Effect of harvesting time on seeds acceleration ageing, electric conductivity and storability of black soybean (*Glycine max L.*) genotypes.

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ABSTRACT This study aim to correlate between nine black soybean genotypes and three harvesting time on seeds acceleration ageing , electric conductivity and storability in two seasons. The experiment was conducted at UNPAD university top farm Indonesia from December 2015 - April 2016 and April – July 2016 .The treatments were nine black soybean genotypes (KA6, KH4, CK5, KA2, KA3, DETAM1, KBI, CK6 and CIKURAY) and three harvesting times (H1= first, H2= second and H3= third harvesting time) with three replications in (RCBD) design. The parameters measure were seeds acceleration ageing, seeds germination and electric conductivity before and after storage. The results showed in wet and dry seasons significant different between genotypes and three harvesting time on acceleration aging . In wet and dry season electric conductivity at harvesting time and after storage 90 days showed significant difference between genotypes. For three harvesting times in wet and dry season at harvesting time and after storage for` 90 days the results revealed no significant difference.

Key word: Black soybean, Genotypes, harvesting times, acceleration ageing, Electric conductivity and storability.

1. INTERDUCTION

The genetic diversity is a key component of any agricultural yield system. The material from the diverse geographical origin of the crop species can help to ensure conservation of co-adapted gene complexes (Frankel *et al*., 1995). Individual soybean genotypes often show restricted adaptation to specific agro-climatic environments (Dlamini, 2015). Environmental stress conditions have been shown to alter yield components and protein expression patterns in crop species (Mohamedahmed *et al*., 2024). The application of genetic variation can also be manipulated either for selecting superior genotypes or to be utilized as parents for the development of future cultivars through hybridization. Genetic improvements could be accelerated if physiological attributes were used as selection criteria (Khan *et al*., 2011). However, information about late sowing in southwestern Japan is still limited. To select the most effective combination of growing season and cultivar, it is necessary to evaluate the growing season of new cultivars so as to achieve stable production of soybean (Yohei *et al*, 2018). Physiological maturity of seed is considered to occur when the seed has accumulated its maximum dry weight accumulation of seed dry weight and complete transition from green to yellow color. The percent moisture (wet-weight basis) of soybean seed at the maximum dry weight is variable, ranging from 50-62%. There have been multiple attempts to describe PM of soybeans and the developmental stage when it occurs. Determined PM by correlating it with qualitative characteristics was reached at the reproductive development stage R7, described as “pods yellowing” and “50% of yellow leaves yellow. One mature pod on the main stem was an acceptable indicatored of PM and found that seed moisture at PM ranged from 54-62% in soybeans. In the past, a common method for determination of PM of a single seed was to describe the seed as completely yellow, which was not useful for the determination of PM of the whole plant. The study of several visual indicators of PM determination concluded that results from their previous research proved to be a useful indicator in the determination of PM for a single plant or field population of soybeans. Change of color in the soybean hilum was found to characterize PM, similar to the presence of an abscission layer (black layer) in corn. The loss of green color from pods may be a useful tool for prompt determination of PM. Seed shrinkage may also be a useful indicator PM in soybeans because seed shrinkage occurred immediately following the loss of green color in seeds (Ennen, 2011). Under subtropical and tropical environments soybean seed (*Glycine max* (L.)Merrill) are harvested early to avoid deterioration from weathering. Careful after-harvest drying is required and is an important step in maintaining the physiological quality of the seed. Soybean seed should be harvested when the moisture content is in a range of 16-20%. Traditional drying utilizes a high-temperature air stream passed through the seed mass without dehumidification. The drying time is long because the system is inefficient and the high temperature increases the risk of thermal damage to the seed (Roberval *et al.*, 2004). New technology identified as heat pipe technology (HPT) is available and has the unique feature of removing the moisture from the air stream before it is passed through the seed mass at the same environmental temperature (Hurburgh, 2008).

Two studies were conducted to evaluate the performance of HPT for dry soybean seed. In the first study the seeds were dried from 17.5 to 11.1% in 2 hours and 29 minutes and in the second study the seeds were dried from 22.6 to 11.9% in 16 hours

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and 32 minutes. This drying process caused no reduction in seed quality as measured by the standard germination, tetrazolium-viability, accelerated aging and seedling vigor classification tests. It was also observed that there was a significant difference between hybrids and harvesting times. After the accelerated aging test (Konuşkan *et al.*,2021). It was concluded that the HPT system is a promising technology for drying soybean seed when efficiency and maintenance of physiological quality are desired (Krzyzanowski *et al.*,2006). There was a strong negative correlation between electrical conductivity and germination, showing a faster deterioration due to leakage of electrolytes (Chirchir *et al*.,2016). However, the highest EC depend on genotypes. Electrical Conductivity (EC) was also significantly influenced by the harvesting times (Konuşkan *et al.*,2021).

