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Variety Study on Germination Power of Palm Seeds (*Elaeis guineensis* Jacq.)

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Abstract

Seeds as planting material play an important role in agricultural development. The high demand for oil palm sprouts causes the long germination time to become an obstacle for consumers and seed producers. The aim of this research is to examine varieties on germination capacity of oil palm seeds. Research was conducted at the PPKS Seed Processing Unit on nine PPKS varieties (Simalungun, PPKS 540, Yangambi, PPKS 239, PPKS 718, Dumpy, Avros, Langkat, and PPKS 540 NG). The parameter observed was the germination power (DB) of the seeds. The treatment given in the germination process for all varieties is carried out to ensure that the environment is favorable for germination (according to the SOP). Observation results showed that PPKS 540 variety had the highest DB (84.9%), followed by Simalungun (81.46%), PPKS 540 NG (75.46%), Langkat (75.43%), Dumpy (73.41 %), PPKS 718 (72.29), Yangambi (68.81%), PPKS 239 (65.74%), and Avros (56.92%). This is thought to be due to the influence of internal factors, related to the conditions of the germinated seeds, both genetics and hormones, as well as external conditions which include optimal water, temperature and oxygen treatment during germination. The results show that the water content (KA) of the seeds in the soaking period (I) was 16-20%, and soaking (II) was 19-22%, all processed seeds were still at a safe level of water content for the process of breaking dormancy of oil palm seeds. The characteristics of parent tree of the seed variety are the cause of differences in seed germination

Keywords: *Germination; Heating; Oil Palm Seeds; Seed Dormancy; Seed Varieties*

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INTRODUCTION

The Palm Oil Research Center (PPKS) is one of the oil palm sprout producers that applies the International Organization for Standardization (ISO) ISO 9001:2015 system as a form of quality management guarantee for the sprouts it produces. Since starting the ISO system in 2002 until the end of 2023, PPKS has distributed 1,273,678,000 sprouts or the equivalent of 6,368,390 – 7,075,988 hectares of oil palm land (PPKS, 2023). Oil palm breeding activities are known as Reciprocal Recurrent Selection (RRS), which is a cross based on plant characteristics from two basic populations (Sulistyo, 2010). The assembly of oil palm plant varieties can be carried out through the development of a plant breeding program in assembling oil palm plant varieties by utilizing the genetic diversity of *Elaeis oleifera* which is crossed with the commercial oil palm *Elaeis guineensis* (Murphy, 2014; Purba, 2019; Sihotang et al., 2022; Sihotang et al. , 2019) *E. oleifera* with *Elaeis guineensis* can produce the first F1 offspring Crossing Elaeis (Mendez et al., 2013).

Setiowati et al., (2023) stated that germplasm is an important part of a plant breeding program to support the achievement of breeding goals. Germplasm acts as a source of diversity for selection. Thirty-six oil palm progenies from 19 female parents originating from the Deli dura lineage and 11 male parents from Africa namely Yangambi, La Mé x SP540 were tested in the field with pedigree information used to estimate the breeding value (general combining ability) of the female, male and female parents. dominant deviation (Amal et al., 2021). The results of research by Sujadi et al., (2020) stated that varieties that have a faster duration of the bunch development phase (Dumpy, Avros, and PPKS 540) are predicted to adapt more easily to rising air temperatures.

The seeds produced by the Palm Oil Research Center are 9 types of varieties that have been actively produced consisting of DxP Yangambi, DxP Avros, DxP Simalungun, DyxP Dumpy, DxP PPKS 540, DxP PPKS 540 NG, DxP PPKS 718, DxP Langkat, and DxP PPKS 239. Determination of varieties is based on grouping (Khair et al., 2014; Afrillah, 2018; Gunawan, 2018; PPKS 2023), namely (1) DxP Langkat, a variety with compact plant characteristics and medium-sized bunches, (2) SP540 derivative which is a group of varieties with the characteristics of high oil production and medium sized bunches, (3) DyxP SP-1 (Dumpy), a variety with the characteristics of a slow upward growth rate and large bunch size, and (4) Yangambi derivative, is a group of varieties with large bunch characters.

