GENOTYPIC DIFFERENCES IN SOYBEAN SEEDS FOR RESISTANCE TO FIELD DETERIORATION : II. THE ROLE OF SEED COAT CHARACTERISTICS

KERAGAMAN RESISTENSI BEBERAPA GENOTIPE BENIH KEDELAI TERHADAP DERAAN CUACA: II. PERANAN KARAKTERISTIK KULIT BENIH

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ABSTRACT

Few studies have been considered the role of seed coat characteristics on resistance to preharvest deterioration. The objective of the study was to relate soybean seed coat characteristics with resistance to weathering. Eleven soybean genotypes were grown on November 2000 at the Agriculture Faculty Experimental Farm Bengkulu in a randomized complete block with three replications and subjected to (1) incubator weathering, (2) field weathering, (3) wet-bag weathering, and (4) unweathered seed as a control. Across black and yellow seeded genotypes, soybean with black seed coat showed less susceptible to all weathering treatments than that with yellow seed coat. Germination of all black seeded genotypes following incubator weathering was above 50% and remained above 50% after accelerated aging except for Merapi. Not all yellow seeded genotypes were susceptible to incubator weathering. There was a yellow seeded genotype such as Lumajang Brewok showing resistant to this stress. Germination, germination after accelerated aging and electrical conductivity following all weathering stresses were significantly correlated with lignin content in the seed coat except for germination following field weathering. The correlation coeffcients [r] ranged from 0.07 to 0.89 for germination, from 0.40 to 0.77 for germination after accelerated aging, and from -0.66 to -0.82 for electrical conductivity. Overall, genotypic differences in resistance to preharvest deterioration were influenced by seed coat color and seed coat lignin content.

Keywords : soybean, lignin, seed coat, field weathering

ABSTRAK

Kemunduran mutu benih kedelai dapat terjadi sewaktu masih di lapangan sebelum dipanen. Tujuan penelitian ini adalah untuk menghubungkan sifat khusus kulit benih kedelai dengan ketahanan terhadap deraan cuaca. Sebelas genotipe kedelai ditanam di kebun percobaan Fakultas Pertanian Bengkulu pada bulan November 2000 dalam rancangan acak kelompok lengkap dengan tiga ulangan dan diperlakukan dengan (1) *incubator weathering* (*IW*), (2) *field weathering* (*FW*), (3) *wet-bag weathering* (*WBW*), dan (4) tanpa penderaan sebagai kontrolnya. Benih berkulit hitam lebih tahan terhadap deraan cuaca daripada benih berkulit kuning. Setelah IW, daya kecambah (DK) semua benih berkulit hitam lebih dari 50% dan tetap lebih besar dari 50% setelah penuaan dipercepat kecuali Merapi. Semua genotipe berkulit kuning rentan terhadap deraan cuaca kecuali Lumajang Brewok. Genotipe ini tetap memiliki DK dan daya kecambah setelah penuaan dipercepat (DKSPD) lebih dari 50%. DK, DKSPD dan daya hantar listrik (DHL) pada semua deraan cuaca memiliki hubungan yang erat dengan kandungan lignin dalam kulit benih kecuali DK setelah FW. Koefisien korelasinya berkisar antara 0,07-0,89 untuk DK, 0,40-0,77 untuk DKSPD, dan –0,66 - -0,82 untuk DHL. Dengan demikian, keragaman resistensi benih kedelai terhadap deraan cuaca dipengaruhi oleh warna kulit benih maupun kandungan lignin dalam kulit benihnya.

Kata kunci: kedelai, lignin, kulit benih, deraan cuaca

INTRODUCTION

Humid, tropical environments are con-ucive to seed deterioration and make the production of high quality soybean [*Glycine max* (L.) Merrill] seed difficult. Deterioration of seed in the field prior to harvest is usually referred to as field weathering or as field deterioration.

Several studies indicated that high temperature, humidity and precipitation play a critical role on field weathering. (Keigly and Mullen, 1986; TeKrony *et al*., 1980).

Genotypic differences in resistance to field weathering have been reported (Dassou and Kueneman, 1984; Marwanto, 2003b; Paschall and Ellis, 1978). The tolerance has been assoiated with seed coat characteristics (Horlings *et al*., 1991). Dassou and Kueneman (1984) conluded that black-seeded genotypes were more resistant to weathering than yellow-seeded genotypes. In the same study, Dassou and Kueneman (1984) reported that seed coat permeability plays an important role on resistance to weathering.

Other reports concluded that the lignin content in the seed coat has been reported to be related to impermeability of soybean seeds of certain genotypes (McDougall *et al*., 1996; Tavares *et al*., 1987). They also stated that it occurrence exerts an important effect on the capacity and velocity of water absorption throughout the seed coat, leading to the hyphothesis that the higher the lignin content of the seed coat, the lower the seed coat permeability and consequently the more resistance of the genotypes to weathering.

Few studies have been considered the role of seed coat characteristics on resistance to weathering. The objective of the study was to relate soybean seed coat characteristics with resistance to weathering.

