alor Setar and from 4% to 69% for samples from Parit. Masria samples from Alor Setar and Parit respectively exhibited the shortest dormancy period of 4.5 and 13.0 days. Bahagia recorded the longest dormancy period (70.5 days) from Alor Setar sample and 83.4 days dormancy for the second sample (*Table 1*). From Parit, rice sample with the longest dormancy, however, was Kadaria (98.5 days). Kadaria sample from Alor Setar had a dormancy lasting only 33.5 days. Taking both samples into consideration, it appeared that Masria was the variety with the shortest dormancy while

Table 1. Duration of dormancy in 27 varieties of rice from Alor Setar and Parit

Variety	Duration (days)	
	Alor Setar*	Parit*
Bahagia	70.50a	83.00c
Jaya	54.70b	53.00f
Seberang	53.50b	72.50d
Manik	48.00c	71.50d
Murni	46.75c	89.75b
Mahlinja	42.25d	40.00hi
Sekembang	36.75e	79.50c
Sekencang	34.00ef	48.25fg
Kadaria	33.50efg	98.50a
Setanjung	32.50efg	65.75e
MR 82	30.75fg	
Sri Malaysia 1	29.25g	51.25fg
MR 85	24.50h	
Makmur	22.75h	38.25hi
MR 84	13.00i	37.50i
Ria	13.00i	23.75l
Muda	10.75i	36.50ji
Pulut Malaysia 1	10.50i	50.00fg
Muda 2	10.50i	18.50m
Masria	4.50j	13.00n
Improved Mahsuri	62.25e	
MR 81	49.25fg	
Mahsuri	48.50fg	
Mahsuri mutant	42.25h	
Pulut Siding	32.50j	
MR 101	28.25k	
Seri Malaysia 2	22.00lm	

* Mean values of four readings
Mean values in each column with the same letter are not significantly different at $p = 0.05$ according to DMRT

Table 2. Analysis of variance for number of days to reach 90% germination for samples from Alor Setar and Parit

	Alor Setar		Parit	
Source	df	ms	df	ms
Variety	19	1 275.54**	24	2 087.27**
Error	60	8.23	75	8.41
Mean	31.10	50.22		
C.V.	9.22	5.77		
S.E.	2.02	2.04		

** Significant at 1% level

Bahagia had the highest degree of dormancy among the varieties tested.

There is a highly significant difference in dormancy period between samples from the two locations (*Table 3*). The interaction effect between location and variety on duration of dormancy is also highly significant.

Table 3. Combine analysis of variance for number of days to reach 90% germination for samples from Alor Setar and Parit

Source	df	MS	F value
Location	1	15 583.36	2 263.62**
Rep (location)	6	6.88	
Variety	17	3 415.70	4.95
Location x variety 17	689.91	78.04**	
Error	102	8.84	

** Significant at 1% level

The Parit samples had longer dormancy period as compared with the Alor Setar samples for any one variety (*Table 1*). The increase in the duration of dormancy ranged from 8.5 (Masria) to as long as 65 days (Kadaria). Takashi et al. (1987) found that high temperature and long daylength as well as high relative humidity during seed maturation can cause a high degree of dormancy in rice. Differences in weather conditions during grain formation have been found to cause discrepancies in duration of dormancy for rice seed harvested in different seasons (Ghosh 1962). In other investigations (Araullo et al. 1976; Dev 1981), it was found that seed harvested during humid weather have a longer dormancy than those harvested in dry weather. In this study, the Parit samples which had longer dormancy period, received more rainfall during the seed maturation stage and were harvested in more humid weather compared with the Alor Setar samples. During the last 2 months before harvest, Parit received a total of 369.2 mm rainfall, while the amount received in Alor Setar at a similar stage was only 57.1 mm (*Table 4*). These results are in agreement with the findings of the other workers mentioned.

The overall results show that local varieties do not have long dormancy period. Eleven out of 20 varieties and 19 out of 25 varieties from Alor Setar and Parit respectively have dormancy of 1–3 months (*Table 5*). Ten other varieties from Alor Setar and five varieties from Parit had even shorter dormancy of less than a month. Only two varieties from Parit had dormancy exceeding 3 months. Thus it can be concluded that seeds from the main season can be used in the following off-season planting and vise versa without the problem of ungerminated seeds due to dormancy. Planting should be scheduled to avoid seed maturation and harvesting falling in the wet season as this not only increases the chance for disease incidences, aggravates drying but also can increase the length of the dormancy period. It is thus important to carry out germination test on seed lots harvested during rainy season to ascertain the germinability of the seeds to be used for immediate planting.

