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EFFECTS OF PRE-HARVEST GRAIN DISCOLOURATION ON SEED QUALITY OF RICE (*Oryza sativa* L.)

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ABSTRACT

Discolouration lowers the quality of both paddy (*Oryza sativa* L.) seed and consumption grain. Panicle submergence with lodging is the major reason for seed discolouration. Presently, seed lots with up to 25% discoloured seed are accepted as seed paddy if they meet other seed quality standards. However, effects of different levels of seed discolouration on seed quality have not being evaluated. A study was undertaken at the Seed Testing Laboratory, Peradeniya to quantify the effects of four discolouration levels; 0-5%, 20–25%, 45-50%, and 75-80% of two varieties; Bg 300 and Bg 94-1 on seed viability, germination and seedling vigor. Results indicate that all samples including the 0-5% discolouration level were infected with *Fusarium*, *Helminthosporium*, and *Pyricularia* spp. Samples with up to 50% discolouration had acceptable levels of viability and germination at the beginning. However, during storage seed lots with 0%, 25%, and 50% discolouration levels of both varieties declined in viability to below 85% by 3 months, 2 months, and 1 month, respectively. Seedling growth rate was lower in all lots from the beginning when compared to unaffected lots and declined gradually with storage. Level of seed discolouration increased by about 25% in all the lots including 0-5% lot within 3 months of storage, perhaps through contamination. Therefore, rice seed discoloured due to submergence during maturation, including lots with very slight discolouration cannot be recommended as seed rice, especially when it is required to store them for more than 3 months before sowing.

KEY WORDS: Discolouration, Germination, Rice, Seed quality, Pre-harvest

INTRODUCTION

Quality of paddy (*Oryza sativa* L.) seed used for planting is an important factor that affects rice yields. Discolouration by various means lowers the quality of paddy seeds. Submergence of panicles after lodging during maturity is one of the common reasons for rice seed discolouration. Fungal infections are responsible for seed discolouration (Misra *et al.*, 1994). Some of these fungi may not intrude the kernel or the embryo but will contaminate only the outer husk and may not affect seed viability. Some may infect even the embryo during storage. Baldacci and Corbetta (1964) reported that in addition to fungi, bacteria are also associated with discoloured rice seeds. Soybean seed discoloured due to fungal infections produced plants with less vigour when compared to normal seeds (Harnowo and Baliadi, 1996).

According to the rules of the International Seed Testing Association (ISTA), discoloured seeds cannot be accepted as seed rice. However, occurrence of discoloured seed is a problem especially under tropical weather conditions and could affect seed supply programmes and crop establishment.

Varietal differences could exist on susceptibility to discolouration and seed viability. No quantitative information is available on this aspect under Sri Lankan conditions for local rice cultivars. An investigation was carried out to quantify the effects of rice seed discolouration on viability, germination and seedling vigour of two popular rice cultivars, BG 300 and BG 94-1. Considering the fact that the major cause for rice seed discolouration is submergence during maturity, rice seed of two cultivars with different levels of discolouration due to the above reason were used in the present study.

MATERIALS AND METHODS

Seed samples of different discolouration levels were collected from farmers' fields in Ampara district where panicles were submerged after lodging due to heavy rains during grain maturation. Two cultivars namely; Bg-300 and BG-94-1 that were harvested during the last two weeks of March 1999 were used for the study. Percentage of discoloured seed were calculated by counting the number of seeds with more than 25% discolouration on the pericarp in a sample of 500g with four replications. Seed lots with 0-5%, 20-25%, 45-50%, and 70-75% Discolouration Levels (DL) were selected on this basis for the present study. Initial moisture content of all the samples was adjusted for 12% by sun drying. Samples of 3 kgs with each discoloratation Level from each cultivar were packed in woven polyproperline bags and stored under room temperature (29°C / 23°C day/night average) in the Seed Testing Laboratory, Peradeniya in a completely randomized design with four replications. Relative humidity, minimum and maximum temperature were monitored in the study location (Annexure 1). Initial seed viability, vigour and discolouration levels were measured and same parameters were measured at one-month intervals. Pathological assays were conducted for all samples at the beginning to identify the fungi and bacteria associated with grain discolouration.

