

Influence of Position of Panicle on Seed and Seedling Characteristics of Rice (*Oryza sativa* L)

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ABSTRAK

Ciri-ciri biji benih diperoleh daripada cabang-cabang bulir primer, sekunder dan tertier dalam empat jenis padi Indica (Oryza sativa) telah dinilai. Pola-pola percambahan dan viabiliti biji benih yang diperoleh serta kekuatan dan ciri-ciri anak benih yang membesar daripada biji-biji benih ini juga telah dikaji. Ciri-ciri biji dan anak benih daripada tiga jenis dahan yang sama bagi empat jenis padi ini adalah serupa. Sebaliknya perbezaan yang ketara kelihatan antara biji benih yang diperoleh daripada tiga jenis dahan. Biji benih daripada dahan primer bulir mempunyai berat lebih 100 biji. Berat terendah diperhatikan pada biji-biji benih daripada cabang-cabang tertier. Perbezaan ini pada asasnya disebabkan endosperma yang lebih bagi biji-biji benih di dahan primer, yang seterusnya meningkatkan nisbah endosperma: embrio. Daya tahan dan daya percambahan ketiga-tiga biji benih adalah sama dengan ciri-ciri biji benih tersebut. Biji benih daripada cabang primer bulir mempunyai daya tahan yang lebih tinggi. Anak benih daripada biji-biji benih ini juga lebih kuat. Perbezaan pertumbuhan anak benih daripada ketiga-tiga dahan bulir padi tersebut adalah sama daripada segi ciri-ciri dan dayatahan bijinya. Kajian tersebut menunjukkan bahawa anak benih daripada biji-biji benih cabang primer memperlihatkan pertumbuhan yang lebih unggul disebabkan ciri-ciri biji benih yang lebih baik. Beberapa implikasi praktikal kajian tersebut akan dibincangkan.

ABSTRACT

The characteristics of seeds obtained from primary, secondary and tertiary branches of panicles in four varieties of Indica rice (Oryza sativa) were evaluated. The germination patterns and viability of procured seed and the vigour and characteristics of seedlings developed from these seeds were also studied. The characteristics of seeds of the three branch types of the four varieties and their seedlings were similar. In contrast, marked differences were observed between the seeds obtained from the three types of branches. Seeds of primary branches of the panicle had a greater 100-seed weight. The lowest weight was observed in seeds from tertiary branches. This difference was principally due to the heavier endosperm of the seeds of primary branches, which in turn increased the endosperm:embryo ratios. The viability and germinability of the three categories of seed were similar to those of seed characteristics. Seed from primary branches of the panicle had a higher viability. The vigour of seedlings from these seeds was also greater. Differences in growth of seedlings from these seeds was also greater. Differences in growth of seedlings from the three branches of the rice panicle were similar in terms of characteristics and viability of seeds. The study revealed that seedlings from seeds of primary branches manifested superior growth because of better seed characteristics. Some practical implications of the study are discussed.

Keywords: Branches, panicles germination patterns, seed and seedling characteristics, *Oryza sativa* L

INTRODUCTION

Seeds play an important role in determining the success of rice culture. Thus, selection of good quality seeds is considered a primary factor in ensuring high yields.

Seedling emergence and subsequent early growth affect final yields in cereals (Evans and Bhatt, 1977). Variations in field emergence, particularly under poor management are attributed to differences in seed vigour (Matthews, 1980).

Seed with low vigour either emerge late or produce abnormal seedlings, resulting in poor yields.

Seed vigour is affected by the storage material in the seed (Heydecker, 1969). This has been reported to be the cause in regard to cereals (eg. Evans and Bhatt, 1977) and legumes (e.g. Grotechusmann and Robbeler, 1985). Rice (Tashiro *et al.*, 1988) also showed differences in storage material within and between varieties. These differences have been attributed to sev-

eral factors, ranging from panicle position and development to variations in growth and environmental conditions.

Rice panicles have three types of branches, namely primary, secondary and tertiary. The position of the seed on the panicle also affects grain filling during seed development (Vijayalaksmi *et al.* 1988). This study was carried out to determine the physical characteristics of seeds on different branches of a rice panicle and their germination patterns. The study also evaluated differences in seedlings grown from seeds obtained from different branches of the rice panicle.

METHODOLOGY

The study was carried out in a plant house at the University of Peradeniya, Sri Lanka (7°N, 81°E, 385m above sea level). The mean environmental conditions during the experimental period were: Temperature - $27.4 \pm 1.8^\circ\text{C}$; Relative humidity $76.8\% \pm 3.45\%$ and a daylength of 10 - 11 hours. Uniform seeds of four rice varieties (3 1/2 - 4 month maturity group, germination $94.5 \pm 1.5\%$), namely BG 34/8; 94/1, 278/5 and 379/2 were selected for the study. The 100-seed weights of these varieties were 2.811g, 2.801g, 2.849g and 2.816g respectively. Thus the mean 100 seed weight of the four varieties was $2.811 \pm 0.427\text{g}$.

