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Phenology Study of Pod Formation and Determination of Physiological Maturity Age on Seed Quality in 5 Genotipes of Winged Bean Plants (*Psophocarpus Tetragonolobus L.)*

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Abstract

The kecipir plant is an undertilized crop, the kecipir plant can be cultivated as a source of protein. Efforts to obtain quality seeds by knowing the right physiological maturity age. The exact age of physiological maturity can be seen from the phenology of pod formation on physiological characters with the characteristics of changes in color and fruit size (length and width) in kecipir pods. The study was conducted by observing each population of 5 genotypes, each genotype population consisting of 30 plants. Seed quality research was conducted using a completely randomized design repeated 8 times with treatment on each of the 5 genotypes of kecipir: color changes in pods not added to the harvesting day, color changes in pods plus 5 days of harvesting age and color changes in pods plus 10 days of harvesting age. The results showed there were variations in different harvesting ages in the ages obtained are as follows: NSM 2.1.1, Kpj 1.1.1.1, PTL 2.1.2.1, and KePM 2.2.2 genotipes: (53 HSP,58 HSP,63 HSP), while in MML 1.4.2.1 genotipe: (48 HSP,53 HSP,58 HSP). The treatment of discoloration on pods not added to the day of harvesting age or age 48 HSP on MML 1.4.2.1 genotipe and age 53 HSP on NSM 2.1.1, Kpj 1.1.1.1, PTL 2.1.2.1, and KePM 2.2.2 genotipes showed the best age with average yield values, moisture content of 10.36%, weight of 100 grains 56.75 g, seed diameter 9.80 mm, germination 92%, growth speed 42.49% and growth uniformity 56.75%. The optimal harvesting ages varied among genotypes, with the best results observed at 48 HSP for MML 1.4.2.1 and 53 HSP for NSM 2.1.1, Kpj 1.1.1.1, PTL 2.1.2.1, and KePM 2.2.2. At these ages

Keywords: Age, Genotype,Seed, Quality

Introduction

Legume plants are important plants as a source of oil and protein, one of which is the kecipir plant *(Psophocarpus tetragonolobus L.)* (Adegboyega *et al.*, 2020). The kecipir plant is a type of small-podded plant that can grow in the tropics, especially Asia (Eagleton, 2022). According to Bramastyo *et al.*, (2020) the superiority of kecipir in 100g fresh pods of kecipir, contains 7.9g carbohydrates, 4.3g protein and 3.1g fiber. Handayani et al., (2015) stated that vitamin A content is also found in the leaves of the kecipir. In addition, kecipir can also be used as an antioxidant, and reduce cholesterol levels in the body. This provides a high opportunity for kecipir to be cultivated and developed as an alternative source of food and vegetable protein (Mohanty et al., 2013). One of the important factors in increasing interest in the cultivation of kecipir plants is the availability of high quality seeds, which are strongly influenced by the process of pod formation and the stage of physiological maturity.

Phenology is the study of the timing of naturally occurring plant growth phases (Fenner, 1998). Growth phases start from flower formation, young pods to seed ripening (Wu et al., 2018). This is an important indicator in determining the right time for seed harvesting. Learning phenology can play an important role in planning for quality seed production. The phenological process of pod formation needs to be considered starting from the day after pollination (HSP) which is marked by the appearance of small light green pods that are still covered by dry petals until the increase in size such as width and length as well as changes in color in the pod, for this reason, understanding these processes can be used to identify the physiological maturity of the seeds produced.

Physiological maturity of seeds is a condition of maximum viability, vigor, and dry weight. The level of seed maturity at harvest greatly affects seed viability. Harvesting pre-ripe or overripe seeds can reduce seed quality such as physical damage (cracking and shrinking) and physiological damage. According to Pérez-García et al. (2008), indications of physiological fruit maturity are recognized by changes in fruit morphology and biochemistry. Fruit maturity is often described by fruit characteristics such as color, size and fruit moisture content. Determination of seed maturity can be done by paying attention to fruit color, hardness of fruit skin, fruit loss, in research by Manggung *et al.*, (2016) towards physiological maturity in bambara bean plants, the color of the pods turns brown, there are spots or patches of blackish brown (50-75%) on the surface of the pods, fresh seeds are dark in color (blackish purple or black).