Table 4. Rainfall distribution during the growth and maturity of seed crop

Month	Year	Total rainfall (mm)
Alor Setar		
December	1985	17.4
January	1986	9.0
February	1986	48.1
Parit		
January	1988	162.3
February	1988	226.1
March	1988	143.1

Dormancy and crop maturation

The relationship between dormancy period and crop maturation period has also received considerable attention from various workers. Maurya and Vaishi (1984) in their studies on upland rice noticed that there was no relationship between crop duration or kernel

Table 5. Grouping of the rice varieties according to lenght of dormancy periods

Dormancy period (months)	Variety	
	Alor Setar	Parit
< 1	Masria, Muda 2, Pulut Malaysia 1, Muda, Ria, MR 84 Makmur, MR 85, Sri Malaysia 1	Masria, Muda 2, Sri Malaysia 2, Ria, MR 101
1-3	Bahagia, Jaya, Seberang, Manik, Murni, Malinja, Sekembang, Sekencang, Kadaria, Setanjung, MR 82	Pulut Siding, Muda, MR 84, Makmur, Malinja, Mahsuri Mutan, Kadaria, Sekencang Mahsuri, MR 81, Pulut Malaysia 1, Seri Malaysia 1, Jaya, Improved Mahsuri, Setanjung, Manik, Seberang, Sekembang, Bahagia.
> 3	None	Murni, Kadaria

colour and the degree of dormancy. The absence of any association between crop duration and dormancy period was also reported by Dore (1955) and Agrawal (1981). Chang and Tagumpay (1973) noticed that long growth duration was not positively associated with the strong grain dormancy in the hybrid progenies of rice studied and the former trait seemed more heritable than the latter. Other workers, on the other hand, stated that crops of longer duration generally showed a longer dormancy period (Jalote and Viash 1976). In the varieties studied, the calculated dormancy periods and crop maturation periods are shown in *Table 6*. There was, however, no significant correlation between dormancy period and maturation period of the crop in the two samples (r = 0.17 and 0.31 respectively).

Effect of heat on germination

The results show significant effects of heat treatment at 50 °C on germination of dormant seeds of Seberang variety (*Table 7*). Heat treatment for 48 h did not accelerate germination of the dormant seed but exposure to heat for 72 h and 96 h reduced the dormancy period considerably (*Table 8*). The best treatment was heat exposure for a duration of 96 h whereby dormancy was shortened by 7 weeks. Increases in the germination of dormant seeds due to heat have been reported by other workers (Murty and Raghaviah 1965; Agrawal 1981; Tomar et al. 1987) including published work on certain local varieties (Hor and Khuzaimah 1986).

The effects of heat on breaking of dormancy vary with the intensity of dormancy and thus with variety. Intensively dormant varieties require a longer period of exposure to heat treatment before dormancy can be completely overcome. The duration of the heat treatment is more important than the temperature itself to break dormancy. Jennings and Jesus (1964) gave heat treatments up to 10 days and at temperatures ranging up to 65 °C to strongly dormant Seraup 27. Results showed that 9–10 days was the most effective duration and 50 °C was superior to higher temperature. Murthy (1984) divided 26 varieties of rice in his investigation into strongly dormant and weakly dormant groups based on percentage germination obtained after heat treatment at 50 °C for 4 days.

In the case of variety Seberang (MR 77), Hor and Khuzaimah (1986) found that the germination was raised from initial 5% when freshly harvested to 32% after exposure to heat treatment at 45 °C for 4 days. Heat treatment on Seberang, with higher initial germination of 26% and at the

Table 6. Dormancy and crop maturation periods of the related varieties of rice

Variety	Dormancy period(days)		Average crop maturation periods (days)
	Sample 1*	Sample 2*	
Murni	48	93	137.5
Masria	10	18	125.5
Jaya	52	52	125.0
Sri Malaysia 1	-	50	140.0
Sri Malaysia 2	34	25	129.0
Pulut Malaysia 1	14	51	140.0
Pulut Siding	-	31	139.0
Setanjung	31	69	138.5
Sekembang	44	80	143.0
Sekencang	44	50	123.0
Kadaria	42	99	129.0
Manik	54	68	142.5
Muda	17	39	129.0
Seberang	57	75	134.0
MR 84	18	39	134.0
MR 81	-	43	134.5

* Sample 1 from MARDI Station Alor Setar
Sample 2 from MARDI Station Parit

Table 7. Analysis of variance for effects of heat treatment (50 °C) on germination of dormant rice seed

Source	df	SS	MS	F-value
Treatment	3	9 067.50	3 022.5	187.44**
Mean	49.25			
C.V.	8.15			
S.E.	4.02			

** Significant level less than 0.001

Table 8. Effects of heat treatments (50°C) at three durations on the number of days to reach 90% germination in dormant rice seed

Heat duration (h)	Mean no. of days
48	73.25a
0	72.50a
72	29.75b
96	21.50c

Significant at 5% level by DMRT

higher temperature of 50 °C, resulted in a much higher germination (91%) in this study. In both studies, germination increased with heat treatment. This suggests the possibility of complete removal of seed dormancy immediately after harvest if the exposure time is further prolonged. Heat treatment (50 °C) can therefore be an effective method of overcoming dormancy in rice, while the degree of effectiveness will depend on the intensity of the dormancy as well as the exposure time.

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