Effect of Harvest Time on Soybean Seed Quality of Detap-1 Variety

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Abstract. One of the factors responsible for the low soybean yield in Indonesia is low seed quality. Harvesting at the right time is an appropriate method for obtaining quality soybean seeds. Furthermore, harvest age can directly influence the physiological quality of seeds. This research aims to determine the effect of harvest time on the Detap-1 variety soybean seed quality. The experimental design was a randomized block (RBD) with variations in harvest time (R7, R8, R8 + 3, R8 + 6, R8 + 9, R8 + 12 days) as a factor. The observed data were then analyzed with the F test and the DNMRT test at a significance level of 5%. In addition, the variables observed were moisture content at harvest, seed germination and vigour, growth speed, the weight of 100 seeds and weight of seeds per pod. The results showed that the best quality seeds of soybean Detap-1 variety were obtained in the treatment where the harvest was in the R8 + 3-day phase.

Keywords: harvest time, soybean, seed, quality

1. Introduction

Soybeans are one of the most important food crops in the world mainly produced in the U.S. (36.7%), Brazil (31%), Argentina (16%), and China (4.8%) [1];[2]. Soybean seeds constitute a source of feed for livestock, oil for human consumption [3], and more recently, for biodiesel production [4];[5]. According to [6] and [7], soybeans play a role in nutrition for humans, livestock, industry and health, as they are rich in macro and microelements. Among other food crops, the highest soy protein content ranges between 30-50% [8]. Furthermore, they contain eight essential amino acids, namely: Isoleucine, Leucine, Lysine, Methionine, Phenylalanine, Threonine, Tryptophane, Valine [9].

In South Sulawesi, soybean production in 2015 reached 67,192 tons of dry beans, with a harvest area of 38.04 thousand ha and a productivity level of 17.67 quintals per hectare. However, it decreased in 2016 to 62,054 tons or around 7.65%. One of the efforts made to increase productivity involved the use of superior varieties (quality seeds) [10]. Seeds are the primary key to the success of plant cultivation [11] because they contain genetic information which determines the possible results of adaptation to environmental conditions and resistance to pests and diseases [12]. Generally, seeds of good quality produce better yields than the ones of low quality. The use of quality seeds is the most basic and cheapest among other methods of crop production. High-quality seeds possess the following features; (uniform size, good moisture content, and clean from dirt), genetic (high species purity), and physiological qualities (germination and vigour). The use of high-quality seeds help to produce an optimum plant population [13]. Furthermore, problems that need to be considered in the process of producing quality
seeds include the time of harvest. For seed production, harvest must be performed when seeds reach their peak condition in form of physiological maturity. This is because at that time the quality of seeds are at their best. Therefore they can grow and develop according to their potential (description) when planted in correlation with the appropriate environmental factors.

Harvest age directly affects the physiological quality of seeds. Harvesting should be performed on time because, in terms of maturity level, its timeliness is the first capital for the continuity of quality for future seeds. It should also be carried out when they reach physiological maturity because, after that, seed vigour will decrease [14]. The quality of soybean seeds will decrease if the harvest time is delayed. When seeds are harvested early, either they do not germinate, or the sprouts are less vigorous. Maximum seed vigour cannot be achieved when the seeds have not reached physiological maturity. However, in some plant species' seeds germinate before reaching the physiological maturity stage.

Superior varieties possess certain advantages compared to the local varieties. The benefits of these high yielding varieties include higher yield, shorter lifespan, more resistance to pests and plant diseases, and drought resistance. The superiority of the variety is accompanied by the high quality of the seeds. Quality seeds from high yielding varieties are one of the factors that determine high and low production levels. Other efforts can only have a maximum effect when accompanied by seeds from superior varieties [15]. Therefore, determining the right time to harvest is essential in producing quality seeds. This research aims to determine the effect of harvest time on the Detap-I variety soybean seed quality.

2. Materials and Methods

2.1. Time and Place of Research

Field research for seed production was carried out in Mangilu Village, Bungoro District, Pangkep Regency, from April to July 2019, while that of seed quality testing was performed at the Seed Technology Laboratory.

2.2. Tools and Materials

The tools used include a hoe, sickle, hand sprayer, sprout, Petri dishes, tweezers, a germinator, scissors, label paper, a scale, writing tools, and a camera. Furthermore, the materials used were Detap-I variety soybean seeds, liquid fertilizer, straw paper, plastic bags, bamboo stakes, and raffia.