Objective determination of seed maturity is based on dry weight and seed vigor. So that the determination of the right physiological cooking age of seeds can determine the highest viability and vigor in the kecipir. Physiological maturity of seeds also affects the nutritional content of seeds, in the research of Ishthifaiyyah *et al.*, (2021) the determination of medium harvest maturity can affect the nutritional content of the soybean seed pods. So that the physiological maturity of seeds becomes a benchmark for determining the moisture content of soybean seeds (Rahman et al., 2015). The right seed moisture content can affect the viability and vigor of the seeds. Seeds harvested too early or too late can experience a decrease in quality, such as low germination and seed vigor.

Each genotype of kecipir has different phenological characteristics, including the speed of pod formation and physiological maturity of seeds. This can determine the optimal seed quality production strategy for each genotype. Therefore, this research aims to study the phenology of pod formation and determine the physiological maturity of seeds in five different genotypes of kecipir starting from the day after pollination (HSP).

Research Method

Time and place of research

The research was conducted in Tugu Village, Sendang District, Tulugagung Regency. In December 2023 until August 2024 and further research was carried out in September 2024 at the Plant Breeding Laboratory of Brawijaya University Malang.

Tools and Materials

Planting materials used were 5 genotypes of kecipir (NSM 2.1.1, MML 1.4.2.1, PTL 2.1.2.1, Kpj 1.1.1.1, KePM 2.2.2) for research on pod formation phenology,

Mulch, raffia rope, stakes, Materials used for seed quality research were 5 genotypes of kecipir from previous research treatments, compact disk (CD) paper, plastic, research labels, Aquades water, Digital Scales, Oven, Germinator.

Research Methods

Research on pod formation phenology was conducted by observing each population of 5 genotypes, each genotype population consisting of 30 plants. Each population of each genotype was taken 10 samples on one plant. With the treatment of each of the 5 genotypes of kecipir: color changes in pods not added to the harvesting day, color changes in pods plus 5 days of harvesting age and color changes in pods plus 10 days of harvesting age. Furthermore, seed quality research was carried out using a completely randomized design with 15 treatment combinations repeated 8 times.

Data Analysis

Data analysis used to see the phenology of pod formation by finding the average value and presented in the form of diagrams in descriptive analysis. Furthermore, to see the interaction between genotypes and harvesting age treatment using factorial analysis of Variance (ANOVA), if there is an effect on each treatment, the Honest Real Difference Test (BNJ) is conducted at the 5% level.