A soybean with both high yielding and high concentrations of desired seed quality components is an ideal cultivars (Mandi´c *et al.*,2020). On the other hand, seed conservation potential during storage is directly related to environmental conditions (mainly temperature and relative humidity) as pointed out by other researchers. Consequently, it is important that soybean seeds are stored at moderate temperatures and relative humidity below to 70% field-damaged soybean seeds stored at high moisture levels deteriorated even faster. Their oil presented high free fatty acid content, unpleasant flavor and high refining losses (Copeland and McDonald ., 2001). The higher the unsaturation degree of the fatty acids, the faster their concentrations were reduced. A high correlation between free fatty acid content and iron content was found in injured soybean seeds leading to poor quality refined oils. Oil acidity increase during storage was proportional to initial free fatty acid content (Shaban, 2013).

The closer to the ideal seed moisture content, the less triglyceride hydrolysis occurred in soybean during storage. Seeds stored at 13% moisture level prevented peroxide formation during 50 days. Based on these facts, this work was conducted aiming mainly to study the relationship between the time of harvesting and soybean storability, seeking to characterize the interaction between physiological and chemical manifestations of the deterioration process(Copeland and McDonald ., 2001). In the natural environment and when stored at ambient room conditions, seeds respond to constantly changing relative humidity and temperatures. Maintaining seeds under controlled conditions lowers metabolic activity, thereby reducing the aging process and increasing the longevity of the seed lot. For most seeds, a cool and dry environment is preferred and for orthodox seeds the cooler and drier the greater the longevity that can be achieved. Which one percent reduction in moisture content doubles the life of the seed and 10 degrees F reduction in temperature doubles the life of the seed (Gupta and Aneja, 2004).

Seed deteriorates through normal physiological reactions and changes that occur within the seed over time. These changes result in the accumulation of deleterious by-products that increase the seed's vulnerability to external challenges and decrease the ability of the seed to survive (Justice and Bass, 1978). According to Vertucci and Roos (1990), optimum protocols for seed storage must take into account the chemical composition of the seed, the physiological status of the seed, and the physical status of water within the seed.

In addition, it was concluded that the critical moisture content for storage for each seed lot would increase with decreasing storage temperature. The preservation of seed viability and quality in storage is an important trait both for food usage and for seed use. Generally, viability and quality of seeds gradually deteriorate after harvest, but the deterioration in long-term storage depends on the environment, biochemical, biological, and genetic factors. Changes characterized during the aging process in seeds include alterations in membrane protein composition, disruption of the nuclear envelope, protein degradation oxidative stress, and decreases in mRNA translation and DNA replication capabilities (De Castro *et al*., 1995 and Young,2017). Reduced levels of antioxidant enzymes such as superoxide dismutase, catalase, and ascorbate peroxidase can also lead to oxidative damage (Bailly *et al*.,1998).

For seed storage purposes, longevity is used synonymously with storability. To preserve the initial seed quality, seeds must be properly stored between the time of harvest and the planting of a subsequent crop. Delouche (1973) defined the total seed storage period as comprising segments of bulk storage, which is the period from harvest through packaging including conditioning. This study try to know the effect of three harvesting time on seeds acceleration ageing, electric conductivity and storability of black soybean genotypes.

2. MATERIALS AND METHODS

1.Time and Place Of The Experiments

The experiments were conducted at the station of experiment Padjadjaran University Ciparanje Jatinangor, Sumedang Regency, West Java Province. Location attitude of 720 m above sea level, with an average rainfall of 175.3 mm per month and daily temperature 23^{o}C. The experiment was conducted during December 2015 until march 2016. There were cultivate nine of soybean genotypes 1. KH 4. 2. KBI. CK 5. 4. CK 6. 5. KA 2. 6. KA 3. 7. KA 6. 8. CIKURAY. 9. DETAM 1. This experiment was arranged in randomise complete block design genotypes were main factors and subfactors three-time of harvesting H1 harvesting after 50 % physiological maturity when the pods beginning to change color from green to yellow, H2 harvesting after 50 % full change in color and H3 harvesting after 50 % the full maturity and the pods lost its moisture contents. Each plot consisting of 5 rows each of 300 cm in length and width 200 cm with a row to row distance 40 cm

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with 15 cm of plant space and the space between plots 100 cm. The crop was grown under Field conditions. Land was prepared manuals to make plots. Before hand sewing, pesticide powder was added in the holes. The irrigation depended on rain. Weeds control by manuals. Randomly selection plants for samples The samples hold to the green house for drying. Then storage in the storage room under 25 ^{o}C for 90 days.

