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Breaking the Dormancy of Some Varieties of Papaya (*Carica Papaya* L.) Soaking KNO_3 Solution

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Abstract
Dormancy is a state of stopping growth experienced by plants. This research aimed to determine the concentration of KNO3 solution in breaking dormancy in several papaya varieties. The research method used in this research was a completely randomized design (RAL) Factorial with 2 treatment factors. The first factor is variety (V), consisting of V1 = Callina, V2 = California, and V3 = Local. The second factor is the concentration of the KNO_3 (K) solution consisting of: K0 = Control, K1 = 10%, K2 = 20% and K3 = 30%. The variables observed were growth synchrony and germination speed index. Data analysis uses analysis of variance. The variables observed were growth synchrony and germination speed index. An analysis of variance was used to test the effect of treatment. To test mean differences between treatments, honest significant difference tests, regression, and correlation were carried out at a test level of 5%. The research results showed that seed variety had a significant effect on growth synchrony and germination speed index. The concentration of KNO_3 solution has a significant effect on growth synchrony and germination speed index. The interaction between the variety and concentration of KNO_3 solution had no significant effect on all observed parameters.

Keywords— Concentration, Dormancy Breaking, KNO_3, Variety.

Introduction

Based on data from the Central Statistics Agency (2018), for the last eleven years (2007 – 2017), the amount of papaya consumption in Indonesia experienced a significant increase. From 2007 to 2010, there were fluctuations. However, there was an increase in 2011, amounting to 1,031 kg per capita. In 2012, there was a pretty drastic decline, namely 1,148 kg per capita. However, from 2013 to 2017, papaya consumption increased. A significant increase occurred in 2017, namely an increase of 2,451 kg per capita or an increase of almost 100 percent from the previous year. This data shows that papaya is increasingly in demand by consumers. This happens because of increasing public awareness of the importance of health by consuming fruit. Consumers choose papaya based on its delicious taste, affordable price, and easy access(Haryanto, 2021).

Increasing papaya fruit production must begin with the provision of good quality, affordable seeds that are available in sufficient quantities. Papaya fruit is a dicotyledonous plant

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that can be developed using seeds, so high-quality seeds are needed to support excellent production results. The quality of the seeds includes genetic, physiological, and physical qualities. On the other hand, papaya seeds have a dormancy period of up to 12-15 days. This is due to the presence of aryl and phenolic compounds in the arils of the seeds(Dipenogoro, 2019).

In the practice of cultivating papaya, we often encounter problems with seeds experiencing dormancy. Papaya plant seeds are dormant, which means they experience a period of rest/cannot germinate immediately even though the surrounding environmental conditions support the germination process. Seed dormancy indicates a situation where healthy (viable) seeds fail to germinate when they are under normal conditions that are good for germination, such as sufficient humidity and suitable light. Dormancy is a strategy to prevent germination under conditions where the chances of seedling survival are low(Lisarini, 2019).

Several methods can be used to break papaya seed dormancy, both physical, mechanical, and chemical. Soaking is a prolonged procedure to overcome physical dormancy, but many types of seeds have had their dormancy broken by immersion in water.(D. T. Ardi & Ginting, 2018).

Soaking with KNO3 solution is known to break the secondary dormancy of seeds. Breaking papaya dormancy, which has been researched extensively, is done using KNO3, GA3, and heat shock at a temperature of 36°C. The KNO3 compound is composed of the elements K, N, and O, each of which has a specific function(Maulidina, 2020). The K element helps the formation and breakdown of proteins and carbohydrates in seeds as energy in the seed germination process. The N element is needed for the formation or growth of vegetative parts, forming proteins and fats. The function of O is for respiration in living cells in embryonic organs so that cell respiration becomes active(Lisarini, 2019). Seeds that have germination inhibitors that delay germination or are experiencing a period of seed dormancy can be overcome, among other things, by soaking in plain water, soaking in hot water, and chemical treatment (Lisarini, 2019).

KNO3 can reactivate seed cells that are in a state of dormancy to germinate more quickly. Apart from that, KNO3 also activates the working power of enzymes faster, thereby stimulating germination (Suriana et al., 2022). This is proven by research conducted by (Ariani et al., 2017), which shows that soaking seeds in 1% KNO3 solution for 24 hours can increase seed germination by up to 88.33% compared to the control, which only germinated at 36.67%. The size of the concentration determines the effect of KNO3; if the KNO3 concentration is not correct, it can cause reduced germination. This means that if the concentration is too high, it can cause poisoning of the seeds, and if the concentration is too low, it will not have any effect on the seeds.