Results and Discussion

Result

Phenology of bean pod formation

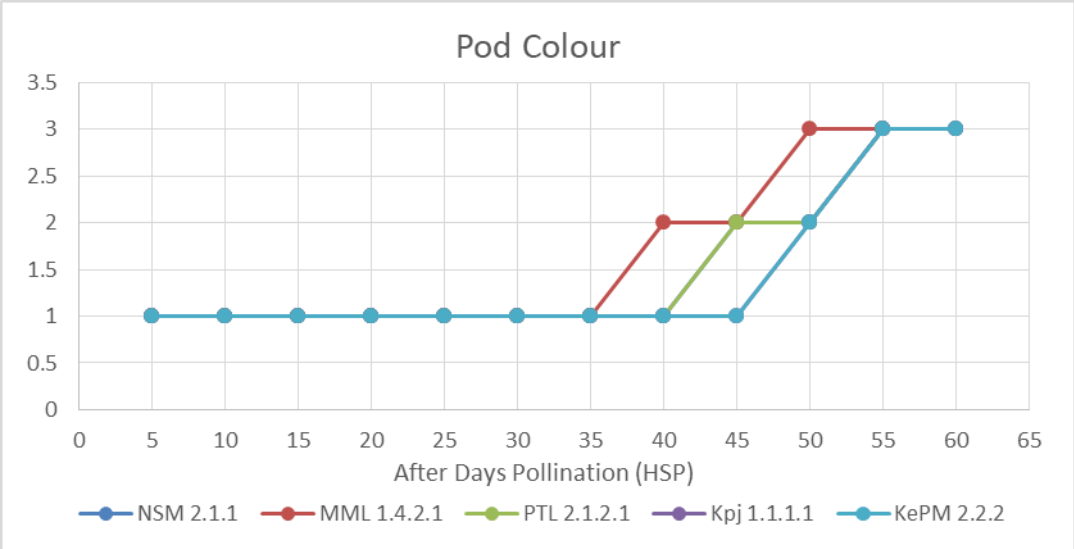

Figure 1. Pod color progression chart

Based on the results of the graph above, it shows that the color changes in the pods of 5 genotypes of kecipir show at the age of 5-35 days after pollination (HSP) show a green color. At the MML 1.4.2.1 genotype at the age of 40 days after pollination (HSP) the pods turned into a spot color, at the NSM 2.1.1, PTL 2.1.2.1, Kpj 1.1.1.1, KePM 2.2.2 genotypes at the age of 45 days after pollination (HSP) the pods turned into a spot color and at the MML 1.4.2.1 genotype the pods turned into a brown color. Age

50 days after pollination (HSP) in genotypes NSM 2.1.1, PTL 2.1.2.1, Kpj 1.1.1.1, KePM 2.2.2 pods turned brown. In the research of *(Arif et al., 2024)* stated that changes in skin color can indicate the level of maturity of seeds in the fruit, the more mature the chili fruit, the synthesis and accumulation of carotenoid pigments that change the color of the fruit skin will occur. Based on the graph of color changes in pods of genotypes NSM 2.1.1, Kpj 1.1.1.1, PTL 2.1.2.1, and KePM 2.2.2: (53 HSP,58 HSP,63 HSP) on genotype MML 1.4.2.1: (48 HSP,53 HSP,58 HSP).

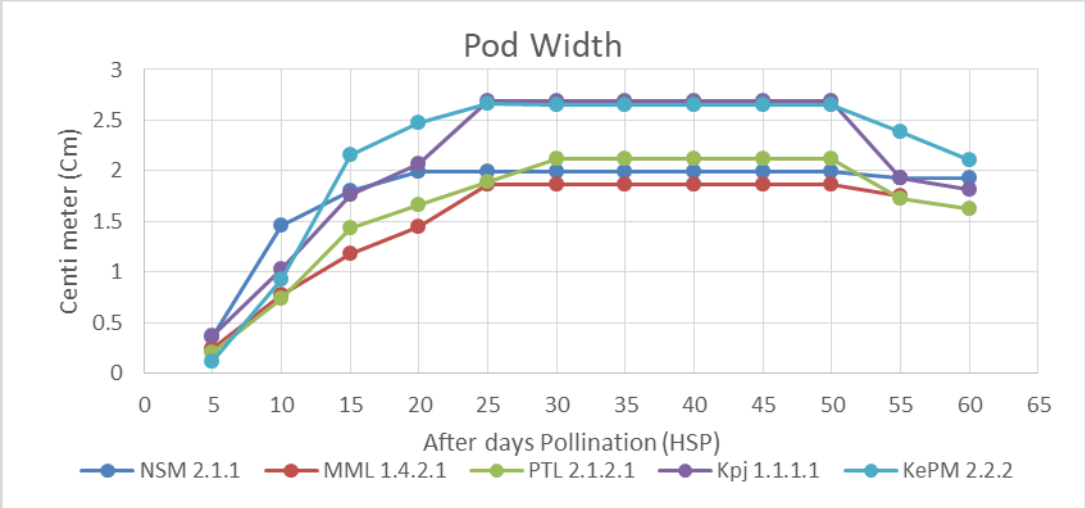

Figure 2. Pod width progression chart

The development of pod width began at 5 days after pollination (HSP) with an average width of 0.2-0.3 cm. The development of pod width continued to increase until the age of 25 days after pollination (HSP) with an average value of 1.8-2.6 cm. At the age of 50-60 days after pollination (HSP) there was a decrease with an average value of 1.8-2.1 cm.