Seed viability was measured by observing the pattern of staining the kernel of dissected seeds in a solution of 1% Tetrazolium salt. Standard germination was tested by placing a representative samples in sand boxes with sterilized sand. They were exposed to alternate 30°/20° C day/night temperature regime for nine days. Percentage of normal seedlings was counted at 9th day following the rules of the ISTA. Seedling vigour was measured by using accelerated aging test where 100 randomly selected seeds were sown in pots filled with soil, which were maintained at saturated moisture level all the time. Percentage of normal seedlings of height greater than 6 cm at 10 days after sowing were counted and recorded as the percentage of vigorous seedlings in each treatment.

RESULTS

Change of discolouration level during storage of the two cultivars is presented in figures 1 and 2. Discolouration level increased by about 25% in all the treatments including the lowest (0-5%) level in both cultivars over four months storage, period.

The behavior of seed viability in different treatments over the storage period is shown in figures 3 and 4. Treatments with 0-5%, 20-25%, and 45-50% discolouration levels had an acceptable level of viability at the beginning of the study and it declined below acceptable level (85%) by 3 months, 2 months and 1 month after storage, respectively in both cultivars. There was a declining trend in seedling vigour with the increase of discolouration level and storage period irrespective of the cultivar (figures 5 and 6). Weekly averaged temperature has been varying from 20 – 32 °C and the Relative humidity from 60 – 90 % during the period of the study (table 1).

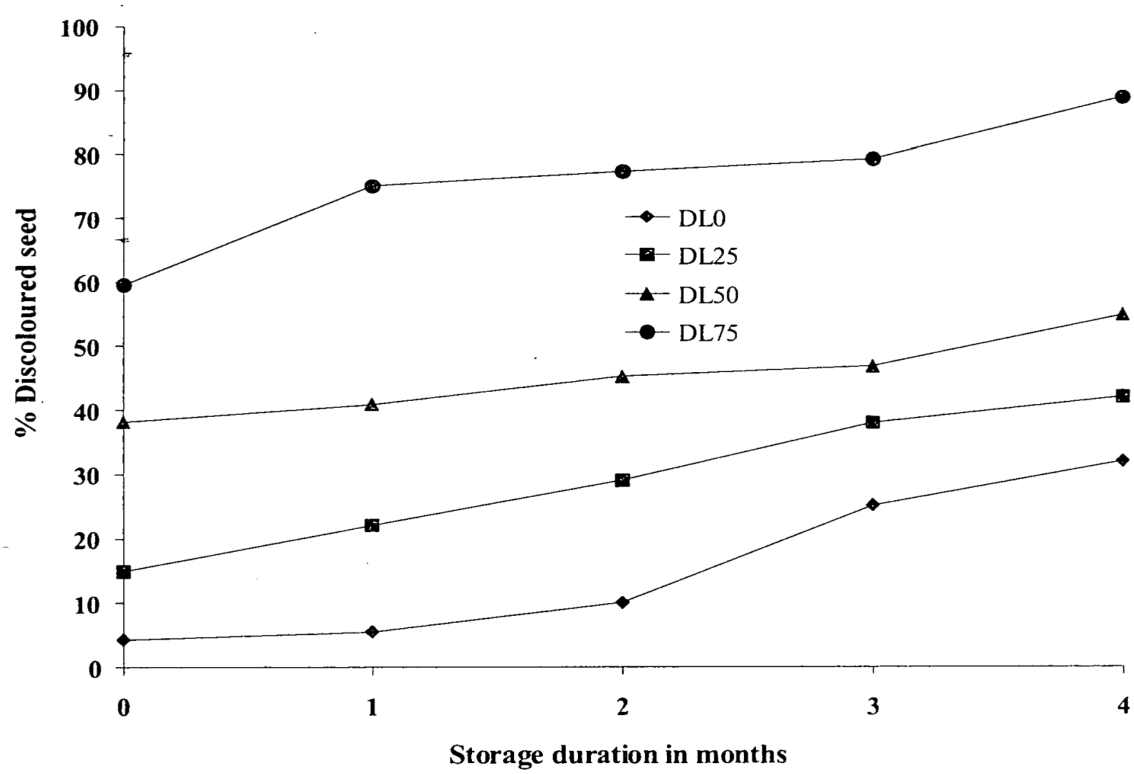

Figure 1. Change of discolouration level of discoloured rice seed of cultivar Bg 300 during storage (DL – Percentage discolouration level).