The selected seeds were immersed in distilled water for six hours and planted in plastic pots containing approximately 6 kg of a saturated low humic gley soil. The soil selected had a clay loam texture with 65.1% clay. Planting was carried out to ensure 4 plants per pot.

The lay out of the plants was a completely randomized design with four replicates per variety. The crop was managed on the basis of recommendations for rice in Sri Lanka (Gunasena, 1974). Soil moisture was maintained over field capacity until seed ripening, and then left to dry under normal farm conditions until harvesting.

At full ripening, seeds of primary, secondary and tertiary branches of the selected varieties were removed carefully. A sample of each category was dried to determine the moisture content, and the seed weights calculated at 14% moisture and the 100 seed weights determined. The following studies were carried out to determine the seed and seedling characteristics from seeds obtained from the three types of branches of a panicle -

A. Samples of 50 seeds from each category were soaked for 24 hours in distilled water, and dissected to determine the weights of husk, endosperm and embryo. The dissected samples were dried, and the weights calculated at a moisture content of 14%.

B. Germination characteristics of the three types of seed were determined by planting 100 seeds per category from each variety on trays containing 2.5 cm of fine river sand. The seeds were placed in rows and lightly covered with sand. These were watered daily. Seed germination was measured daily until 70% emergence was obtained, the tray were maintained for 21 days to obtain the final germination. The percentage abnormal seedling and percentage dead seedling were also determined as described by ISTA (1985) from these samples at the 21st day after planting. In addition seed viability was tested by the tetrazolium method on 50 seeds per sample suggested by ISTA (1985).

C. Seedling vigour was determined by planting 50 seeds of each category from the four varieties at different depths in fine sand. The depths of planting were at 1, 3, 5 and 7cm. Final emergence of seedling was determined at 20 days after planting.

D. Growth of seedling emerging from seeds obtained from different branches of the panicle was determined by planting 100 seed of each category per replicate in trays containing 2.5 cm of fine sand. Seedlings were harvested at 21 days, and the shoot and root dry weight were determined by drying 20 healthy seedling per replicate from each category of the four varieties at 80°C to a constant weight. In addition, the total root length of the seedling was determined by the Grid technique as described by Tennent (1975).

The data were analysed according to methods described by Gomez and Gomez (1981). As the results of all four varieties were similar, they were pooled for the final analysis to determine treatment differences.

RESULTS AND DISCUSSION

Seeds of the three types of branches on rice panicles had significant differences in terms of seed weight (Table 1). The weight of 100 seeds from the primary branches was 3% and 13% greater than those from secondary and tertiary branches respectively. The seed weight components appear to be the causal factors for these

TABLE 1
Characteristics of rice grain on different branches of the panicle

CHARACTERISTIC	BRANCH TYPE			LSD (P=0.05)
	Primary	Secondary	tertiary	
100 Seed weight (g)	2.946	2.862	2.571	0.031
Wt of embryo and endosperm	2.340	2.272	2.008	0.050
Wt of husk (g)	0.606	0.590	0.563	0.041
Wt of endosperm	2.291	2.223	1.995	0.022
Wt of embryo (g)	0.049	0.049	0.053	0.009
Endosperm:Embryo ratio	46.75	45.37	36.88	

differences. The weight of husks of seeds from the different branches were low in all cases, suggesting that the husk does not contribute to of the variaton of seed weights. The weight of embryo and endosperm of seeds obtained from tertiary branches are significantly less than those from the primary and secondary branches. The weights of the embryo and endosperm of seeds of the secondary branches are less than those of seeds from primary branches. The differences in the measurements of these two components are primarily caused by the variations in weights of the endosperm, as seeds of all branches have similar embryo weights. Thus differences in weights of the rice seeds obtained from the different branches of a panicle could be attributed to the variations in the endosperm weights.

In their study of panicle development Tashiro *et al.* (1988) highlight the early pollination and seed set in primary branches and suggest that seeds on the primary branches have a greater sink effect, thereby obtaining carbohydrates from the sources at a faster rate. This could be considered the causal factor for the differences in weights of the endosperms, and the greater weights of seeds on primary branches in our study. The endosperm:embryo ratios also illustrate differences between the three seed types (Table 1). The greater endosperm:embryo ratios of the seeds from primary branches indicate the

ability of the food reserves to support the growing embryo to a greater degree than seeds of secondary and tertiary panicle branches.

Germination characteristics (Table 2) of seeds from the different branches of the rice panicle are significantly different. Seeds from primary branches germinate earlier. The 70% germination of seeds from tertiary branches occurs at least a day later than seeds of other branches. This in turn can affect their subsequent growth and also determine competitive effects and final yields (Harper, 1977).

The higher final germination rate also illustrates the superior performances of seeds from primary branches. The germinability of seeds from tertiary branches is 16% and 9% less than that of seeds from primary and secondary branches respectively. This suggests that the use of seeds from tertiary branches alone could reduce plant populations. Examination of viability (Table 2) also illustrates differences in characteristics among seeds of different branches. Seeds from the tertiary branches of the panicle show a lower percentage of viability, suggesting poor capacity for germination.