California papaya is a type of papaya that has advantages; among others, the fruit is not too large with papaya size between 0.8-2 kg/fruit, has thick skin, is smooth and shiny, oval in shape, ripe fruit is yellow, tastes sweet. The flesh is chewy(W. Rahayu & Puspitasari, 2021). California papaya plants are relatively easy to plant, have minimal pests and diseases, the price of seeds is low, the time from planting to fruiting is also very short, namely around 7 months, and the plants can bear fruit for 3 years (36 months).(Purnadi et al., 2017).

The outer appearance of the fruit looks thick. However, if you cut it open, the inside shows a red color, so this papaya fruit is auspicious to be used as an export fruit, considering that Indonesia is one of the countries that imports tropical fruit. Apart from that, this plant can grow well all year round (without knowing the season) in Indonesia. By planting papaya in California or Calina, IPB 9 is expected to increase farmers' income.

Literature Review

Papaya (Carica papaya L) is a fruit plant, a herb from the Caricaceae family that originates

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from Central America and the West Indies, even in areas around Mexico and Costa Rica. Papaya plants are widely planted in tropical and subtropical regions, wet and dry areas, or lowland and mountainous areas.(S. Rahayu, 2017). The optimum temperature for papaya growth ranges from 22-26ºC with rainfall of 1000-2000 mm/year. Papaya can be planted in the lowlands and highlands, with a soil pH of around 6-7 (neutral). Soil conditions with a poor drainage system can cause papaya plants to die because if the soil conditions are not good and the plant is flooded, it will quickly die. Growth requirements that are not met will cause a decrease in production in terms of quality and quantity. Papaya develops a relatively strong taproot after planting. Under suitable conditions, roots can penetrate the soil to a depth of 2 m. Most of the roots responsible for nutrient absorption are found in the top 500 mm layer of soil, with the greatest concentration above 250 mm.(Wibawa, 2015).

Germination is the metabolic process of seeds that produces the growth of the sprout components (plumule and radicle). The definition of germination is if the germination can be observed, namely the radicle and plumule, and both usually grow within a certain period by the provisions (ISTA) International Seed Testing Association, 2014. Every seed germinated or tested does not always have the same percentage of sprout growth(Avivi, 2021).

For a short time, seeds must be stored at 30-450C with low water content; temperature conditions and water content affect germination. Seed germination informs users about seeds that usually grow into plants that produce average production in optimal biophysical conditions in the field. The parameters used can be the percentage of regular sprouts based on an assessment of the embryo's growth structure, which is observed directly. Indirectly by only looking at the symptoms of seed metabolism, which are related to the seed's life (Dipenogoro, 2019).

Dormancy is defined as a status where seeds do not germinate even in ideal environmental conditions for germination. Several dormancy mechanisms occur in both physical and physiological seeds, including primary and secondary dormancy. Primary dormancy is the most common form of dormancy and consists of two types: exogenous and endogenous. Exogenous dormancy is a condition in which the essential requirements for germination (water, light, temperature) are not available to the seed, so it fails to germinate. This type of dormancy is usually related to the physical properties of the seed coat.(Mubarrok, 2018).

Dormancy in seeds can last for several days, a season, or even several years, depending on the type of plant and the type of dormancy. Growth will not occur as long as the seeds have not gone through their dormancy period or before the seeds are subjected to special treatment. Methods for breaking physiological dormancy can be done by prechilling, preheating, dry storage, light, tightly wrapped in polyethylene plastic bags, soaking with gibberellic acid (GA3), soaking with potassium nitrate. (KNO3), mechanical scarification, and acid scarification (ISTA). The International Seed Testing Association added that fresh papaya seeds can experience post-harvest dormancy, which will break after six months of storage. The high content of phenolic compounds in the sarcotesta of papaya seeds can prevent the seeds from germinating(Devi, 2022).

