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PERAGI

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Changes in Seed Quality of Mung Bean Genotypes with Different Seed Characteristics as Affected by Field Weathering During Maturity Stages

Perubahan Kualitas Benih Kacang Hijau dengan Karakteristik Benih yang Berbeda Akibat Deraan Cuaca Lapang Selama Pematangan

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ABSTRACT

Susceptibility to field conditions conducive to deterioration during seed maturation has been associated with large seeds. The objective of this study was to determine the effect of seed characteristics on mung bean seed quality due to field weathering during maturity stages and to relate the seed characteristics on seed quality indicators. Seeds of four genotypes were grown in research plots at Agriculture Faculty, Bengkulu University on April 10, 2007 in a split-plot arrangement, with harvest stages as main plots, genotypes as subplots and pod position as sub-subplots with three replications. At maturity stages R7, R7.5, R8, and HM, the seeds from each genotype were harvested and evaluated for seed moisture, seed germination, accelerated aging germination (AAG) and electrolyte conductivity. Over the entire harvest stage, germination of seed from the top portion of small-seeded genotypes was above 90%, while that of large-seeded genotypes dropped to about 70-80% at HM. On the bottom portion, seed germination of two large-seeded genotypes was about 60-70%. The two small-seeded genotypes having good seed germination also had good AAG values throughout the stage, while AAG value for large-seeded genotypes was severely reduced to below 70% at HM. The decline in seed viability and vigor was followed by an increase in electrical conductivity values. The increase was more observed in the small-seeded genotypes than in large-seeded genotypes. Overall, this finding shows that genotypes with good seed quality had relatively small seed.

Key words: mung bean, seed viability, vigor, harvest stage, field weathering

INTRODUCTION

High quality of mung bean [*Vigna radiata* (L.) Wilczek] seed is difficult to produce in the humid tropical regions due to its susceptibility to field weathering damage. Deterioration of seed in the field prior to and after harvest is usually referred to as field weathering or as field deterioration. Field weathering taking place before harvest is also called pre-harvest weathering, whereas after harvest is called post-harvest weathering. Field weathering of seed is associated with unfavorable weather conditions and its occurrence was mainly due to moisture, in the form of high humidity and precipitation, and high temperature (TeKrony *et al.,* 1980).

Several workers have reported that seed attains its high potential quality at physiological maturity (maximum seed dry weight) (Andrews, 1966; Delouche, 1974). Unfortunately, due to high moisture content, the seed can not be harvested commercially at this growth stage and must remain in storage on the plant through a desiccation period. This period may vary from a few days to over three weeks before the seed reaches a harvestable moisture level (TeKrony et al., 1980). Meanwhile, when seed harvest is delayed beyond optimum maturity caused by wet field conditions, it extends exposure of mature seed to unfavorable conditions in the field and intensifies seed deterioration.

Studies on changes in seed quality due to field weathering after harvest maturity have been conducted in legume seeds. Marwanto (2003) and TeKrony *et al.* (1980) reported that soybean seed viability was maintained at a relatively high level for 14 days following harvest maturity, but seed vigor began to decline within a few days after harvest maturity stage. The similar result was also reported by Marwanto (2007) for mung beans. Instead of 14 days following harvest maturity, mung bean seeds maintained at high level after 21 days harvest maturity stage. He further reported that the different resistance in mung beans was associated with impermeable seed coat or hard seed character and lignin content in the seed coat. In addition to a decrease in seed vigor, seed deterioration was also associated with the progressive loss of membrane integrity (Marwanto, 2003; Ching and Schoolcraft, 1968).

Seed size also played a role on reducing deterioration when harvest was delayed (Dasson and Kueneman, 1984). They further reported that small-seeded genotypes were more resistant to post harvest weathering than large-seeded genotypes in soybeans. However, not all small-seeded lines were resistant to filed weathering.

As mentioned earlier that Marwanto (2007) has documented many instances of poor seed quality in mung bean seeds and strongly contends that adverse weather conditions following harvest maturity stage caused moderate to severe seed quality problems. However, studies on the changes in seed quality of different mung bean genotypes harvested at different maturity stages and pod position due to unfavorable climatic conditions prior to harvest maturity and the role of seed coat characteristics were limited. The objective of this study was to determine the effect seed characteristics on mung bean seed quality due to field weathering during the seed maturity and to relate the seed characteristics on seed quality indicators.