Based on research by Julyan et al., (2017); Norsazwan et al., (2016) the seeds of the Yangambi group varieties have characteristics of medium-large size, this variety generally begins to germinate at 20- 21 days of germination. The seeds of the Avros variety are small-medium sized seeds, with a fairly high rate of emergence of non-core seeds. This variety generally germinates at 25- 27 days of germination. The seeds of the Simalungun variety group, 540 are the seeds with the largest size and core, this variety generally germinates at 20-21 days of germination. Asmono et al., (2005); Corley & Tinker (2016) stated that superior characteristics of oil palm varieties can be seen from genetic quality (high yield potential), physiological quality (growth capacity), and morphological quality (seed uniformity and hygiene).

According to Green et al., (2013), the germination yield (DB) of oil palm seeds ranges widely, between 3 and 89 %, influenced by the length of the heating phase during the germination process and the genotype of the seeds germinated. Corley & Tinker (2016) stated that when germination is carried out using appropriate methods, the germination capacity of oil palm seeds reaches 50 % 15 days after the seeds break dormancy and increases to 80% on the 30th day. Corley & Tinker (2016) do not deny the discovery of many cases of low germination caused by abnormal embryos formed due to imperfect seed development. Sadjad (1993); Kaewtaphan, et al,. (2016), believes that seed dormancy is a condition where the seed experiences complete rest so that even though the seed growing medium is optimal, the seed does not show any symptoms or phenomena of life. Seeds as planting material play an important role in agricultural development (Rhebergen, 2020).

Procurement of seed plant material or what is known as seed technology for oil palm is not as easy as for other crops. Palm seeds are seeds that are difficult to grow because they require treatment before the plumules appear. Naturally it takes several months and the growth percentage is low. The skin (shell) of the seeds is quite hard, making it difficult for them to germinate quickly (Lubis, 2008). This fact is related to the nature of seeds which experience what is called a dormancy period. This hard seed coat inhibits the process of absorbing water and oxygen which the seeds really need to germinate. According to Delouche (1985); Kok et al., (2013), dormancy in the seed coat (physical) can be overcome by stratification, namely heat treatment for a short period of time before cold treatment. The method that has long been applied to break the dormancy of oil palm seeds is a dry heat treatment system for 60 days at a temperature of 38° – 40° C (Norziha et al., (2017); Chaerani & Herman, 1992).

Certified superior seeds guarantee uniform quality and productivity of palm oil, so that potential income can be optimized (Sugiarto & Raisawati, 2021). Consumers of certified seeds are also protected by the government by implementing regulations on seed producers contained in the Decree of the Minister of Agriculture of the Republic of Indonesia Number 26/kpts/KB.020/10/2021 concerning guidelines for the production, certification, distribution and supervision of oil palm seeds. This regulation explains the need to determine and evaluate seed source gardens in order to produce superior and quality seeds according to applicable standards (Ayuningtyas et al., 2022).

Germination is the reactivation of axic embryonic growth activities in seeds that have stopped to form seedlings (Kamil, 1979; Kaewtaphan et al., 2016). Every seed that is germinated or tested does not always have the same percentage of sprout growth, this happens because germination is influenced by various influencing factors. Germination is generally characterized by the emergence of a radicle from within the surface of the seed coat, while the germination process begins when the seed imbibes water through the skin until the formation and development of cells from the embryo occurs. The speed and characteristics of germination of each seed are usually related to the presence of dormancy factors, environmental factors and genetic factors (Sugiarto, et al,. 2021).

The method of breaking dormancy that is generally implemented by plant material producers on an industrial scale is the dry heat method (DHM) which was first applied commercially in 1959 in Malaysia (Herrera et al., 1998). Martine et al., (2009) stated that DHM has several weaknesses such as high costs and long dormancy breaking and germination times to obtain a percentage of germination capacity (DB) that is considered feasible, however, this practice of breaking dormancy is still carried out today in many coconut sprout producing countries palm.