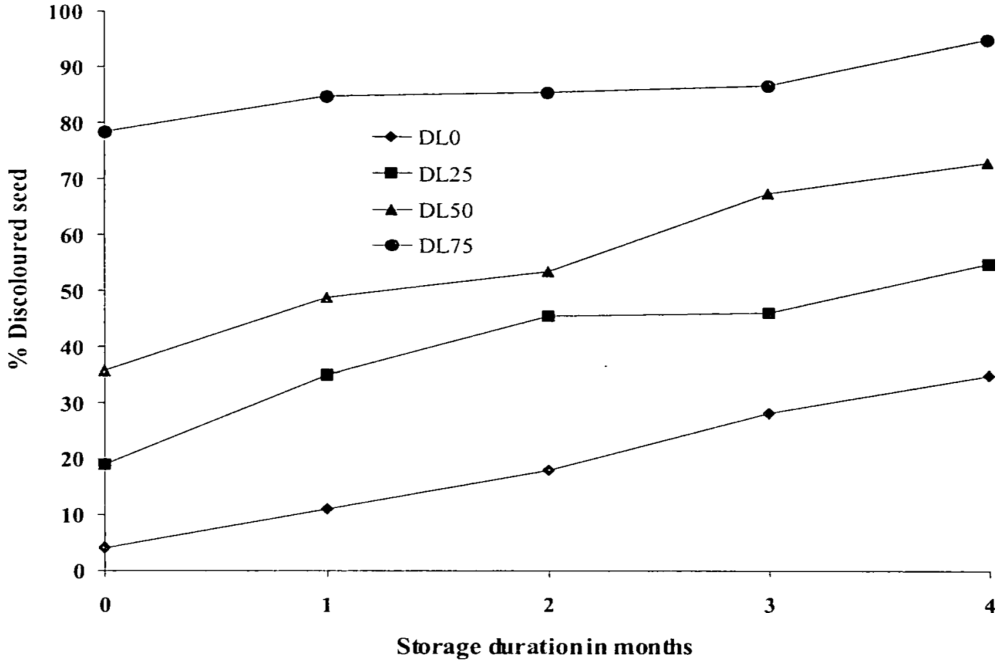

Figure 2. Change of discolouration level of discoloured rice seed of cultivar Bg 94-1 during storage (DL – Percentage discolouration level).

Results of the pathological assay are given in table 1.

Table 1. Fungal infections recorded in different seed lots at the beginning of the study.

Cultivar	*Discoloration level*	*Available fungi* *
Bg 300	0-5%	1
	20-25%	1 + 2.
	45-50%	1 + 2
	70-75%	1 + 2
Bg 400	0-5%	1
	20-25%	1
	45-50%	1 + 2
	70-75%	1 + 2

*1. *Helminthosporium* spp, *Pyricularia* spp, and *Fusarium* spp
2. Mucor and *Aspergillus* spp.

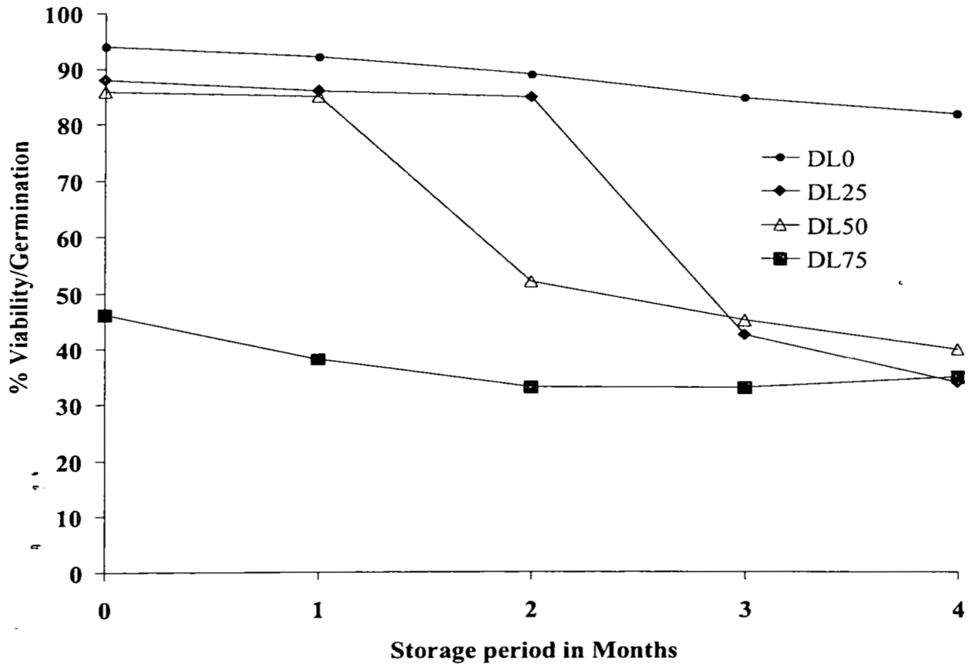

Figure 3. Effects of pre-harvest discolouration of rice seed on seed germination after different periods of storage – Cultivar Bg 300 (DL – Percentage discolouration level).