Table 3 presents the vigour of emerging seedlings from the selected seed classes. Seeds of all categories placed on the surface show the greatest percentage of germination. This suggests that burial of seeds which deprives the

TABLE 2
Germination of rice grain on different branches of the panicle

CHARACTERISTIC	BRANCH TYPE			LSD (P=0.05)
	Primary	Secondary	Tertiary	
Time to 70% germination	7.05 days	7.48 days	8.47 days	0.32
Final germination (%)	92.6	85.9	76.4	2.65
Viability (%)	98.5	94.6	86.5	1.48

TABLE 3
Influence of planting depth on emergence of rice seedling from seeds
obtained from different branches of the panicle

Planting depth	Primary	Secondary	Tertiary	LSD (p=0.05)
		Percentage	Emergence	
Surface	88.5	86.7	79.2	0.13
1 cm	85.9	81.5	74.6	0.67
3 cm	76.5	70.5	61.7	0.98
5 cm	66.4	58.3	42.6	1.89
7 cm	58.9	49.6	35.3	3.98
LSD (P=0.05)	4.65	5.96	2.99	

seeds of light could retard germination. Germination of seeds decreases with increasing depth. The differences between the emergence of seedling from seeds of the three categories are clearly significant. Seedling emergence from seeds of the primary branches is greater at all depths. This shows high seedling vigour. In contrast, reductions in emergence of seedling from seeds of tertiary branches indicate low seedling vigour. This again highlights the superior performance of seeds of primary branches of the rice panicle.

Characteristics of seedling also follow the trends of seed characteristics of the different branches. This clearly indicates the influence of seed characteristic on seedling growth. Seedlings emerging from seeds of primary branches have a greater shoot and root dry weight at 21 days. Dry weights of shoot of the secondary and tertiary branches are approximately 10% and 35% lower by comparison, whereas the differences are greater in terms of root weight (i.e. 13% and 37% lower than those of seedlings from seeds of primary branches respectively). Thus shoot growth seems to be affected more by seed size than root growth; this phenomenon warrants further study.

The differences in total root length are less marked than those of weight. The reductions in total root length of seedling from seeds of secondary and tertiary branches of the panicle are 14% and 29% respectively when compared to those of seedlings from seeds of primary branches. This suggests that root dry matter accumulation, especially in seedlings from seeds of tertiary branches, exceeds that of root length. Evaluation of the types of seedlings also clearly illustrates differences between the seed types. Seeds from tertiary branches produce a greater quantity of abnormal seedlings. The number of

seedlings that do not survive is also greater among this category of seeds. This occurrence is significantly reduced in seedlings emerging from seeds of secondary branches. In contrast, seeds from the primary branches produce the highest number of normal healthy seedlings.

In the process of panicle development of rice, primary branches set seed earlier. The secondary and tertiary branches set seed later (Vijayalakshmi *et al.* 1988). This phenomenon can have a significant impact on seed development (Rao, 1989). The current study indicates that seeds from tertiary branches tend to have a greater number of partially filled grain. The weights of the fully filled grain are also less than those from secondary and primary branches of the same panicle.

Seed weight has a significant impact on seedling growth (Perry, 1972), which can influence establishment and subsequent competitive relationships. This study illustrates that seeds of primary branches of the rice panicle are heavier, mainly due to the well developed endosperm. Thus, the developing embryos of these seeds, which are similar in weight to those of seeds from other branches have a greater source of carbohydrates for seedling growth, as shown by the endosperm:embryo ratios.

The differences in seed characteristic affect all aspects of germination and seedling development. The greater viability of seeds on primary branches, the higher germination percentages and seedling vigour together with better growth of the emerging seedling, could be considered the resultant effects of superior seed characteristic.

Farmers establishing rice strive to obtain the optimum populations with seed available. Thus seed characteristics are very important. This study

TABLE 4
 Characteristics of seedlings from seeds of primary, secondary
 and tertiary branches of the rice panicle

Characteristic	Primary	Secondary	Tertiary	LSD (P=0.05)
Shoot dry wt at 20 days (g)	0.65	0.58	0.42	0.04
Root dry wt at 20 days (g)	0.59	0.51	0.37	0.11
Total root length at 20 days (cm)	247.5	210.0	174.5	18.96
% Normal seedlings	84.5	78.5	60.7	6.31
% Abnormal seedlings	7.4	10.8	21.4	1.96
% Dead seedlings	8.1	10.7	17.9	0.92

clearly illustrates that heavy seed, preferably from primary or secondary branches of the panicle, could provide better germination and healthy seedlings. These factors are important considerations in breeding and selection programmes where the seed supply is limited. However, in practice, procuring seeds only from selected branches of a panicle is a difficult task especially when the whole plant is harvested, unless there are breeding and selection programmes. Rao (1989) has suggested that the development of rice plants with panicles having a greater number of primary and less of tertiary branches should be considered a useful source for obtaining healthy seedlings of rice which could produce sturdy plant with the promise of higher yields; such a programme with also ensure good planting material for a crop that is primarily propagated by seed.

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