According to Ginting (2020), in his research, the greater the concentration of KNO3, the higher the percentage of average dry weight of sprouts. This is because administration of KNO3 activates cell metabolism and accelerates germination(D. T. Ardi & Ginting, 2018). This statement states that KNO3 increases the growth hormone activity in seeds and makes the seed coat easier for water to penetrate during the imbibition process.(Sinaga et al., 2021). KNO3 concentration significantly affects increasing regular sprouts, index, vigor, fresh weight of sprouts, dry weight of sprouts, and reducing seeds that have not yet grown.(Candra et al., 2017).

Research Method

This research was carried out at the Seed Technology Laboratory of the Indonesian Methodist University, Tanjung Sari, Medan Selayang District, Medan City, with an altitude of ± 32 meters above sea level (masl). The research method used in this research was a completely randomized design (RAL) Factorial with 2 treatment factors. The first factor is variety (V), consisting of V1 = Callina, V2 = California, and V3 = Local. The second factor is the concentration of the KNO3 (K) solution consisting of: K0 = Control, K1 = 10%, K2 = 20% and K3 = 30%. Data analysis uses analysis of variance. The variables observed were growth synchrony and germination speed index. An analysis of variance was used to test the effect of treatment. To test mean differences between treatments, honest significant difference tests, regression, and correlation were carried out at a test level of 5%.

Results and Discussion

Simultaneity of Growth (%)

DataSimultaneous growth of several varieties of papaya seeds due to the concentration of KNO3 solution. The variance list shows that papaya varieties and the concentration of KNO3 solution have a significant effect on the synchrony of papaya seed growth. In contrast, the interaction between the two treatments has no significant effect on the synchrony of papaya seed growth. Table 1 presents the average growth synchronization of various seeds of several papaya varieties as a result of treatment with different concentrations of KNO3 solution.

Table 1. AverageSimultaneous Growth (%) of Several Varieties of Papaya Seeds Due to Different KNO3 Concentration Treatments

Treatment	Simultaneity of Growth (%)
V1	6.79c
V2	8.06b
V3	9.38a
K0	7.60c
K1	7.86bc
K2	8.35ab
K3	8.50a
$V1K_0$	6.24
$V1K_1$	6.60
$V1K_2$	7.11
$V2K_0$	7.21
$V2K_1$	7.62
$V2K_2$	7.79
$V3K_0$	8.35
$V3K_1$	8.48
$V3K_2$	8.96
$V4K_0$	9.18
$V4K_1$	9.59
$V4K_2$	9.81

Information:Numbers followed by the same letter in the same column mean that they are not significantly different in the DMRT test at the 5% test level.

Table 1 shows that the use of different seed varieties results in different seed growth synchronization. The highest synchronization of seed growth was found in the V3 variety, which was significantly different from V1 and V2. The simultaneity of seed growth in treatment V2 was significantly different from V1. The relationship between seed variety and seed growth synchronization is shown in Figure 1.

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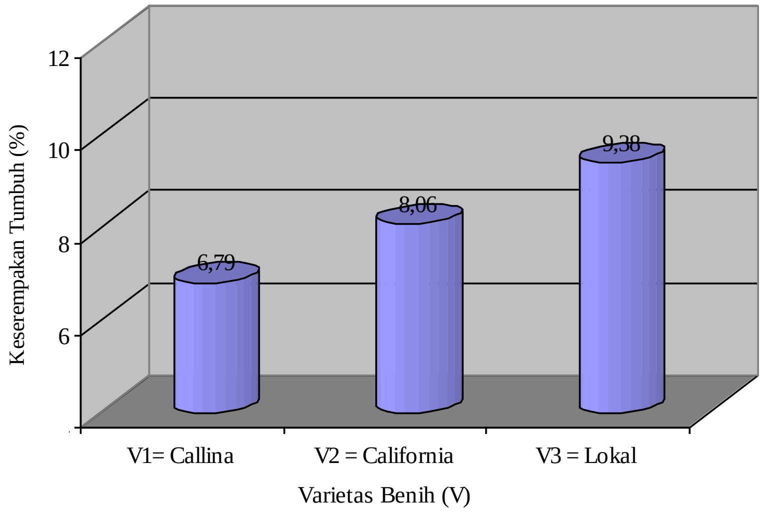

Figure 1. Histogram of the Effect of HubhU Seed Varieties on Simultaneity of Seed Growth

Figure 1 shows that the simultaneity of seed growth is higher in the V3 (local) variety compared to the V1 (Callina) and V2 (California) varieties. The lowest seed growth simultaneity was found in the V1 (Callina) variety.