2. Accelerated Ageing Test

The accelerated aging test was performed on 50 of seeds placed on a wire mesh screen and suspended over 40 ml of distilled water inside plastic boxes (15.0 × 11.0 × 6 cm), held at 41°C and near 100% air relative humidity for 72 h. After the aging period, seeds were tested for standard germination, and the number of normal seedling, five-day-old seedlings was evaluated. The germination was calculated as:

$$\mathbf{GP} = [\frac{\textit{total of normal seedling until last day count}}{\textit{total seeds}} \, x \, \mathbf{100}\,]$$

After final germination day, the lengths of germinated seedlings were measured (ISTA, 2008), at harvesting time and after 6 month in two seasons.

3. Electrical Conductivity (EC) before storage and after storage.

Three replications (50-seed)were weighed and immersed in 75 ml of deionizing water within glass cups and kept in a germinator at 25°C, during 24 h. After this period, EC was determined in the imbibitions solution with a conductivity meter .at harvesting time and after 6 month in two seasons.

4. Statistical Analysis

Analysis of variance (ANOVA) was carried out using SPSS package and means were separated by the least significant difference (LSD).

3. Results and discussions

1. Aceleration Aging in Two Season

In wet season the result showed significant different between genotypes. After acceleration aging by alcohol where high germination was KA3 94,00% and low was KA2 37,77%. The three harvesting times revealed significant difference where H1 76,44%, H2 80,37% and 68,22%. In wet season acceleration aging by alcohol test for vigor the result showed significant difference between genotypes where high vigor was KA3 9,12 and low KA2 3,77. For three harvesting times revealed significant difference between genotypes where H1 7,61, H2 8,01 and H3 6,73.

In dry season the result showed significant difference between genotypes. After acceleration aging by alcohol where high germination was KH4 87,77 % and low was KA2 54,88%. In three harvesting times revealed significant difference where H1 76,59%, H2 72,74% and 56,74%. In dry season acceleration aging by alcohol the result showed significant difference between genotypes where high vigor was KA3 7,91 and low was KA2 5,43. The three harvesting times revealed significant difference where H1 7,44, H2 7,08, and H3 5,53. Acceleration ageing in two season compereing between germination and vigor in Acceleration ageing in wet season was more better than in dry season but the genotypes showed more better in dry season (KA6, KA2, and cikuray) and seed longevity during stronger for long time due deterioration of this seeds in dry season emergence to environment during seeds harvesting Chirchir*et al*.,2016).

Table 1. Aceleration Aging in Two Season

Treatments	Wet Season (December 2015-March 2016)		Dry Season (April 2016-July 2016)	
	Germination (Aceleration	Vigor (Aceleration	Germination (Aceleration	Vigor (Aceleration

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	Aging)	Aging)	Aging)	Aging)
		Harvesting Time		
H_1	76,44c	7,61 b	76,59 b	7,44 b
H_2	80,37c	8,01 b	72,74 b	7,08 b
H_3	68,22d	6,73 a	56,74 a	5,53 a
CV	16,6%	16,6%	20%	10,28%
CV	16,8%	16,8%	29,3%	9,74%
		Genotype		
KA6	60,44 b	6,04 b	64,22 b	6,33 b
KH4	91,77 d	9,17 d	87,77 d	8,40 d
CK5	90,22 d	9,01 d	75,33 c	7,31 c
KA2	37,77 a	3,77 a	54,88 a	5,43 a
KA3	94,00 d	9,12 d	81,33 cd	7,91 cd
DETAM 1	73,11 c	7,26 c	63,11 b	6,11 ab
KBI	83,55 cd	8,35 cd	60,22 ab	5,91 ab
CK6	84,66 cd	8,44 cd	66,88 b	6,52 b
CIKURAY	59,55 b	5,94 b	64,44 b	6,23 b
CV	16,8%	16,8%	29,3%	9,74%

Note: same letter means did not have significant differet effect. Different letter means had significant effect.

2. Electric Conductivity in Two Season

In wet season electric conductivity at harvesting time the result showed that significant different between genotypes where high electric conductivity was CIKURAY 0,631 and low was CK6 0,477. In three harvesting times revealed no significant where H1 0,554, H2 0,559 and H3 0,550. In wet season electric conductivity after storage (90) days the result showed significant different between genotypes where high electric conductivity was KBI 0,803, and low was CK6 0,506. For three harvesting times the result showed no significant different where H1 0,658, H2 0,670 and H3 0,651.