MATERIALS AND METHODS

Seeds of four mung bean genotypes representing different types of seed coats were used in these studies. 'Bhakti' was classified as small seed and slow imbiber, 'Betet' was small seed and rapid imbiber, 'Merak' was large seed and slow imbiber, and 'IPB.M/97-13-60' was large seed and rapid imbiber. Their seed characteristics are given in Table 1. The seeds were planted in research plots at Agriculture Faculty, Bengkulu University on April 10, 2007 in a split-plot arrangement, with harvest stages as main plots, genotypes as subplots and pod position as sub-subplots with three replications. Each genotype was planted in a plot consisting of a single raised bed, 65 cm wide and 4 meters long. Two rows were planted per bed. Row spacing was 35 cm between rows within beds and 65 cm between beds. Seeds were planted in hills 20 cm apart with 3-4 seeds per hill. N, P, and K fertilizer at a rate of 100, 30 and 80 kg ha^{-1} was applied prior to planting.

At maturity stages R7, R7.5, R8, and seven days after R8 (harvest maturity=HM), the seeds from each genotype were harvested for quality evaluation by hand picking of the pods. Reproductive stage was determined as described by Fehr and Caviness (1977) for soybean. Reproductive stage R7 (physiological maturity) was attained when about 90% of the pods were green but before they had turned brown. Reproductive stage R7.5 was attained when about 50% of the pods were mature color. Reproductive stage R8 was attained when about 90% of the pods were black. HM was seven days after R8. For seed quality evaluation, 50 mature pods were picked from each treatment-replicate.

At each harvest the top 50% of the pods bearing nodes were separated from the bottom 50%. Then, they were dried with heated air (<35°C) to reduce moisture content to 10-12% for threshing. The dried pods contained in jute bags were threshed by flailing and the seeds were separated from the pod walls and another plant parts by sieving. Sieving (round hole) was used to eliminate the small, immature and insect damaged seeds.

The time of occurrence of physiological maturity was determined by harvesting 25 pods at approximately daily intervals 1 week before the stage was attained and measuring the seed moisture content and weight per seed.

Seed quality evaluation of each genotype harvested at each maturity stage included seed moisture content, viability and vigor.

Table 1. Selected mung bean genotypes used in this study with their lignin content expressed as % ADL (acid delinted lignin), seed coat permeability (P) and seed weight..

Genotipe	Lignin content (%ADL)	P ($g\ g^{-1}\ hr^{-1}$)	100-seed weight* (g)
Bhakti	0,070	0,008	4,34
Betet	0,054	0,071	3,82
Merak	0,070	0,013	6,64
IPN.M/97-13-60	0,042	0,056	6,27

* Weight in grams of 100 seeds at 12% moisture

Table 2. Temperature (temp.), rainfall and relative humidity (RH) collected from Pulau Bai Weather Station, Bengkulu from May 20 to July 2 2007

Date	Weather Condition			Date	Weather Conditions		
	Temp, (°C)	Rainfall (mm)	RH (%)		Temp, (°C)	Rainfall (mm)	RH (%)
May 20	27,2	0[y]	81	June 11	27,0	0	81
May 21	26,4	0	83	June 12	27,1	0	84
May 22	26,3	trace	90	June 13***	27,0	0	88
May 23	27,1	0	90	June 14	26,0	5	84
May 24	26,9	0	89	June 15	26,8	0	89
May 25*	27,3	0	86	June 16	26.4	2	94
May 26	27,1	0	86	June 17	23,1	8	82
May 27	26,2	0	83	June 18***	25,8	0	82
May 28	26,1	0	84	June 19	31,8	13	82
May 29	26,4	0	85	June 20	26,9	9	76
May 30*	26,9	0	90	June 21****	26,8	8	80
May 31	26,7	0	90	June 22	25,9	25	80
June 1	27,3	0	83	June 23	25,5	27	81
June 2	26,8	0	85	June 24	26,2	3	85
June 3	26,8	0	84	June 25****	27,0	0	82
June 4**	26,6	3	88	June 26	27,2	0	87
June 5	25,4	0	91	June 27	25,9	0	81
June 6	26,4	8	86	June 28	27,0	0	86
June 7	25,7	8	87	June 29	26,8	0	82
June 8	26,4	8	87	June 30	26,5	0	82
June 9**	26,5	0	83	Juli 1	27,0	0	85
June 10	26,5	0	83	Juli 2	28,0	0	84

[x]: trace means rainfall less than 1 mm; [y]: 0 means no raifall; *: first harvest date; **, second harvest date; ***, third harvest date****, fourth harvest date

Seed moisture was determined on seed fraction of the mung bean sample. Samples of about 20 g in duplicate from each treatment-replicate were placed in an oven at 105 °C for 24 hours to obtain dry weight and determine the amount of moisture lost. Seed moisture content was calculated on a wet weight basis and expressed in %.