Table 1 shows that in the KNO3 concentration treatment, the highest seed growth simultaneity was found in the K3 treatment, which was significantly different from K0 and K1 but not significantly different from K2. The simultaneity of seed growth in the treatments K2 was significantly different from K0 but not significantly different from K1. The simultaneity of seed growth in treatment K1 was not significantly different from K0. The effect of KNO3 concentration on seed growth synchronousness can be seen in Figure 2.

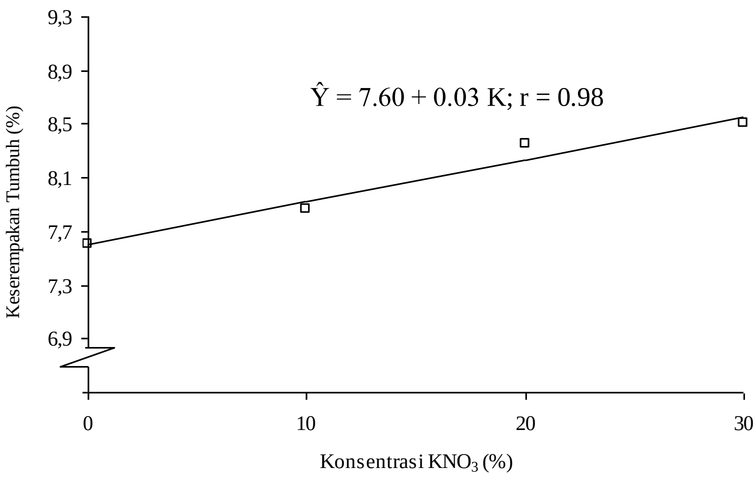

Figure 2. Effect of KNO3 Concentration on Simultaneity of Seed Growth

Picture 2 shows that the higher the KNO3 concentration, the greater the simultaneity of seed growth, following a positive linear regression curve. Every increase in KNO3 concentration by 1% can increase the synchronization of seed growth by 0.03%.

Germination Speed Index (%)

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DataGermination speed index of several varieties of papaya seeds due to the concentration of KNO3 solution. The variance list shows that papaya variety and KNO3 solution concentration have a significant effect on the papaya seed germination speed index, while the interaction between the two treatments has no significant effect on it. Table 2 presents the average germination speed index for various papaya varieties of seeds treated with different concentrations of KNO3 solution.

Table 2. AverageGermination Speed Index (%) Several Varieties of Papaya Seeds Due to Different KNO3 Concentration Treatments

Treatment	Germination Speed Index (%)
V1	8.02c
V2	8.36b
V3	8.67a
K0	8.19b
K1	8.30ab
K2	8.42a
K3	8.49a
$V1K_0$	7.88
$V1K_1$	7.97
$V1K_2$	8.05
$V2K_0$	8.18
$V2K_1$	8,10
$V2K_2$	8.29
$V3K_0$	8.52
$V3K_1$	8.55
$V3K_2$	8.60
$V4K_0$	8.63
$V4K_1$	8.70
$V4K_2$	8.75

Information: Numbers followed by the same letter in the same column mean that they are not significantly different in the DMRT test at the 5% test level.

Table 2 shows that different seed varieties produce different seed germination speed indices. The highest seed germination speed index was found in the V3 variety, which was significantly different from V1 and V2. The seed germination speed index in treatment V2 was significantly different from V1. The relationship between seed variety and seed germination speed index is shown in Figure 3.

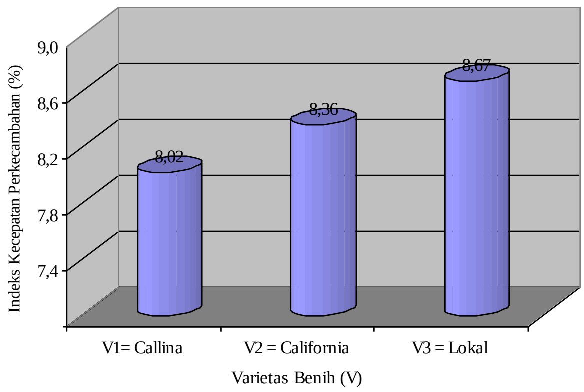

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Figure 3. Histogram of the Effect of HubhU Seed Varieties on Seed Germination Speed Index

Figure 3 shows that the seed germination speed index is higher in the V3 (local) variety than in the V1 (Callina) and V2 (California) varieties. The lowest seed germination speed index was found in the V1 (Callina) variety.