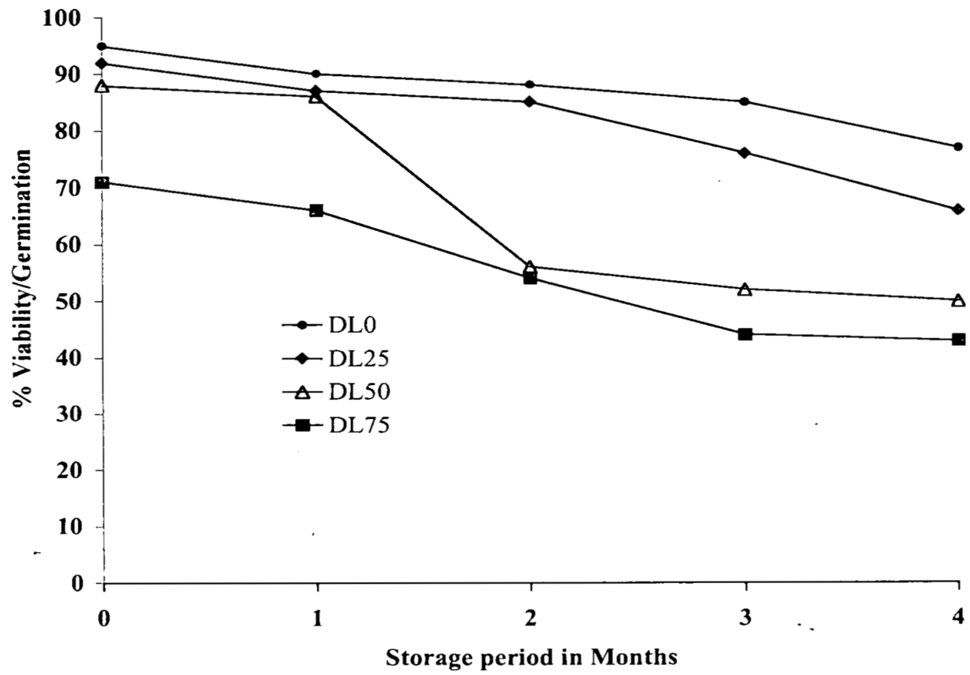

Figure 4. Effects of pre-harvest discolouration of rice seed on seed germination after different periods of storage – Cultivar Bg 94-1 (DL – Percentage discolouration level).