METHODOLOGY

Eleven soybean genotypes consisting 5 black and 6 yellow seeded genotypes (Table 1) were grown on November 2000 at the Agriculture Faculty Experimental Farm in a randomized complete block with three replications. Each genotype was planted in a single row 20m long with 1m between rows and 20cm between plants within a row and subjected to the following weathering treatments:

(1) incubator weathering. In this treatment, pods were hand harvested at physiological maturity (Fehr and Caviness, 1977) and subjected to 30 ^{0}C and 90% relative humidity for 10 days.
(2) field weathering. In this treatment, seeds were left in the field for 10 days after harvest maturity.
(3) wet-bag weathering In this treatment, pods harvested at physiological maturity were loosely wrapped with a moist paper towel. These pods were placed inside a plastic bag and sealed for 10 days.
(4) As a control, pods harvested at physiological maturity were air dried for 10 days.

Table 1. Soybean genotypes, with their seed coat characteristics used in this study

Genotype	Seed Coat Color	100-Seed Weight (g)	Lignin Content (%ADL)
Kalitur	Black	8.44	23.12 a
B-3468	Black	10.12	17.29 b
B-3618	Black	9.19	16.92 b
B-3770	Black	8.57	16.83 b
Merapi	Black	8.01	15.40 b
L.Batang	Yellow-green	8.65	1.43 c
Meratus	Yellow	10.59	1.36 c
Lokon	Yellow	11.29	1.26 c
Galunggung	Yellow	13.10	0.97 c
L.Brewok	Yellow	7.78	0.95 c
Malabar	Yellow	10.57	0.83 c

To determine the effect of the weathering treatments on seed quality, seeds of all treatments were evaluated for viability by standard germination test, vigor by accelerated aging test, and leachate conductivity by electrical conductivity test.

In standard germination test, fifty seeds from each replication were place on moist paper towels which were rolled and palced inside plastic bags and kept at a room temperature. Germination seeds were counted after 4 and 7 days. The number of germinated seeds were expressed as a percentage of the total.

In accelerated aging test, seeds were subjected to a period of accelerated aging, 42 ^{0}C and near 100% RH, for 48 hours prior to standard germination test. Fifty seeds from each replication were placed on a wire mesh tray of 20 cm x 5 cm x 2.5cm. The tray was placed inside a plastic box of 30 cm x 10 cm x 5 cm 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 ^{0}C for 48 hours. After aging, seeds were taken out of the aging box and subjected to standard germination test.

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

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

Analysis of variance of each variable was conducted as a randomized complete block design.The means were separated by Duncan Multiple Range Test at the 0.05 level of probability. Regression analysis between germination, germination after accelerated aging and electrical conductivity following all weathering treatments and percent lignin content of the seed coat of the tested genotypes was determined.

RESULTS AND DISCUSSION

Previous study reported that genotypic differences in resistance to all weathering treatments were observed, as reflected by germination, germination after accelerated aging, and electrical conductivity of seed leachate (Marwanto, 2003b). Further study reported in this paper indicated that there was a close association between resistance to preharvest deterioration of seed with seed coat characteristics.

Across five black and six yellow seeded genotypes, the black seed type consistently exhibited a greater resistance to all weathering treatments than the yellow seed type, as shown by higher mean germination and germination after accelerated aging and lower mean value of electrical conductivity (Table 2). This is in agreement with the results reported by Dassou and Kueneman (1984) and Starzinger and West (1982). The difference in the mean values of the three seed quality indicators between black and yellow seed types was significant for all weathering treatments. Extreme seed deterioration of the yellow seed type occurred following wet-bag weathering and it was more observed on germination after accelerated aging. Due to severe seed deterioration, all seeds of the yellow seed type lost their germinability after accelerated aging. While the yellow seed type was more susceptible to the weathering stresses, there were genotypic differences among black-seeded genotypes following incubator weathering (Marwanto,2003b). With this weathering treatment, black-seeded genotypes identified as resistant types were Merapi, Kalitur, B-3468, B-3770, and B-3618 based on germination and Kalitur, B-3468, B-3770, and B-3618 based on germination after accelerated aging, respectively. Their germination remained above 50% for all black-seeded genotypes and their germination after accelerated aging was also above 50% except Merapi. The two seed quality indicators declined far below 50% for all yellow-seeded genotype except Lumajang Brewok. This genotype was superior to some black seeded genotypes such as Merapi, Kalitur, B-3468, and B-3770 based on germination and such as Kalitur based on germination after accelerated aging. The resistance exhibited by this genotype was possibly due to its small seed size (Table 1). It was clear that not all yellow-seeded genotypes were susceptible to incubator weathering, indicating that seed coat color was not the only seed characteristic to be involved in preharvest deterioration resistance mechanism in soybeam seed.