Seed viability was determined by the standard germination test. In this test, 50 seeds from each treatment-replicate were placed on mosit paper towels, which were rolled and placed inside plastic bags and kept at a room temperature. Germinated seeds were counted aftar 5 and 8 days. Dead seeds were removed after 5 days, while hard seeds after 8 days and counted with germinated seeds. The number of germinated seeds was expressed as a percentage of the total.

Seed vigor was determined by the accelerated aging test. In this test, 50 seeds from each treatment-replicate were subjected to a period of accelerated aging, 42 °C and near 100% RH, for 48 hours prior to standard germination test. They were placed on a wire mesh tray of 20X5X2.5cm. The tray was placed inside a plastic box of 30x10x5cm and the box was filled with

100 mL of water. A 10-mm gap was maintained between the water surface and the seed tray. The box was covered with airtight lid and kept in oven at 42 °C for 48 hours. After aging, seeds were taken out of the aging box and subjected to standard germination test as previously described. The result of the test was expressed as accelerated aging germination (AAG).

In electrical conductivity test, a weighed sample of twenty five seeds were soaked in 40 ml distilled water for 12 hours at a room temperature. The electrical conductivity (EC) of seed leachate was determined with a Cole-Parmer conductivitimeter (Chicago, Illinois) and was expressed in mmhos cm^{-1} g^{-1}.

The seed coat lignin content expressed as % ADL (Acid Delinted Lignin) was determined using 1.0 g of seed coat tissue for each genotype by the sulphuric oxidation method (Van Soest and Wine, 1968).

To determine permeability of seed for each genotype, one set of two replicates of 10 g of seed was randomly drawn from seed fraction of the mung bean sample. Initial seed moisture content of each genotype was adjusted to about 10%. Permeability of seed was determined following 2 hours of submersion in deionized water and expressed in g g^{-1} h^{-1}.

Analysis of variance of each variable except seed moisture was conducted as a split plot design. When significant differences were revealed by use of the F test, comparisons of the means involved were made, using the Duncan's Multiple Range Test (DMRT) at the 0.05 level of probability. Correlation analysis was also used to determine the association between seed coat characteristics and seed quality indicators.

RESULTS AND DISCUSSION

Harvest schedule presented in Table 2 showed that genotypes of Bhakti and Betet reached harvest maturity stage at the same time on May 25, 2007, 5 days earlier than those of Merak and IPB.M/97-13-60. Loss of seed due to shaterring problem occurred for all genotypes when pods were scheduled for the third harvest, but not for the first and second harvest. Less rainfall and high temperature a few days before the third harvest period were probably responsible for shaterring problem to occur.

Climatological data presented in Table 2 also showed that almost no rainfall occurred several days before all genotypes reached harvest maturity stage although at this period daily average temperatures and relative humidity were above 26°C and 85%, respectively. Less rainfall during this seed maturation was probably responsible for almost maximum level of seed vigor of all genotypes.