2.3. Experimental design

This study used a randomized block design (RBD) with six harvest age treatments repeated four times to obtain 24 research units. The treatments tested involved one factor, specifically the age of harvest based on the physiological maturation, namely A = R7 (half of the plants had ripe pods), B = R8 (all pods were 100% ripe), C = R8 + 3 days, D = R8 + 6 days, E = R8 + 9 days, and F = R8 + 12 days.

2.4. Research implementation

Soil processing was carried out twice within one-week intervals. The plot was made with a 4 x 5 m while the spacing used was 40 cm x 20 cm. Planting was performed by drilling two seeds per hole at a depth of 3 cm. Watering was carried out daily until the plants were seven days old, after which the next watering was done once in three days to one week before harvest. Furthermore, Aphis pest control involved the use of Azodrin. Harvesting was based on the harvest time for each treatment. Testing of seed quality includes testing of physical (seed moisture content, seed weight of 100 seeds, seed weight per clump) and physiological qualities (germination capacity, seed vigour and growth rate). The germination test used the paper-to-paper test in a germinator (25°C), while the method for determining water content and germination followed the ISTA method, 2014[16]. In addition, the germination test was carried out using 400 seeds per lot, which were arranged in eight rolls of 50 seeds, using germination paper as a substrate and placed in a germinator at a temperature of 25 ± 2°C. The first evaluation was carried out on the fifth day, while the second was on the eighth day.
3. Results and Discussion

3.1. Physiological quality

3.1.1. Germination and Vigor of the Seed

The germination of seeds reflects the seeds that will germinate when planted, and subsequently grow into new plants. The higher the seed germination, the better the quality, as planting material and fewer seeds are required. Meanwhile, seed vigour denotes the seeds' ability to produce typical plants in an inadequate environment (suboptimum) and stored in suboptimal storage conditions [17]. Germination and seed vigour did not have a significant effect between treatments. Therefore, the germination rate and seed vigour were the same for each treatment. The highest germination capacity was observed in treatment R8 + 3, as well as the highest seed vigour, specifically 98.45% and 89.50% (Table 1). This signifies that the harvest time of R8 + 3 is the period when the maximum viability of a seed can be achieved.

The physiological qualities of seeds determine plant growth. A germination is a metabolic event that results in the embryo's development, and subsequently the origin of seedlings [18]. Germination can be determined by the emergence of seedlings in ideal planting conditions [18]. Furthermore, seeds with high vigour guarantee the development of normal and vigorous seedlings, as well as rapid and uniform emergence even in unfavourable climatic conditions [19][20]. Germination is considered the most critical phase due to its high vulnerability to climatic stresses [21]. The use of seeds with a high physiological quality assurance ensures the uniformity of growth and yield stability [22].

A seed shows an optimal germination capacity when harvested at physiological maturity. For soybean plants, physiological maturity is when the soybean pods are brown, dry (90-95%), and the seeds have hardened [23]. The maximum quality or physiological maturity occurs at the end of the filling period or sometime after the pod filling phase [24]. Furthermore, the seeds' quality begins to decline after reaching a maximum rate, causing delays in harvesting age. If the harvest is late, the seeds' quality deteriorates due to varying environmental conditions such as high temperature and rainfall, or pest and animal damage [25].

Physiologically ripe seeds have perfect food reserves (maximum) to support the growth of sprouts. Physiological maturity was reached before harvest time, and seed quality deterioration had not occurred. Overall, the harvest time caused the seed viability to increase as the average germination rate was more than 80%, although soybean was harvested during the R7 to R8 + 12 phase (Table 1). According to [26], plants adapt and experience physiological, morphological changes depending on their new environment. This follows the research of [27] on three soybean varieties that decreased their percentage germination alongside a delay in harvesting age and an increase in shelf life. The harvest at physiological maturity showed the highest percentage germination.

3.1.2. Growth Speed

The speed of growth shows the synchronization of seeds growing in the field, thereby facilitating crop management. The highest growth speed was achieved in the R8 + 3 harvest time treatment of 38.4% etnal1, while the lowest speed was obtained at the R7 harvest time treatment of 36.3% (Table 1). Meanwhile, the difference in the appearance of radicles and plumules in sprouts is closely related to seed growth strength. The seeds with the highest germinating strength and growth strength depend on the food reserves contained in the seeds [28]. The higher the seed vigour, the faster the seeds germinate. At physiological maturity, they have a maximum dry weight, causing sufficient food reserves to grow faster. The physiological pre-maturity period has a low seed growth strength, and gradually increases until it reaches its maximum at physiological maturity. The seeds with the lowest vigour emerge later in the early stages of growth. In addition, soybean viability is strongly influenced by genetic factors of variety [29].
Table 1. Seed germination, vigour and growth speed at various harvest times