Table 5 shows that in the KNO3 concentration treatment, the highest seed germination speed index was found in the K3 treatment, which was significantly different from K0 but not significantly different from K1 and K2. The index of seed germination speed in the treatments was significantly different from K0 but not significantly different from K1. The seed germination speed index in treatment K1 was not significantly different from K0. The effect of KNO3 concentration on the seed germination speed index can be seen in Figure 4.

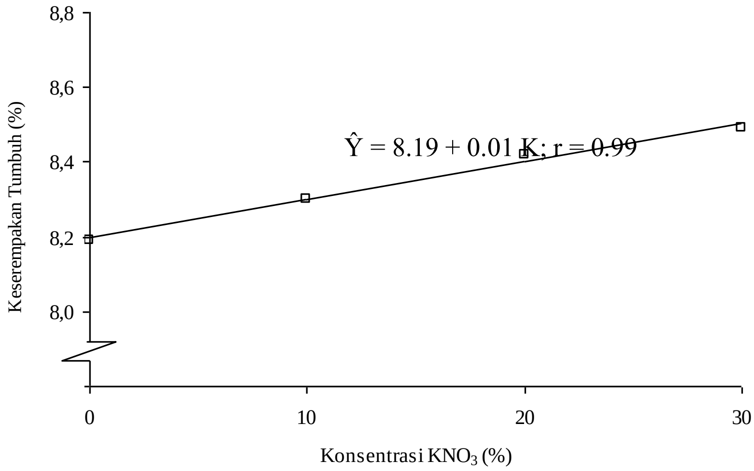

Figure 4. Effect of KNO3 Concentration on Seed Germination Speed Index

Picture 4 shows that the higher the KNO3 concentration, the higher the seed germination speed index increases following a positive linear regression curve. Every increase in KNO3 concentration by 1% can increase the seed germination speed index by 0.01%.

Discussion

***Influence of Seed Varieties on Papaya Seed Dormation (Carica papaya* L.)**

Results The variance test showed that papaya seed varieties significantly affected germination, maximum growth potential, vigor index, germination speed index, and growth simultaneity but had no significant effect on seed dormancy breaking age.

The results showed that seed variety affected the germination speed index. The highest germination speed index found in treatment amounted to 8.67%, while the lowest was in treatment V1 at 8.02%. Seeds with more food reserves will germinate faster. Seeds that germinate quickly mean they have the opportunity to grow a longer embryonic axis, allowing for swelling at the tip so that the roots become longer. The roots will continue to develop and stimulate the growth of the root system(Dhani et al., 2014; Dharma et al., 2015; Sitorus et al., 2024).

The results of the research show that seed variety influences the synchronization of seed growth. The highest growth synchrony was found in treatment, which amounted to 9.38%, while the lowest was in treatment V1 at 6.79%. It is suspected that the seeds of the Callina and California papaya varieties contain more excellent water content, which will affect the viability of the seeds, which will be lower compared to papaya varieties with lower water content. According to(Maisaroh, 2023; Panataria et al., 2024), variety can affect the seed dormancy period, where seeds with a smaller size have a more extended seed dormancy period. The low seed germination obtained in this study may be due to germination being carried out indoors in conditions with a lack of sunlight, which will cause the germination environment to be less than optimal so that the seeds cannot grow normally. This non-optimal environment also causes seed germination to be low and the coefficient of diversity in the variety to be high. A study(Haryanto, 2021)states that to germinate, papaya seeds need light, and this light requirement can be provided before the seeds are planted through drying. Generally, embryos that are covered during maturation by parent tissue containing a certain amount of chlorophyll need sufficient light to germinate. This is because chlorophyll absorbs red phytochrome wavelengths, which inhibit the formation of infrared light into other forms in the ripening embryo, so mature seeds need infrared phytochrome to stimulate germination. Papaya seeds that come from overripe or overripe fruit are the most appropriate as a seed source. (Dipenogoro, 2019)Stated that seeds originating from Mengkal papaya fruit that were not cured for 0 days had low seed viability and vigor. Ripening Mengkal papaya fruit can increase seed viability and vigor. Ripening papaya fruit for 4 and 7 days produces vigor and viability that is as good as seeds from ripe papaya trees with a yellow tinge of 80 - 85%.