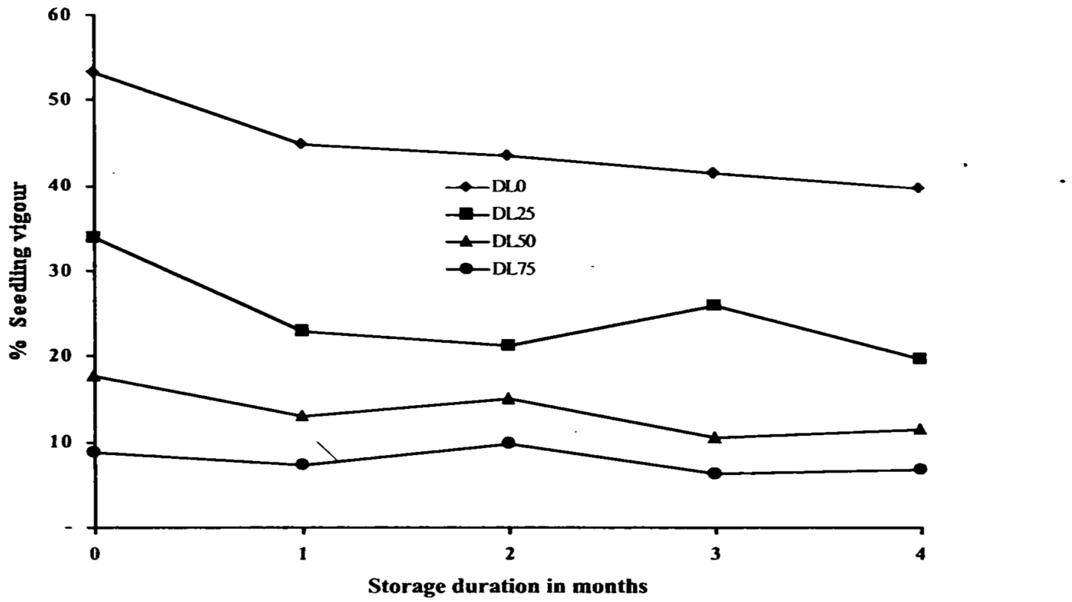

Figure 5. Effect of seed discolouration on seedling vigor of cultivar Bg 300 (DL Percentage discolouration level).

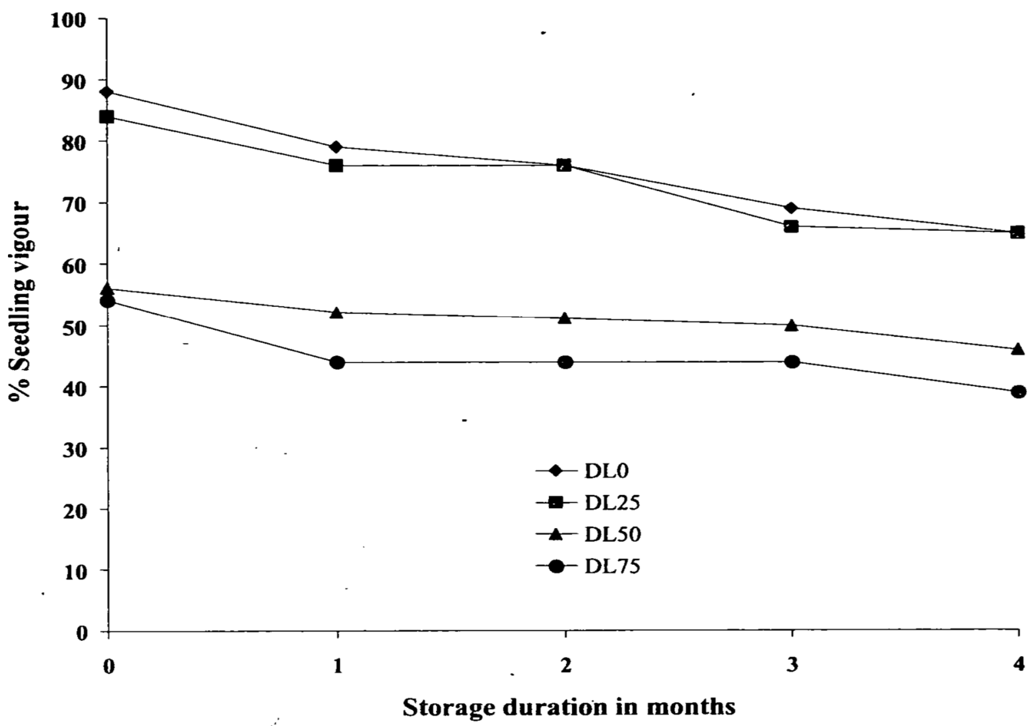

Figure. 6. Effect of seed discolouration on seedling vigor of Cultivar Bg 94-1 (DL – Percentage discolouration level).

DISCUSSION

Percentage germination of both cultivars showed strong negative correlations to the level of seed discolouration (figure 7) indicating that the fungal infections associated with seed discolouration were responsible for lowering seed germination. This agrees with Misra *et al.*, 1990 and Ou, 1985 who reported that the germinability of rice seeds decreases when discoloured due to fungal and bacterial infections. Querijero *et al.*, 1993 also showed, using seed samples of different discolouration levels, that the germinability could be lowered by 39% due to fungal infections associated with discoloured rice seeds. Strong negative correlation was observed between the level of seed discolouration and the seedling vigour (figures 8 and 9). Decay of the storage food in the rice kernel due to the activities of the infected fungi could be one of the reasons for lowering the seedling vigour of discoloured rice seeds. As shown by Misra *et al.*, 1994, seed discolouration is caused by toxins that are produced by fungi and therefore, as shown by them, it could affect both physical and chemical qualities of the grain. Therefore, the level of discolouration must be related to the degree of fungal infection. The level of seed discolouration in all the treatments increased during storage indicating that most of the seeds in lots with even a very low level of discolouration at the beginning must have been infected with fungi that were responsible for discolouration. The high positive correlation observed between the percent discolouration at the beginning and that of four months after storage (figure 10) supports this argument. This could be the reason for the observed reduction in seed viability and vigour with the increase of storage period (figure 5 and 6). High relative humidity (>85%) and maximum temperature (above 30°C) during the storage period must also have been contributing for the observed behavior of treatments.