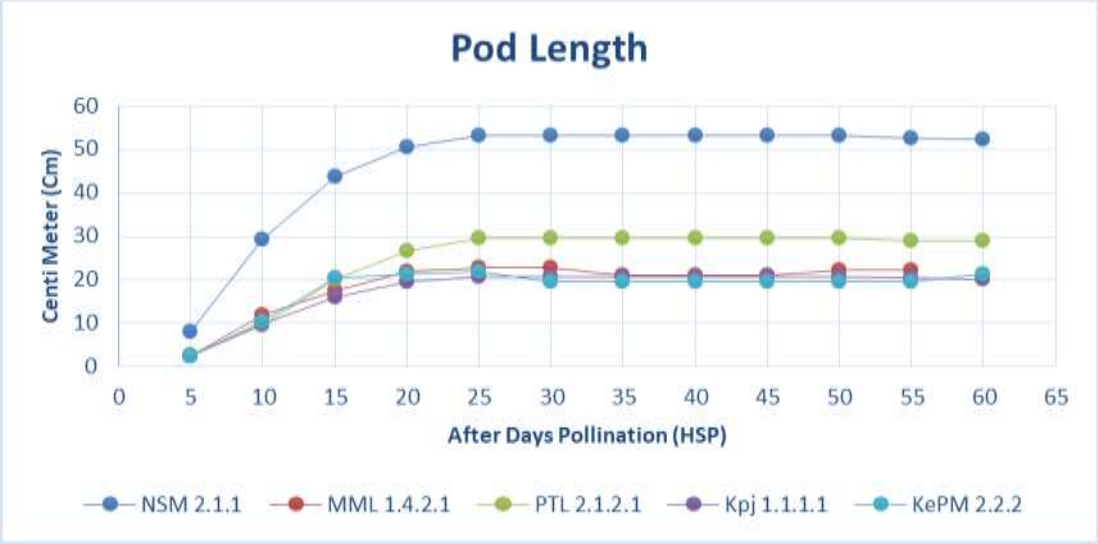

Figure 3. Pod length progression chart

Observations of pod length development began at 5 days after pollination (HSP) with an average pod length of 2-4 cm. The development of pod length continued to

increase in each genotype until the age of 20 days after pollination (HSP). At the age of 45-60 days after pollination (HSP) there was a decrease in each genotype with an average decrease of 1-2 cm.

Physical quality of seeds

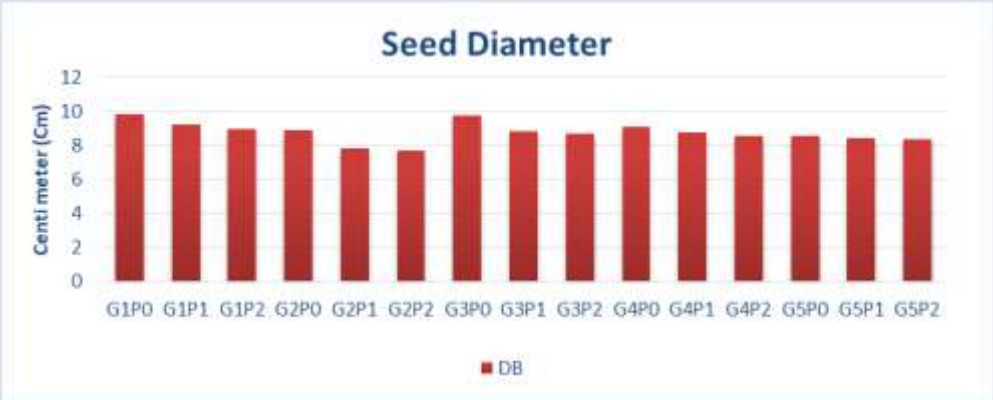

Figure 4. average value of seed diameter

Based on the figure 4 shows that, the NSM 2.1.1 genotype with color change treatment on pods not added days of harvesting age shows the highest average value of 9.81 cm. Along with the length of harvesting age, it shows a decrease in the size of the seed diameter with the treatment of pod color changes plus 5 and 10 days of harvesting age in 5 genotypes of kecipir.