In addition to seed coat color, seed coat lignin content also involved in protecting soybean seeds from preharvest deterioration. Regression analysis produced a significantly high correlation between resistane of soybean seeds to all weathering treatments as reflected by germination, germination after accelerated aging, and electrical conductivity with the lignin content in the seed coat except for germination following field weathering (Table 3). Germination as well as germination after accelerated aging was positively correlated (r = 0.07 to 0.89) for germination and r = 0.40 to 0.77 for germination after accelerated aging) with lignin content, thus establishing positive influence of lignin content on maintaining seed viability and seed vigor prior to harvest. Meanwhile, an inverse relationship was observed between the electrical conductivity of the solution of soaking soybean seeds for all weathering treatments and lignin content (r = -0.66 to –0.82); the lower the lignin content in the seed coat, the higher the values of the electrical conductivity. Thus, lignin content in the seed coat contributed to genotypic variability in resistance to preharvest deterioration through controlling membrane deterioration.

Previous study indicated that significant variation in lignin content was found among soybean genotypes (Marwanto, 2003a). The same result was also reported by Alvares *et al.* (1997) for different soybean genotypes. Among the genotypes, the black-seeded genotypes exhibited a significantly higher lignin content than the yellow-seeded genotypes. The mean lignin content across five black-seeded geno-types was 17.91%, while across six yellow-seeded genotypes was 1.13% (Table 1). There-fore, the greater resistance of black-seeded ge-notypes to preharvest deterioration than that of yellow-seeded genotypes may have been due to higher seed coat lignin content. In addition, the black-seeded genotypes may gain their pro-tection from preharvest deterioration since lig-nin in the seed coat has impermeabilization characteristics and exerts an important effect on the capacity and velocity of absorption of water throughout the seed coat (McDouall *et al.*, 1997). The reason was also supported by Marwanto (2003a) who was able to demonstrate an inverse relationship between seed coat per-meability and seed coat lignin content.

Table 2. Mean germination (germ), germination after accelerated aging (AAG), and electrical conductivity (EC)) average across black and yellow genotypes following 4 weathering treatments.

Weathering	Seed Coat Color	Seed Quality Indicators		
		Germ (%)	AAG (%)	EC (mmhos cm^{-1} g^{-1})
Unweathered	Black	80.1 a	63.3 a	0.329 b
	Yellow	75.4 a	43.2 b	0.497 a
Incubator	Black	66.94 a	55.34 a	0.409 b
	Yellow	31.43 b	27.88 b	0.815 a
Field	Black	74.26 a	63.24 a	0.319 b
	Yellow	67.98 a	42.45 b	0.444 a
Wet-Bag	Black	49.2 a	22.5 a	0.843 b
	Yellow	6.9 b	0.0 b	2.273 a

Means within the same weathering treatment and the same seed quality indicator not sharing a letter in common differ significantly at the 0.05 level of probability.

Table 3. The 5 genotypes with the best resistance to incubator weathering as reflected by germination (germ), germination after accelerated aging (AAG), and electrical conductivity (EC)

Genotype	Seed Coat Color	Seed Quality Indicators		
		Germ (%)	AAG (%)	EC (mmhos cm^{-1} g^{-1})
Kalitur	Black	72.7	88.0 (9.43)	0.375
B-3468	Black	68.0	62.7 (7.98)	0.335
B-3618	Black	54.0	52.0 (7.27)	0.513
B-3770	Black	62.7	54.0 (7.42)	0.570
L. Brewok	Yellow	62.0	63.3 (8.00)	0.874
LSD 0.05		11.4	(1.30)	0.283

( ): transformed data

Table 4. Regression equations and correlation coeffcients for the relationship between germination (Germ), germination after accelerated aging (AAG), and electrical conductivity (EC) for three weathering treatments conducted on 11 soybean genotypes.

Trait	Regression Equation	Correlation Coefficient
	Incubator Weathering	
Germ	Y = 27.80 + 2.14X	0.82**
AAG	Y = 23.85 + 1.89X	0.64*
EC	Y = 0.83 – 0.02X	-0.82**
	Field Weathering	
Germ	Y = 69.47 + 0.15X	0.07
AAG	Y = 41.96 + 1.11X	0.40*
EC	Y = 0.46 – 0.01X	-0.66*
	Wet-Bag Weathering	
Germ	Y = 5.91 + 2.34X	0.89**
AAG	Y = -0.17 + 1.19X	0.77**
EC	Y = 2.35 – 0.09X	-0.74**

*, ** Significant at the 5 and 1% level of probability, respectively

CONCLUSIONS

The results indicate that black and yellow soybean seed types differred significantly in their resistance to preharvest deterioration. Most black-seeded genotypes were generally superior to yellow-seeded genotypes in resistance to incubator weathering. However, not all yellow-seeded genotypes were susceptible to this weathering stress. There was a yellow seeded genotype with small seed size such as Lumajang Brewok showing higher resistant than some black seeded genotypes. This suggests that the color of seed coat was not the only mechanism of resistance. Germination, germination after accelerated aging, and electrical conductivy was significantly correlated with seed coat lignin content. It suggests that seed coat lignin content had posstive effects on the tolerance of seed for all weathering treatments. Therefore, it could be used as a biochemical parameter for developing improved cultivars with the potential for maintaining good seed quality during weathering.

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