METHOD

This research was carried out in July 2023–January 2024 (by taking germination data for 2020-2023) at the Seed Processing Unit (SPU), Production Division, Plant Materials Strategic Business Unit, Indonesian Oil Palm Research Institute (PPKS), Simalungun Regency. North Sumatra, with an altitude of 369 meters above sea level, at position 20 55' North Latitude and 99005' East Longitude. The research was carried out in stage: Harvesting, Chopping and Detaching, Depericarping, Seed Treatment, Seed Drying, Seed Selection, Seed Induction, and Seedling Selection.

RESULTS AND DISCUSSION

Corley & Tinker (2016) stated that oil palm seeds have additional components, namely endocarp in the form of a shell which can reach 2-8 mm thick, and Hadi et al., (2017) added experience dormancy due to the shell being thick and impermeable to water and gas. The type germinated is Dura type oil palm seed because this type is believed to be more important for plantation scale than the other two types (Corley and Tinker 2016). Sadjad (1980); Arif, (2023) stated that seed maturity can be estimated objectively, one of which is through the parameters of seed viability and vigor. Observation results show that the germination capacity (DB) of seeds of all varieties at harvest age 4.5 - 6 months after pollination (BSP) is relatively the same depending on the internal and external conditions of the seeds. Environmental conditions as an external factor that is maintained and relatively constant have the same influence on the germination capacity of oil palm seeds. According to Kuswanto (1996) the seed germination is influenced by internal and external factors. Internal factors are related to the condition of the seeds being germinated, while external factors are more related to the environment. Apart from that, according to Bewley & Black (1983); Sadjad (1993) the factors that influence germination are internal factors consisting of genetic and hormonal factors. Genes are factors that carry inherited traits found in living things. Genes are influenced by every structure of living things and their development, while hormones are organic compounds that are made in one part of the plant and then transported to other parts, where the concentration is low and causes a physiological impact. Environmental factors are also called external factors that influence germination, namely water, temperature, light, oxygen and medium.

Suryawan et al., (2019) argue that this indicates maximum food reserves for embryos that will grow and develop so that seeds harvested under these conditions will have high viability. The observation data shows that the order of germination power parameters is highest to lowest; the DxP 540 variety (V2: 84.9%) had the highest germination capacity and was significantly higher than the germination capacity of other varieties. The observation results also showed that there were differences in germination power between varieties in bunches harvested at physiological maturity. The next germination rate was followed by the varieties DxP Simalungun (V1 : 81.5%), DxP PPKS 540 NG (V9 : 75.5%), DxP Langkat (V8 : 75.4%), DxP SP-1 (Dumpy) (V6 : 73.4%), DxP 718 (V5 : 72.3), DxP Yangambi (V3 : 68.8%), DxP 239 (V4 : 65.7%), and showed significantly higher germination capacity than DxP Avros (V7 : 56.9%). The selected sprouts are characterized by a maximum plumule and radicle length of 2 cm. This is based on the fact that if the seeds are packaged in plastic, the plumule and radicle will not be broken during the shipping journey.

The identification of seeds is made by the Production Division as the Division that processes and produces seeds that come from bunches. Seed identification is carried out when sending and packaging the sprouts to consumers. The form of seed identity is no different from bunch identity. Seed identity consists of variety group, pollination number, registration number, number of sprouts, date sent, heating date and selector code.

According to Muharis et al., (2022), that oil palm seeds are one of the seeds that require quite a long time to germinate because oil palm seeds have physical dormancy and are combined with physiological dormancy. Oil palm seed shells have a high lignin content, namely 65 %. Lignin can inhibit respiration and imbibition processes. As a result, there is no activation of enzymes for sprout growth. As we know, oil palm seeds are protected by a seed shell which is impermeable to water and oxygen causing the unavailability of these two components to initiate germination. The germination capacity of oil palm seeds has different characteristics from seasonal crop seeds. Oil palm seeds do not grow synchronously and are greatly influenced by the conditions of the germination space.