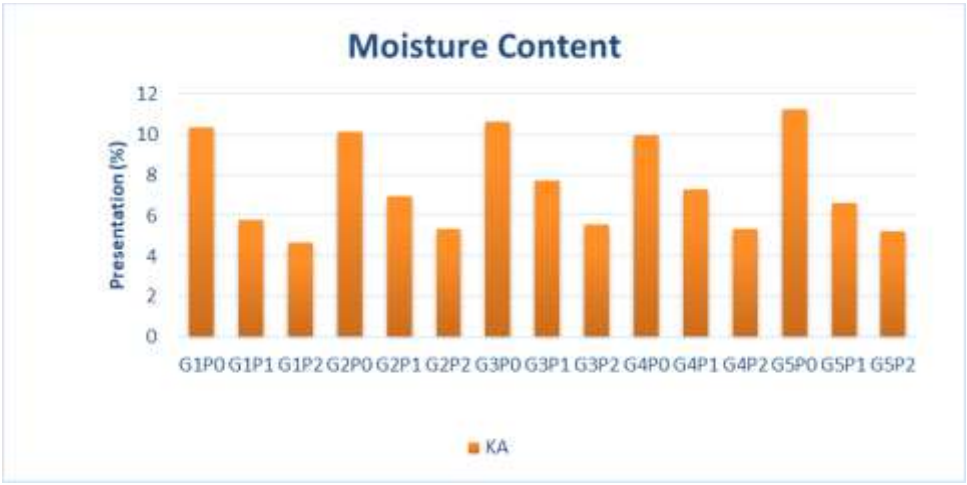

Figure 5. Average value of moisture content

Based on the figure 5 shows the results with the treatment of discoloration of pods not added to the harvesting age on the KePM 2.2.2 genotype with the highest average value of moisture content of 11.25%. Along with the length of harvesting age, it shows a decrease in water content with the treatment of pod color changes plus 5 and 10 days of harvesting age in the genotypes NSM 2.1.1 PTL 1.11, MML 1.4.2.1, Kpj 1.1.1.1, and KePM 2.2.2 showing results with an average value of 4.5%.

Figure 6. Average value of 1000 grain weight

Based on the figure 6 on the treatment of color changes in pods not added to the harvesting age by showing the highest average value of 519.81gram on the genotype NSM 2.1.1. Along with the length of harvesting age, there was a decrease in 1000-grain weight in the treatment of pod color change plus harvesting age of 5 and 10 days in genotypes PTL 2.1.2.1, MML 1.4.2.1. In genotypes NSM 2.1.1, Kpj.1.1.1, and KePM 2.2.2.

Physiological quality

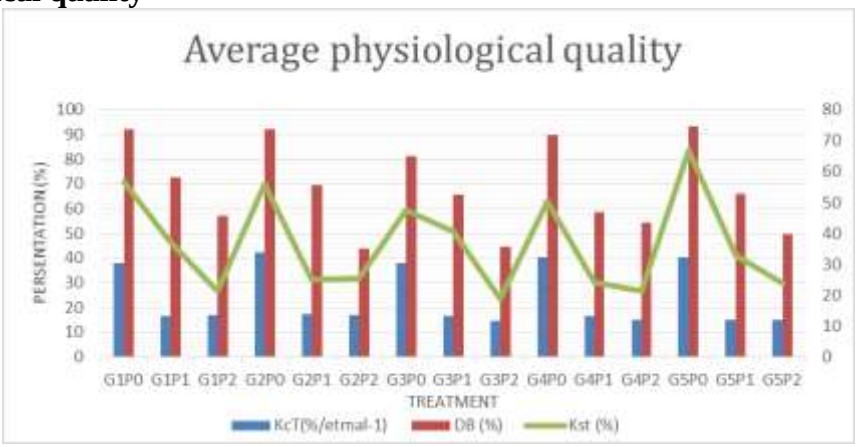

Figure 7. Average value of physiological quality

Based on the graphical figure 7 on the treatment of color changes in pods not added to the harvesting age of 48 HSP at genotype MML 1.4.2.1 showed the highest mean value of 42.50 %$^{etma-1}$. Along with the length of harvesting age, there was a decrease in growth speed in the KePM 2.2.2 genotype with the treatment of color changes in pods plus 5 days and 10 days with an average value of 15.02 %$^{etmal-1}$ in the PTL 2.1.2.1, NSM 2.1.1, MML 1.4.2.1, Kpj 1.1.1.1 genotypes.