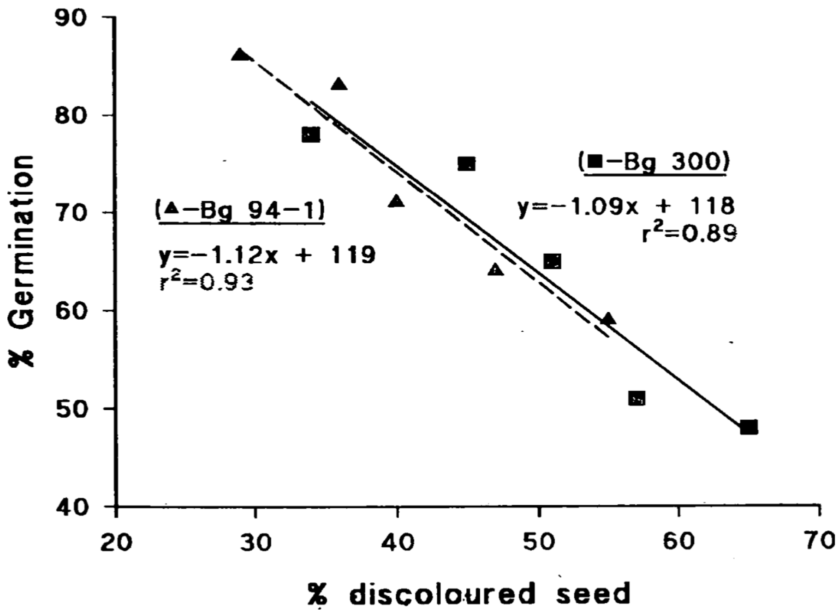

Figure 7. Relationship between the degree of seed discolouration and percentage seed germination of cultivars Bg 94-1 and Bg 300.

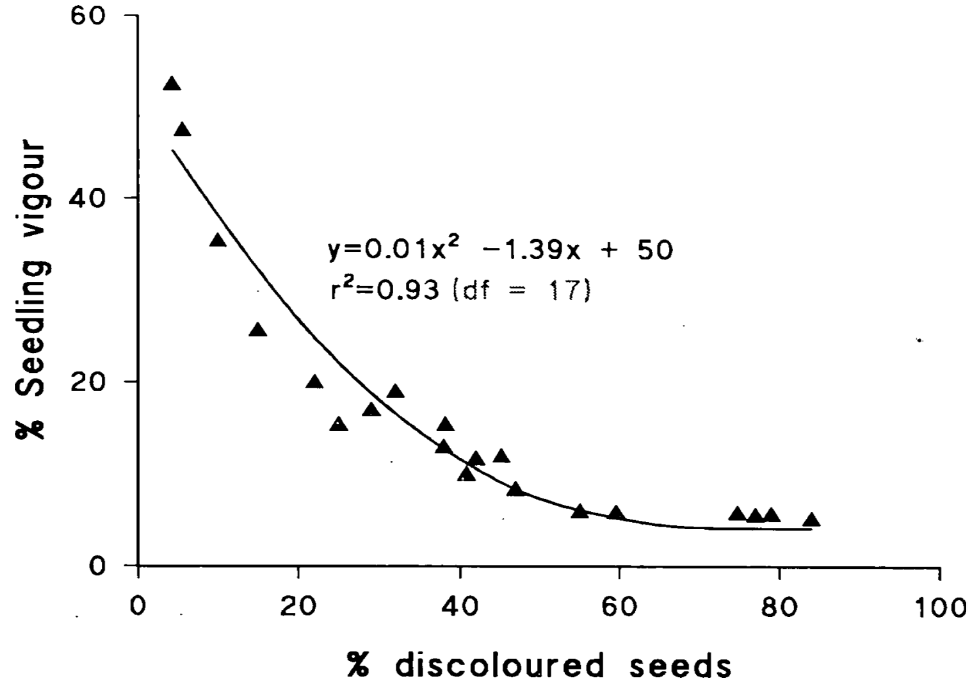

Figure 9. Relationship between level of seed discolouration and seedling vigour of cultivar Bg 94-1.