| Harvest times | Seed germination (%) | Seed vigour (%) | Growth speed (et mal⁻¹) |
|---------------|----------------------|-----------------|------------------------|
| R7            | 92.40                | 74.90           | 37.11 a                |
| R8            | 98.25                | 89.23           | 38.02 a                |
| R8+3 days     | 98.45                | 89.50           | 38.40 a                |
| R8+6 days     | 96.20                | 88.18           | 37.21 a                |
| R8+9 days     | 92.12                | 80.60           | 36.75 a                |
| R8+12 days    | 90.00                | 75.10           | 36.30 a                |

Remarks: Numbers followed by different letters in each column are significantly different at p = 0.05

3.2. Physical Quality

3.2.1. The moisture content of the seeds

The statistical analyses showed that the harvest time influenced the seeds' moisture content and was significantly different between treatments. The highest water content was obtained at harvest time treatment R8 (55.41%). Furthermore, moisture content is one of the characteristics of ripening in seeds. Soybean plants achieve physiological maturity at 30-50% moisture content. This study's favourable conditions were obtained in the R8 + 3 harvest time treatment, specifically 48.99% (Table 2). According to [30], when the seed reaches physiological maturity, it successfully enters stage two of Steinbauer's rule.

3.2.2. 100-grain weight and dry seed weight per plot

The maturity level affects seed yield and weight. The weight of 100 grains describes the seeds' quality, and signifies the endosperm content or size. In the description of superior soybean varieties, the weight of 100 seeds constitutes one of the essential features of soybean plants [31].

The highest weight of 100 seeds and dry seed weight per plot was obtained at the harvest time of R8 + 3, specifically 13.15 g and 315.16 g, while the lowest was obtained at R7, namely 10.20 g and 295.25 g (Table 2). This occurred because many of the filling seeds were not yet perfect, which was expressed by their wrinkle and light weight. In harvest time treatments R8, R8 + 3 and R8 + 6 plants experienced a maximum filling phase, which caused a high weight of 100 grains. However, the treatment of harvest time R8 + 9 and R8 + 12 experienced a lot of metabolic processes (respiration) which caused a reduction in weight. Therefore, the harvest time for soybean seeds is influenced by the environment, including temperature, duration of exposure, and rainfall during seed filling, which influences the seed filling process [32]. [26] also stated that soybean genetic factors caused a significant difference in soybean quality. The quality and quantity of yields are more influenced by each genotype's potential, giving yields and adaptability to the environment [33].

The seeds that have reached physiological maturity are indicated by one of the characteristics: the maximum seed dry weight. The process of seed development starts from fertilization to physiological maturity. Furthermore, the maturity of the seeds continues to increase with time. The closer it is to physiological maturity, the higher the seed maturity level. [34] The early harvest at 87 days after planting (before physiological maturity) produced the least pods as there were many wrinkled seeds. Physical indicators of seed maturity are dry matter accumulated in seeds, while non-physical or physiological signs include seed viability and vigour. The more mature seeds are, the higher the viability and vigour.
Based on the study results, the treatment of R8 + 3 days' harvest age produced the best quality of seeds of Detap-1 variety than other harvest age treatments. This is because the best quality was observed in the parameters obtained at treatment R8 + 3 days.

**Table 2.** Seed moisture content, 100-grain weight, dry weight per plot, at various harvest times

| Harvest times | Seed moisture content (%) | 100-grain weight (g) | Dry weight per plot (g) |
|---------------|--------------------------|----------------------|------------------------|
| R7            | 20,17 e                  | 11,20 a              | 295,25 a               |
| R8            | 55,41 a                  | 12,30 a              | 310,12 a               |
| R8+3 days     | 48,99 b                  | 13,50 a              | 315,16 a               |
| R8+6 days     | 30,11 c                  | 13,10 a              | 311,15 a               |
| R8+9 days     | 25,18 d                  | 11,10 a              | 295,60 a               |
| R8+12 days    | 20,15 e                  | 11,00 a              | 295,27 a               |

Remarks: Numbers followed by different letters in each column are significantly different at p = 0.05

4. Conclusion

Based on the study results, the treatment of R8 + 3 days' harvest age produced the best quality of seeds of Detap-1 variety than other harvest age treatments. This is because the best quality was observed in the parameters obtained at treatment R8 + 3 days.

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