***Effect of KNO3 Solution Concentration on Dormation Breaking of Papaya Seeds (Carica papaya* L.)**

Results The variance test shows that the concentration of the KNO solution3 has a significant effect on growth synchrony and germination speed index.

The results showed that the highest growth simultaneity was found when the seeds were soaked in the KNO solution$_3$ with a concentration of 30%, which is 8.50%. According to (Haryanto, 2021), soaking seeds in a solution KNO3 concentration of 20% is adequate for accelerating papaya seed germination. According to (Anggraini, 2018), administering KNO3 compounds by increasing concentration can increase seed germination. According to (Lasut et al., 2022) that, germination involves a series of events starting with imbibition. The anatomical and chemical structure of the skin influences the diffusion of water and gas into the seed. Seed coats can be categorized as permeable or impermeable, depending on their ability to absorb water. Permeable seeds have soft seed coats so that the seeds absorb water quickly, whereas hard seeds cannot pass water in after a few days or weeks and remain dormant, while hard seed coats are a mechanism for plants to survive against pressure coming from the environment. Around. Soaking seeds in a KNO3 solution can speed up the process of softening the seeds so that water will enter the seeds, which makes the seeds germinate faster.

The results showed that the highest germination speed index was found when the seeds were soaked in the KNO solution$_3$ with a concentration of 30%, which was 8.67%. The greater the KNO3 concentration, the higher the germination speed index. This is because giving KNO3 is effective in accelerating seed germination and accelerating seed acceptance of O2. Dormancy can be overcome by using chemicals to stimulate seed germination, with chemicals, for example, KNO3, as a substitute for the function of light and temperature and to speed up the seed's acceptance of O2, softening the seed coat. Providing KNO3 can also increase the activity of the hormone, which makes it easier for the seed coat to absorb water during the imbibition process. KNO3 plays a role in stimulating germination in almost all types of seeds. Soaking treatment in

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KNO3 solution is also reported to activate cell metabolism and accelerate germination (M. Ardi et al., 2018)

Solution KNO3 has also been proven effective in breaking the dormancy of several plant seeds, including rice and sugar palm. KNO3 functions to increase growth hormone activity in seeds. The size of its concentration determines its effect. Initial treatment with KNO3 solution plays a role in stimulating germination in almost all types of seeds. Soaking treatment in KNO3 solution is also reported to activate cell metabolism and accelerate germination (Solle et al., 2022).

The results showed that soaking the seeds in the KNO solution up to 30% concentration has no significant effect on germination capacity, age at dormancy break, maximum growth potential, and vigor index. This is because a concentration of 30% is not optimal for increasing the germination process of papaya seeds, so it is necessary to use KNO3 at a higher concentration. Research by (Loayza et al., 2023) states that the use of KNO3 up to 15% has no natural effect on breaking the dormancy and vigor of papaya seeds.

The results showed that soaking papaya seeds in a KNO solution at up to 30% concentration can accelerate seed germination. However, it is not optimal to increase the entire germination process; there is an increase in the germination process in papaya seeds. This shows that the KNO3 concentration treatment was able to overcome embryo dormancy and increase the seed vigor index. This non-optimal effect is allegedly caused by poor seed storage processes, resulting in increased seed water content along with the length of time the seeds are stored. The high water content of seeds causes seed respiration to increase. Food reserves in seeds decrease along with the level of seed respiration (Panataria et al., 2023; Umar, 2012).

***Effect of Seed Variety Interaction and KNO3 Solution Concentration on Papaya Seed Dormition Breaking (Carica papaya* L.)**

The interaction between the variety and concentration of KNO3 solution had no significant effect on all observed parameters. This is because the papaya seed skin of the three varieties is similar, so soaking the three varieties of papaya seeds in the KNO3 solution does not have a different effect.