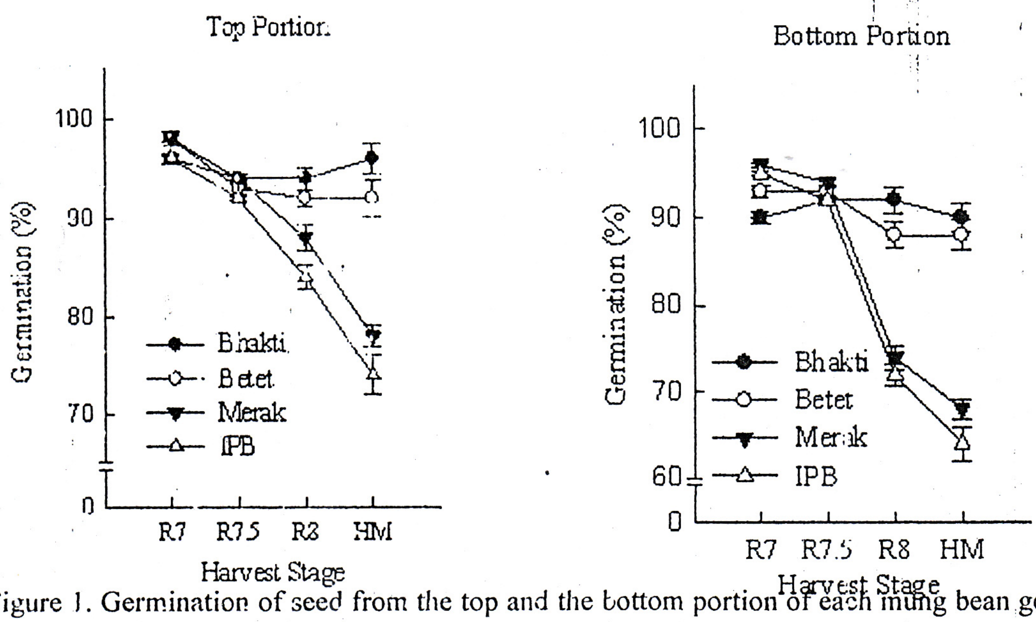

Figure 1. Germination of seed from the top and the bottom portion of each mung bean genotype at reproductive stage R7, R7.5, R8 and M. Vertical bars represent standar error at each stage

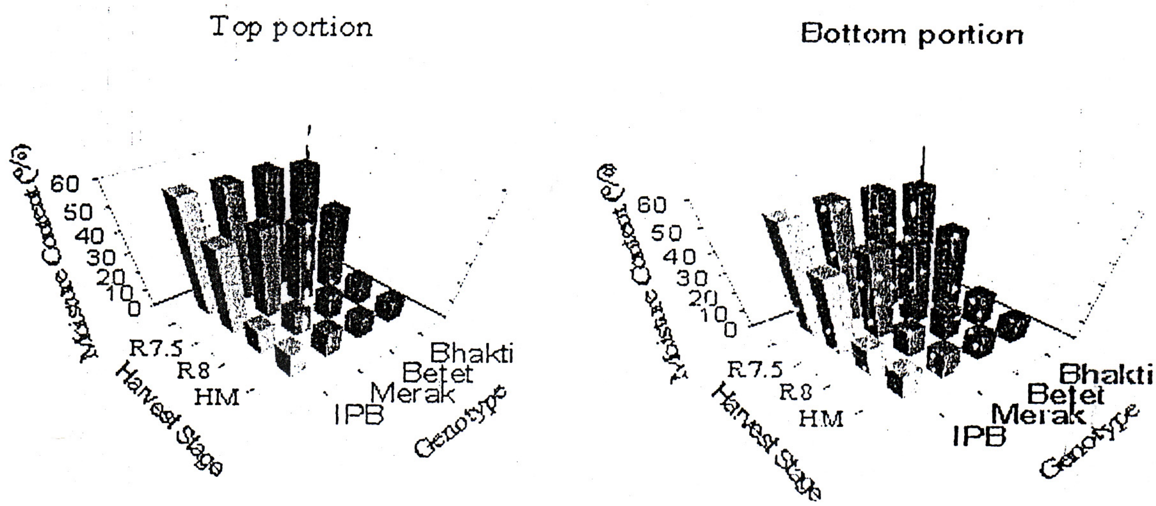

Figure 2. Moisture content of different mung bean seeds from top and bottom portions harvested at different maturity stages

Table 3. Correlation coefficients between seed characteristis and seed quality indicators from the top and the bottom plant portion across seed type and harvest stages

Correlated characters	Plant portion Top	Bottom
Seed germination vs.		
Seed size	-0,670**	-0.61**
Seed coat permeability	-0.258	-0.215
Lignin content of seed coat	-0.253	-0.204
Accelerated aging germination vs.		
Seed size	-0.691**	-0.515*
Seed coat permeability	-0.183	-0.147
Lignin content of seed coat	-0.156	-0.123
Electrolyte conductivity vs.		
Seed size	-0.552*	-0.515*
Seed coat permeability	-0.253	-0.147
Lignin content of seed coat	-0.214	-0.123