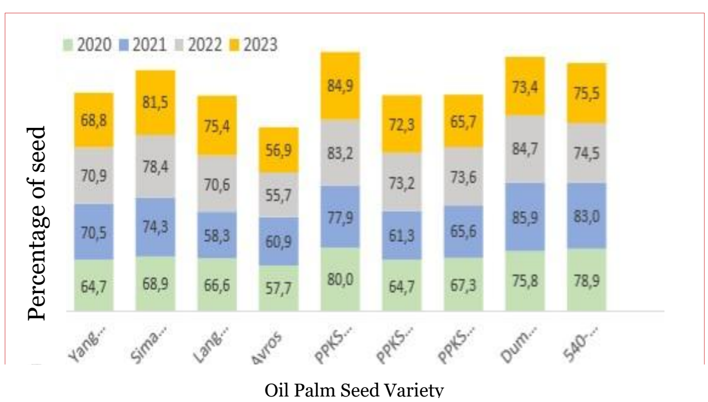

Figure 1. Percentage of seed germination based on variety in the germination process

Julyan et al., (2017) obtained the same results with differences in DB and maximum growth potential between the oil palm varieties tested and stated that the cause of the differences in physiological parameters was differences in seed size. This research refutes the statement by Julyan et al., (2017) above by using seeds of relatively uniform size through a seed screening process in the Production Division, Seed Preparation section as regulated in the Indonesian National Standard (SNI) for seeds with a minimum seed weight of 0.8 grams/grain. Apart from that, according to Sujadi et al., (2020); Pradiko et al., (2019) explained that differences in physiological parameters between varieties are due to differences in bunch maturity levels due to differences in thermal unit requirements for each plant material with different genetic backgrounds.

Even though the parent tree character of the PPKS seed variety has a Dura Deli genetic background, this character comes from a specific lineage. The parent tree of the DxP PPKS 540 variety is Dura Deli which comes from the PA131D self and TI221D x GB30D lines with additive combining power (SK Minister of Agriculture 2007), the parent tree of the DxP Langkat and DxP Yangambi varieties is Dura Deli with dominant combining strength (SK Minister of Agriculture 2003, SK Minister of Agriculture 1985), while the parent tree of the DyxP SP-1 (Dumpy) variety is Dura Dumpy which is a mutation of Dura Deli (Decree of the Minister of Agriculture 1984). Furthermore, Amal et al,. (2021) explained that the additive diversity of male parents is greater than that of female parents, indicating that the diversity of offspring is caused more by male parents. Dominant varieties were significantly different for bunch weight and yield traits, indicating that there was an elite inbreed in the parental population.

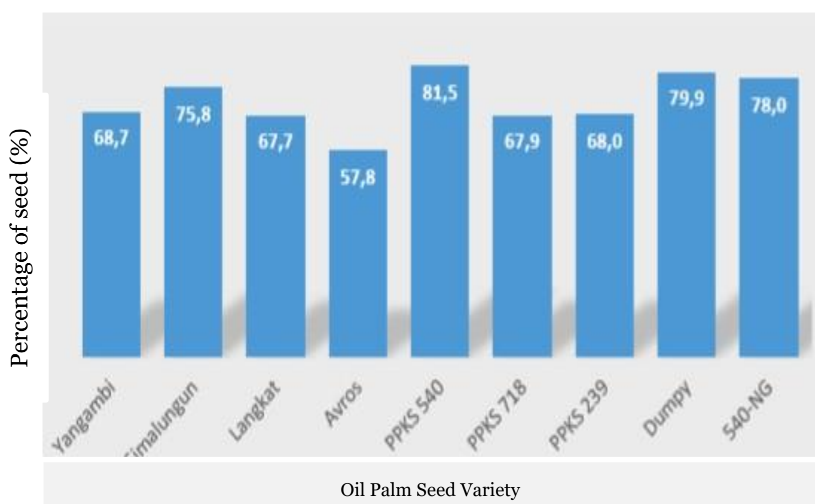

Figure 2. Average percentage of seed germination based on variety in the germination process

It is very important to know the germination capacity (DB) of a seed lot to give an idea of the percentage of growth after the process of breaking dormancy. For oil palm seed producers, germination reflects the number of seeds that can be sold, because oil palm seeds are sold in normal sprout form. Germinating oil palm seeds without treatment before germination can produce around 50% germination within 6 months (Fauzi et al., 2002). Martine et al., (2009) stated that under natural conditions, germination of oil palm seeds takes 1 to 3 years. Corley & Tinker (2016) added that in open areas and forests, a period of 3 years was only able to germinate 25% and 3% of the total seeds. Meanwhile, Hussey (1958); Corley & Tinker (2016) stated that oil palm seed dormancy is not caused by the embryo but due to the nucleus which will remain dormant for up to 6 months. This dormancy can be overcome by heating at a temperature of 40 °C for 80 days.