Conclusion

Seed variety has a significant effect on growth synchrony and germination speed index. The concentration of KNO3 solution also has a significant effect on growth synchrony and germination speed index. However, the interaction between the variety and concentration of KNO3 solution had no significant effect on all observed parameters. **Suggestion.** To break the dormancy of papaya seeds, soak them in a 30% concentration of KNO3 solution. Research using a concentration above 30% is necessary.

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References

Anggraini, P. D. (2018). *Pengaruh pemberian senyawa KNO3 (Kalium Nitrat) terhadap pertumbuhan kecambah sorgum (Sorghum bicolor (L.) Moench)*.

Ardi, D. T., & Ginting, J. (2018). Pemberian KNO3 dan Air Kelapa Pada Uji Viabilitas Benih Pepaya (Carica papaya L): Application of KNO3 and coconut water on papaya seed viability test (Carica papaya L). *JURNAL AGROEKOTEKNOLOGI*, *6*(4), 730–737.

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E-ISSN: 2829-2421
https://doi.org/10.47709/joa.v3i02.3963

Ardi, M., Tahmir, S., & Pertiwi, N. (2018). Knowledge and attitudes with family role in prevention of pulmonary tuberculosis in Maros, Indonesia. *Journal of Physics: Conference Series*, *1028*(1), 12001.

Ariani, E., Yetti, H., & Situmorang, Y. (2017). The Effect of Cocoa Fruit Compost and Phosphorus Fertilizer on the Growth and Results of Red Onion (Allium ascalonicum L.). *FAKULTAS PERTANIAN, PERIKANAN, DAN BIOLOGI UNIVERSITAS BANGKA BELITUNG*, 107.

Avivi, S. (2021). *Buku Teks Fisiologi & Metabolisme Benih*. UPT Penerbitan & Percetakan Universitas Jember.

Candra, R. A., Lahay, R. R., & Sitepu, F. E. T. (2017). Pengaruh Perendaman Beberapa Konsentrasi Potassium Nitrat (KNO3) dan Air Kelapa Terhadap Viabilitas Biji Delima (Punica granatum L.): Effect of Potassium nitrate (KNO3) and Coconut Water Concentrationon Seed Viability of Pomegranate (Punica granatum L.). *Jurnal Agroekoteknologi*, *5*(3), 700–706.

Devi, N. I. (2022). *Kajian analisis Dormansi Pada Tumbuhan*. UIN RADEN INTAN LAMPUNG.

Dhani, H., Wardati, W., & Rosmimi, R. (2014). *Pengaruh pupuk vermikompos pada tanah inceptisol terhadap pertumbuhan dan hasil sawi hijau (Brassica juncea L)*. Riau University.

Dharma, S., Sakka Samudin, A., & Eka, I. P. (2015). *Perkecambahan benih pala (Myristica fragrans Houtt.) dengan metode skarifikasi dan perendaman ZPT alami*. Tadulako University.

Dipenogoro, M. Z. F. (2019). *Pematahan Dormansi Benih Pepaya (Carica Papaya l.) Dengan Berbagai Periode After-Ripening Dan Konsentrasi KNO3*. Universitas Pembangunan Nasional Veteran Yogyakarta.

Haryanto, W. D. (2021). Pengaruh Konsentrasi Kalium Nitrat Dan Lama Perendaman Benih Terhadap Pematahan Dormansi Benih Pepaya. *Naskah Publikasi Program Studi Agroteknologi*.

Lasut, K. Y., Pinaria, A., & Raintung, J. (2022). EFFECT OF CONCENTRATION KNO_3 AND DURATION OF SOAKING ON THE GERMINATION OF SUGAR PALM (Arenga pinnata (Wurmb.) Merr.) SEEDS. *Jurnal Agroekoteknologi Terapan*, *3*(1), 99–107.

Lisarini, E. (2019). Pengaruh Media Perendaman Terhadap Pematahan Dormansi, Perkecambahan Dan Vigositas Bibit Pepaya (Carica Papaya L.). *AGROSCIENCE*, *1*(2), 45–49.

Loayza, A. P., García-Guzmán, P., Carozzi-Figueroa, G., & Carvajal, D. E. (2023). Dormancy-break and germination requirements for seeds of the threatened Austral papaya (Carica chilensis). *Scientific Reports*, *13*(1), 17358.