In dry season at harvesting time electric conductivity showed significant different between genotypes where high was KBI 0,706 and low was CK5 0,495.

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For three harvesting times the result showed no significant different where H1 0,578, H2 0,569 and H3 0,574.

In dry season electric conductivity after storage (90) days the result showed significant different between genotypes where high was KBI 0,747 and low was CK5 0,557 and CK6 0,557. In three harvesting times there were no significant different where H1 0,652, H2 0,640 and H3 0,643. Compared with two season in electric conductivity between genotypes at harvesting time the result showed low leaching and after storage showed high leaching this due to storage and affected to seed membrane the result similar to (Roberval *at el.*,2004; Young,2017 and Chirchir*et al.*,2016).

Table 3 Electric Conductivity Before (EC.B.S) and After (EC.A.S) storage in Two seasons.

Treatments	Wet Season (December 2015-March 2016)		Dry Season (April 2016-July 2016)	
	EC B. S	ECA.S 90 days	EC B. S	EC A. S 90 days
	Harvesting Time			
H_1	0,554 d	0,658 d	0,578d	0,652 d
H_2	0,559 d	0,670 d	0,569d	0,640 d
H_3	0,550 d	0,651 d	0,574 d	0,643 d
CV	13,1%	15,8%	12,31%	9,7%
	Genotypes			
KA6	0,508 cd	0,613 bcd	0,504 d	0,620 bc
KH4	0,611 ab	0,668 bc	0,605 c	0,666 ab
CK5	0,481 d	0,541 d	0,463 d	0,557 cd
KA2	0,570 abc	0,598 cd	0,504 d	0,545 d
KA3	0,554 bc	0,698 abc	0,615c	0,681 ab
DETAM 1	0,544 bcd	0,718 ab	0,633 c	0,723ab
KBI	0,612 cd	0,803 d	0,706 c	0,747 a
CK6	0,477 a	0,506 a	0,495 a	0,557 cd
CIKURAY	0,631 a	0,790 d	0,633 b	0,707 ab
CV	11,7%	13,5%	7,7%	8,4%

Note: same letter means did not have significant differet effect. Different letter means had significant effect.

4. CONCLUSION

The result of three harvesting time in wet and dry season revealed significant different on seeds acceleration ageing for genotypes and three harvesting time. The second harvesting (H_2) Showed better Acceleration compared with $H_1$and H_3 in wet season but the first harvesting H_1 better than others harvesting time in dry season, the genotype which showed good acceleration ageing was KA3for wet season and KH4 in dry season. Electric conductivity at harvesting time and after storage in H_3 showed less electric conductivity so better than other harvesting time in spite the dry season H_2 referred better than H_1 and H_3 , the genotypes CK6 better than other genotypes on electric conductivity in wet season ,in dry season CK5 before storage and KA2 after storage.

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تاثير مواعيد الحصاد علي شيخوخة البذور والفيض الالكتروني وقابليتها للتخزين لطرز وراثية من فول الصويا الاسود (*Glycine max L.*)

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الخلاصة

تهدف هذه الدراسة لمعرفة الارتباط بين تسعة طرز وراثية من فول الصويا الاسود وثلاثة مواعيد حصاد علي شيخوخة البذور والفيض الالكتروني وتخزين البذور في موسمين. اجريت تجربة في مزرعة جامعة باجاجاران بدولة اندونيسيا في الفترة من ديسمبر ٢٠١٥ وحتي ابريل ٢٠١٦ ومن ابريل الي يوليو ٢٠١٦وكانت المعاملات تسعة طرز وراثية (KA6, KH4, CK5, KA2, KA3) ، DETAM1, KBI, CK6 and CIKURAY)وثلاثة مواعيد حصاد H1=)الاول و H2 =الثاني و H3=الثالث) وتم استخدام ثلاثة مكررات بتصميم الحزم المنشة. القياسات التي تم قياسها شيخوخة البذوروالانبات والفيض الالكتروني للبذور قبل وبعد التخزين. اظهرت النتائج وجود فروقات معنوية في شخوخة البذور للطرز الوراثية والثلاثة مواعيد حصاد للموسمين.في الموسم الرطب والجاف الفيض الالكتروني في وقت الحصاد وبعد التخزين ٩٠ يوم اوضحت النتائج وجود فروقات معنوية بين الطرز الوراثية. للثلاثة مواعيد حصاد في الموسم الرطب والجاف عند الحصاد وبعد التخزين ٩٠ يوم اشارت النتائج الي عدم وجود فروقات معنوية.