*, ** indicate significate at the 5% and 1% leveles, respectively

Seed germination was reduced at a different rate depending on genotypes and plant portions as harvest stage was proceeded (Figure 1). It was the highest at R7 for all genotypes and for all plant portion and there was only a little change in viability between R7, R7.5, R8 and HM for seeds of Bhakti and Betet. Seeds of Bhakti and Betet from the top and the bottom portions maintained their germination throughout the harvest stage. Their standard germination ranged from 88 – 98% across the harvest stage. Their superior resistance to field weathering was due to their smaller seed size. Table 3 showed that seed germination was significantly and negatively correlated with seed size. However, there was a substantial decrease in germination of seed of Merak followed by seed of IPB.M/97-13-60 at R8 and HM. The decrease was more obvious in seed of IPB.M/97-13-60 than that of Merak and in seed from the bottom than from the top portion. A similar decrease in seed germination associated with field weathering was also reported by Marwanto (2003) in soybean and Marwanto (2007) in mung bean.

As mentioned before that seed harvested at maturity stages R7, R7.5, and R8 were not significantly different in quality for each genotype from the top portion as reflected by seed germination. However, when harvest was conducted at 1 week after R8, their seed germination markedly declined. This suggests that seed can only be harvested between R7, R7.5, and R8 for each genotype. Unfortunately, due to high moisture the seed can not be harvested at R7 and R7.5. At R7, seed moisture for all cultivars was higher than 50% and at R7.5 was more than 40% except for Bhakti (Figure 2). At R8, seed for all genotypes had reached a harvestable moisture level (13-15%).

In addition to seed viability, seed vigor was also significantly reduced as indicated by reducing AAG and and increasing EC due to field weathering. Many reseachers agreed that the decline in seed vigor with advancing maturity was due to high temperature and humidity (Dassou and Kueneman, 1984). In this study, the decline in seed vigor as reflected by a decrease in accelerated aging germination and an increase in seed leachate conductivity was also due to high temperature and humidity during maturity stages. The mean air temperature and humidity during this period was above 26°C and 85%, respectively (Table 2).

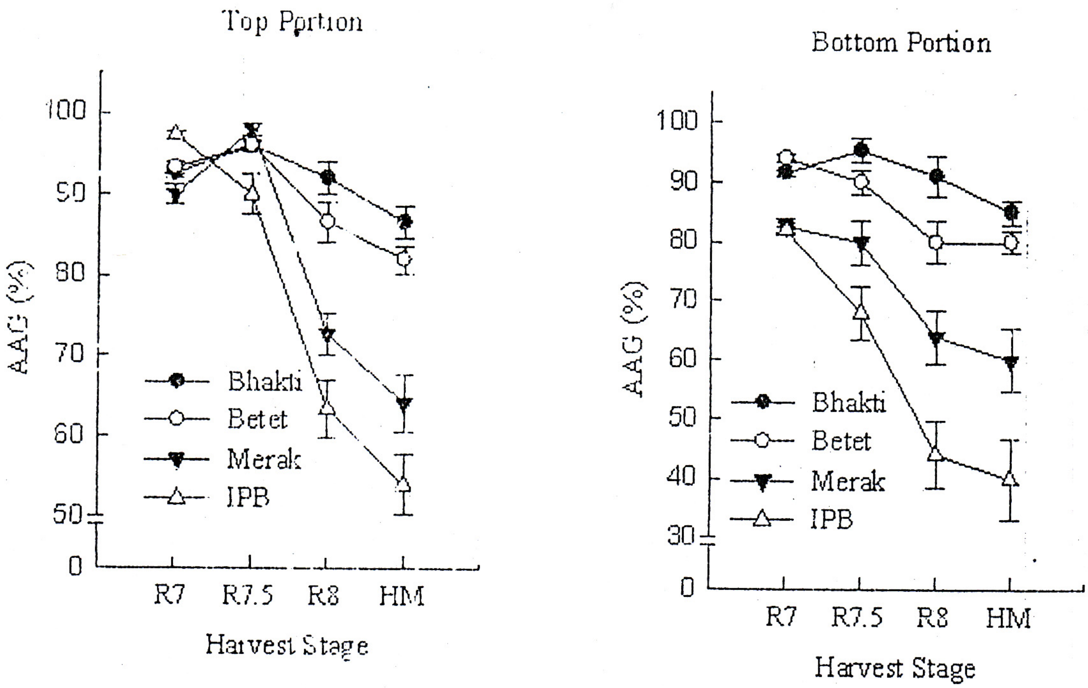

Figure 3. Accelerated aging germination of seed from te top and the bottom portion of each mung bean genotype at reproductive stage R7, R7.5, R8 and HM. Vertical bars represent standard error at each stage