Maisaroh, S. (2023). *Pengaruh lama pemaparan dan kuat medan elektromagnetik terhadap pematahan dormansi biji saga pohon (adenanthera pavonina L.)*. Universitas Islam Negeri Maulana Malik Ibrahim.

Maulidina, N. R. (2020). *Pengaruh pemberian thidiazuron (TDZ) dan hidrolisat kasein terhadap multiplikasi subkultur tunas porang (Amorphophallus muelleri Blume)*. Universitas Islam Negeri Maulana Malik Ibrahim.

Journal of Agriculture (JoA)
Volume: 3 | Number 2 | July 2024
E-ISSN: 2829-2421
https://doi.org/10.47709/joa.v3i02.3963

Mubarrok, F. (2018). *erkecambahan Benih Dan Pertumbuhan Bibit Pepaya (Carica Papayal.) Varietas Callina Pada Perlakuan Air Hangat Dan Medan Magnet.* University of Muhammadiyah Malang.

Panataria, L. R., Saragih, M., Sitorus, E., Simanjuntak, P., Sidauruk, L., Nobel, N., & Panjaitan, E. (2023). Response of Growth and Production of Shallots (Alium cepa L.) to Planting Spacing and Watering Time Eco Enzyme. *Jurnal Penelitian Pertanian Terapan*, *23*(3), 393–398.

Panataria, L. R., Sihombing, P., Sitorus, E., Saragih, M. K., & Manurung, A. I. (2024). Growth Response and Soybean Production (Glycine max L. Merr) Variety Anjasmoro and Grobogan on Giving Dosesof Fertilizer KCl. *International Journal of Multidisciplinary Approach Research and Science*, *2*(01), 165–181.

Purnadi, P., Widhiandono, H., & Darmawan, A. (2017). Penyuluhan kewirausahaan dan cara penanaman pepaya california pada lahan kosong untuk meningkatkan kesejahteraan buruh tani. *Media Ekonomi*, *17*(1), 55–58.

Rahayu, S. (2017). *Isolasi Pektin dari Kulit Pepaya (Carica papaya L.) dengan Metode Refluks Menggunakan Pelarut HCl Encer*. POLITEKNIK NEGERI SRIWIJAYA.

Rahayu, W., & Puspitasari, D. (2021). Penambahan infusa buah papaya california (Carica Papaya L.) Dengan dosis Yang Berbeda Terhadap Kecerahan Warna Pada Ikan Komet (Carasiusauratus). *TOR: Jurnal Budidaya Perairan*, *1*(2).

Sinaga, K., CC, C. H. E. N., & Jagau, Y. (2021). Pematahan Dormansi Benih Kelapa Sawit (Elaeis guinensis Jacq.) Menggunakan Kalium Nitrat (KNO3) dan Air Kelapa. *AgriPeat*, *22*(01), 1–10.

Sitorus, E., Sihombing, P., Panataria, L. R., & Saragih, M. K. (2024). PENGARUH PEMBERIAN PUPUK KANDANG AYAM DAN PENGAPURAN TERHADAP PERTUMBUHAN DAN PRODUKSI TANAMAN JAGUNG MANIS (Zea mays saccharata sturt) DI TANAH ULTISOL. *Jurnal Pertanian Agros*, *26*(1), 5263–5275.

Solle, H. R. L., Taniu, S. I., & Hendrik, A. C. (2022). Pengaruh Lama Perendaman Kno3 terhadap Perkecambahan Benih Pinang (Areca Catechu Linn). *Journal Penelitian Kehutanan FALOAK*, *6*(1), 16–28.

Suriana, C., Junita, D., & Sahputra, H. (2022). Efektivitas Metode Pematahan Dormansi Terhadap Viabilitas Dan Vigor Benih Sawo Manila (Manilkara zapota (L.) Van Royen). *Jurnal Pertanian Agros*, *24*(3), 1407–1413.

Umar, S. (2012). Pengaruh pemberian bahan organik terhadap daya simpan benih kedelai {Glycine max (L.) Merr.}. *Berita Biologi*, *11*(3), 401–410.

Wibawa, N. F. (2015). *Uji Tetrazolium Sebagai Tolok Ukur Viabilitas Dan Vigor Benih Pepaya (Carica papaya L.)*. UNS (Sebelas Maret University).