Based on the picture above, the highest average germination capacity (DB) of oil palm seeds was obtained in the DxP 540 variety (81.5 %), and the lowest in the Avros variety (57.8 %), (soaking time (I) 5-7 days, soaking (II) 3 days and heating time of 55-60 days. This high germination capacity is thought to be due to the influence of optimum seed moisture content before germination, not too long heating time (55-60 days) and optimum treatment during germination According to Haryani (2005); Muharis et al., (2022) the effective heating time to break oil palm seed dormancy is 60 days 55.5 %).

Another factor that has the potential to cause low DB of oil palm seeds is seed damage that occurs during the dormancy breaking process. In the process of breaking dormancy of oil palm seeds, damage to the seed cell membrane can occur due to the rate of water flow between the seed and its environment. water pressure difference. The low water content of oil palm seeds that have been stored for a certain time (Arif & Sihombing 2015; Arif, 2023), while the second DHM process begins with soaking the seeds in running water (Corley & Tinker, 2016), there is concern that cell membrane damage will occur in oil palm seeds. which will germinate due to strong water flow rates from areas of high water pressure to seeds that have low water pressure (Fitriesa, 2015), as is the concept of moisture equilibrium presented by Copeland & McDonald (2001).

Tabel 1. Water Content After Heating Process

Variety/Group	**Heating Duration (day)**	**Water Content (%) I**	**II**
DxP Langkat	55	17	19
DxP PPKS 540, Avros, SMB		17	20
DyxP SP-1 (Dumpy)		20	21
DxP Yangambi, 239, 718		18	22
DxP Langkat	60	16	19
DxP PPKS 540, Avros, SMB		19	20
DyxP SP-1 (Dumpy)		19	22
DxP Yangambi, 239, 718		20	21

The beginning of the process of breaking oil palm seed dormancy with DHM in the form of soaking the seeds in water results in a rapid increase in water content, especially in seeds that have low initial water content. The movement of water masses from the environment into the seeds can cause damage to the cell membranes that make up the seeds which will result in low germination capacity (Mangoni et al. 2004, Rasooli et al. 2006). This method has been proven to increase germination, germination rate, and seedling growth in the field (Ilyas, 2006) in seeds from many species, such as soybeans (Mariani, 2021), Chia seeds (Witkovski et al., 2022), and lettuce seeds (Takahata et al., 2008).

From table 1 it can be seen that the heating time is 55 - 60 days and has a water content of 16 – 20 % (soaking I) and 19 – 22 % (soaking II) after leaving the heater. The water content of oil palm seeds which tends to be stable indicates the physiological maturity of the seeds. The gradual increase in seed moisture content during soaking and heating still shows an increasing pattern, presumably because oil palm seeds are surrounded by a thick shell (Corley & Tinker, 2016). A similar thing was found by Tresniawati et al., (2014) on Sunan Candlenut (*Reutealis trisperma*) seeds and Ilham (2015) on sugar palm (*Arenga pinnata* (Wurmb.) Merr.) seeds. According to Adiguno (1998), the water content of oil palm seeds when heated is not less than 18 %, so that their viability can be maintained. The water content of the seeds decreases with the longer the seeds are in the heating chamber because the heating chamber conditions have a high temperature (39 - 40 °C) and relatively low humidity. This can cause the water content of the seeds to decrease even though the seeds are in a closed plastic tray. In general, temperature and humidity are two parameters that are inversely proportional to each other (Nasrullah et al., 2015, Rahayuningtyas & Kuala, 2016).

Growth Hormone Composition

Dormancy breaking in hormonal balance, where ABA acts as an inhibitor and GA as a promoter. These hormones simultaneously and antagonistically regulate the initiation, maintenance and termination of seed dormancy. In this data, gibberalin (GA) and abscisic acid (ABA) do not interact directly. While ABA produced by the embryo induces dormancy during seed development, GA promotes germination of non-dormant seeds.