The average value of the observation of germination power in the treatment of pod color change not added to the day of harvesting on the KePM 2.2.2 genotype showed the highest value of 93.50%. Along with the length of harvesting age, there was a decrease in the value of germination in genotypes PTL 2.1.2.1 MML 1.4.2.1, and Kpj 1.1.1.1 with the treatment of color changes in pods plus 5 days of harvesting age with an

average value of 66.00% and the treatment of color changes in pods plus 10 days of harvesting age with an average value of 44%.

In the variable of uniformity of growth with the treatment of pod color changes not added to the day of harvesting age in the genotype KePM 2.2.2 with the highest average value of 66.75%. In the genotypes MML 1.4.2.1, PTL 2.1.2.1, NSM 2.1.1, and Kpj 1.1.1.1 with the treatment of pod color changes coupled with 5 and 10 days of harvesting age showed a decrease in the uniformity of growth due to the harvesting age.

Discussion

The phenological development of pod formation on color changes at the age of 5-40 HSP young pods are green, at the age of 5-40 HSP, at the age of 45-50 HSP pods change color to green with brown spots, then more than 55 HSP pods become brown. This color change in the pods can be used as an indication of maturation in kecipir pods. The level of physiological maturity can be marked from the brown fruit skin shown in the graph in the study (Arif *et al.*, 2024), Changes in skin color indicate the level of maturity of the seeds in the fruit, the more mature the fruit, the synthesis and accumulation of carotenoid pigments will occur which change the color of the fruit skin.

Proper harvest age treatment can produce maximum moisture content. Maximum moisture content conditions can cause water mobilization in the initial phase when water is mobilized into the seed until the water in the seed can become a biochemical solvent for cell division and growth activities (Hanapiah *et al.*, 2022). The high water content is 80%, because nucleic acids and proteins are still undergoing synthesis and have liquid water drawn into the capillary structure. Thus, it can produce enough tension to hold water in the seed, in the statement (Bewley *et al.*, 2013) in this phase, plant embryogenesis begins with a spherical shape and contains mostly liquid endosperm.

The maximum moisture content condition will affect the physiological quality of the seeds. Based on the graph 7, the results show that the best germination capacity is in the genotype KePM 2.2.2 with the treatment of discoloration of pods without added harvesting age or age 53 HSP with a value of 93% showing the highest average value. This is because the physiological and biochemical characteristics of seeds during the maturity stage can be the main indicator of seed quality which can be seen from the germination capacity. Along with the length of harvesting age there is a decrease in the presentation of germination value to 44%, this can be caused by the length of the difference in harvesting age, the longer the harvesting age, the hardness of the seed coat of kecipir so that it can inhibit the delay in germination of seeds (Rezaei & Arman, 2023).

Conclusion

Based on the observations of the phenelogical study of the formation of kecipir pods, there are variations in different harvesting ages in 5 genotypes of kecipir. The ages obtained are as follows: NSM 2.1.1, Kpj 1.1.1.1, PTL 2.1.2.1, and KePM 2.2.2 genotypes: (53 HSP,58 HSP,63 HSP) on MML 1.4.2.1 genotype: (48 HSP,53 HSP,58 HSP).

The treatment of discoloration on pods not added days of harvesting age or age 48 HSP on MML 1.4.2.1 genotype and age 53 HSP on NSM 2.1.1, Kpj 1.1.1.1, PTL 2.1.2.1, and KePM 2.2.2 genotypes showed the best age with average yield values,

moisture content 10.36%, 100-grain weight 519.81 g, seed diameter 9.80 mm, germination 92%, growth speed 42.49% and growth uniformity 56.75%.

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