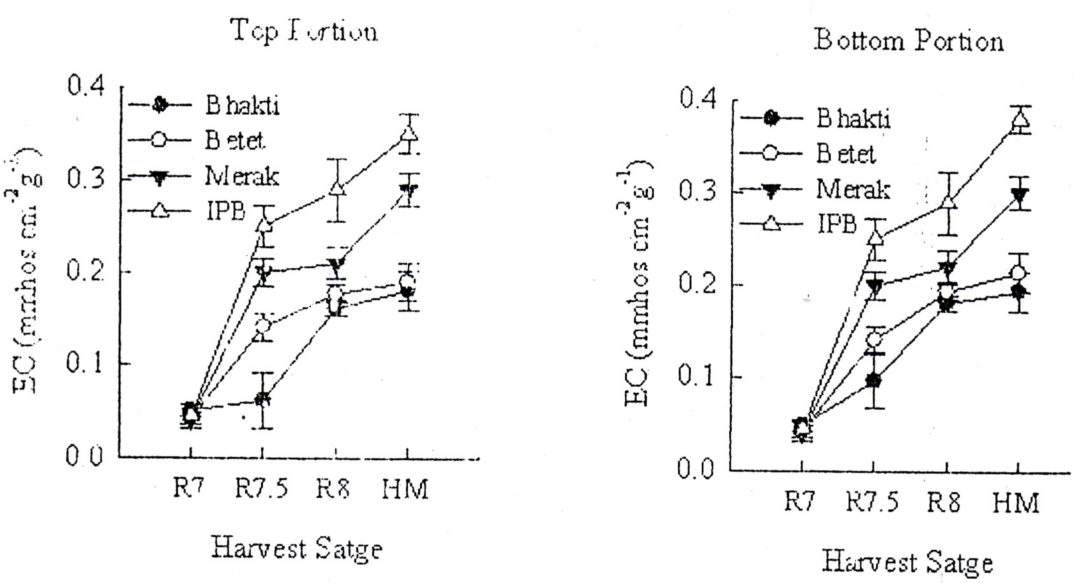

Figure 4. Electrolyte conductivity of seed from the top and the bottom portion of each mung bean genotype at reproductive stage R7, R7.5, R8 and HM. Vertical bars represent standard error at each stage

The decline in AAG was more obvious in seeds of Merak and IPB.M/97-13-60 than in those of Bhakti and Betet and on the bottom portion than on the top portion (Figure 3). AAG of seed of Bhakti and Betet did not fall below 85% at any stages. These results indicated that seed size rather than seed coat permeability or lignin content of seed coat played a role in resistance to field weathering. Table 3 showed that AAG was significantly and negatively correlated with seed size. The similar results were also reported by Dassou and Kueneman (1984) for soybean.

The superior resistance of small-seeded genotypes such as Bhakti and Betet than large-seeded genotypes such as Merak and IPB.M/97-13-60 to field weathering as reflected by AAG was probably related to an increase in number of hard seeds with advanced maturity (Marwanto, 2007). AAG for the top portion of all genotypes was higher than that for the bottom portion. The difference in seed vigor between the top and bottom portions were also supported by several reports (Adams *et al.*, 1989).

EC for all genotypes and for plant portions increased with advanced maturity (Figure 4). The similar results were also reported by Marwanto (2003) for soybean and Marwanto (2007) for mung beans. Seeds of Bhakti and Betet had EC values lower than those of Merak and IPB.M/97-13-60 at most stages. The lower increase in conductvity of seed leachate for Bhakti and Betet was due to their smaller seed size and an increase in number of hard seed with advanced maturity. Table 3 showed that EC was negatively correlated with seed size.

CONCLUSIONS

Field weathering prior to harvest maturity resulted in lowering mung bean seed germination, AAG and an increase in EC especially for seeds from the bottom portion. Seed characteristics affected the three seed indicators. Small-seeded genotypes exhibited greater resistance to field weathering than large-seeded genotypes. Seed coat permeability and lignin content of seed coat had minimal influence on seed quality.

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