Palm oil seeds contain abscisic acid (ABA), cytokinins (kinetin and zeatin), and gibberellins (GA). Growth hormone increases based on the maturity of the seed bunches. The content of the hormone abscisic acid (ABA) in varieties and mature bunches ranges from 17.4 – 25.3 ppm, cytokinins in the range 77.2 – 109.9 ppm, and gibberellins in the range 86.6 – 108.4 ppm. Growth hormones based on harvest age can be seen in the table. Each hormone has its own role in the seed germination process. Abscisic acid has a role as an inhibitor or barrier to the growth and development of sprouts (Asra et al., 2020), while cytokinin and GA play a role in inducing germination (Asra et al., 2020; Triani et al., 2020). These three growth hormones also have specific interactions. Khan (1968) stated that GA activity to encourage the germination process can be inhibited by the presence of ABA but this inhibitory activity can be overcome by the presence of cytokinins.

The composition of growth hormone continues to increase with the harvest age of the seed bunches for each variety. The content of the three growth hormones shows that the best harvest time for oil palm seed bunches is 4.5 - 6 months when GA (a hormone that encourages germination) is at its maximum amount. The ABA content (sprout growth inhibitor) which is also high at the age of 4.5-6 months is overcome by the cytokinin content (a hormone that anticipates the effect of inhibitors) which is at its maximum condition at the time of harvest. According to Poodineh et al., (2014), giving cytokinins to Hamoon wheat cultivar plants has a direct impact on the growth process and the wheat growing period will be longer, due to delayed leaf senescence, resulting in a longer growth period. The problem that can be identified in this research is the interdependence between gibberellins and cytokinins in increasing growth hormones in terms of harvest maturity.

One way to break physiological dormancy in seeds can be done by administering growth regulators (ZPT). Several studies on breaking dormancy by administering gibberellin, such as research by Sari et al., (2014), concluded that administering GA3 at a concentration of 300 ppm was able to break dormancy in Mucuna bracteata seeds. In addition, according to research by Tetuko et al., (2015), giving GA3 at a concentration of 100 ppm to Hevea brasiliensis seeds can increase the germination percentage to 28 % and the germination rate to 45 % of the seeds.

The function of gibberellins in germination is to increase the growth potential of the embryo and act as a germination promoter and overcome mechanical barriers by the covering layer of the seed (Rusmin et al., 2011). Meanwhile, heating treatment is thought to be able to cause cracking of the operculum of the seeds. Cracked operculum causes imbibition so that metabolic processes can run more quickly. According to Kamil (1979), heating and followed by soaking in water means the seed coat will be permeable to water and the entry of oxygen.

Seed decline is something that cannot be reversed which starts from the moment the seed reaches physiological maturity. The biggest cause of seed deterioration is protein denaturation caused by free radicals, so that the integrity of the cell membrane decreases (Harrington, 1972). Therefore, the sooner the seeds are planted or germinated, the risk of seed deterioration will be minimized so that it is hoped that seed viability will still be high. Yulianti et al., (2020) explained that although intermediate seeds can be stored for a relatively longer time than recalcitrant seeds, the storage duration is shorter than the storage duration for orthodox seeds. Recalcitrant and intermediate types of seeds have a slower pattern of decreasing water content when the seeds are still on the parent tree, in contrast to orthodox seeds which undergo a maturation drying process during the seed maturation process (Pramono & Rustam, 2017).

CONCLUSION

The highest germination capacity (DB) of oil palm seeds was obtained from the DxP 540 variety (V2: 84.9%). Estimated seed germination capacity is influenced by heating time, water content, soaking time and source characteristics of the parent tree. High germination capacity is obtained from a heating period of 55-60 days and a change of oxygen, according to the standard germination procedures applied so far. Dormancy breaking is an activity to break the dormant properties found in seeds. The stages of dormancy breaking activities consist of two stages of soaking, heating and drying. Germination is the activity of germinating seeds into sprouts ready for planting, the stages of germination activities are watering and selecting the sprouts.

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