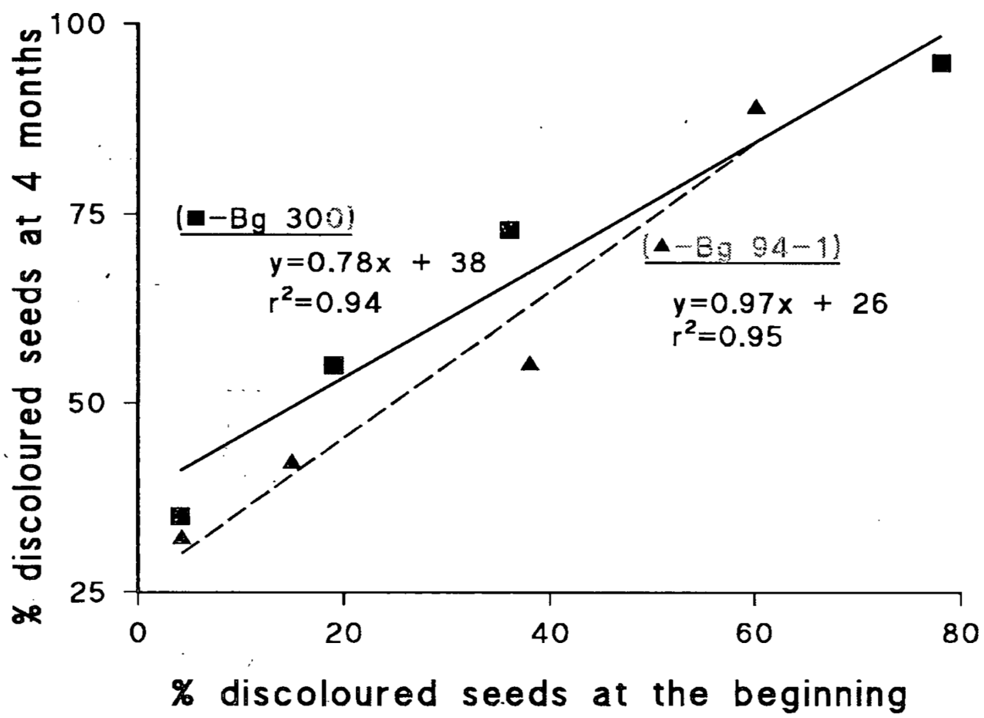

Figure 10. Relationship between the degree of seed discolouration at harvesting and the degree of discolouration after four months of storage for cultivars Bg 94 -1 and Bg 300.

CONCLUSION

Seed coat discolouration after submerging the rice panicle is mainly due to fungal infections. This could lower the seed viability and seedling vigour during storage. Seed lots with up to 25% discolouration could be safely used as seed paddy if used within two months after harvesting. Seed lots with discoloured seeds after submergence during maturity should not be stored under ambient conditions to use later as seed paddy. Possibility of using fungicides to overcome this problem needs to be studied. Effects of different fungi, that causes seed discolouration, on seed viability and vigour need to be investigated.

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Annexure 1: Weekly averaged temperature and relative humidity data for the period of the experiment at Gannoruwa.

Week number	*Temperature °C (Weekly averages)*		*% Relative humidity (Weekly averages)*	
	Maximum	*Minimum*	*Morning*	*Evening*
9	30.8	19.8	76	60
10	31.6	17.1	73	57
11	32.7	20.3	78	61
12	32.2	29.5	86	62
13	32.2	20.9	82	80
14	30.7	21.0	84	91
15	30.3	22.3	83	89
16	28.2	21.7	85	91
17	29.5	21.0	85	86
18	30.7	22.2	85	95
19	30.6	22.1	92	94
20	29.7	21.5	88	96
21	27.8	21.7	92	93
22	27.1	21.7	86	84
23	26.9	21.1	88	86
24	27.0	21.5	90	85
25	29.9	21.0	80	74
26	30.5	19.0	75	68
27	28.0	21.2	85	79
28	28.8	21.6	80	71
29	28.8	21.6	81	76
30	28.3	22.4	82	94
31	28.0	21.4	88	78

Week 9 = (26th Feb. - 4th March 1999) Week 31 = (30th July – 5th August 1999)

Source: Agro- Meteorology unit – NRMC, Peradeniya.