



GERMINATION OF TOMATO SEEDS (*Solanum Lycopersicum* L.) BASED ON SEED AGE AND TYPE OF SEEDLING MEDIA USING THE F&F MANUAL GERMINATOR TOOL

PERKECAMBAHAN BENIH TOMAT (*Solanum Lycopersicum* L.) PADA UMUR BENIH DAN JENIS MEDIA SEMAI MENGGUNAKAN ALAT F&F MANUAL GERMINATOR

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Abstract

The purpose of this study was to determine the effect of different seed age treatments and seedling media types on seed viability and vigor of tomato seeds. The results showed that seed age treatments significantly affected germination rate, vigor index, growth synchrony, growth rate, normal seedling length, and normal seedling fresh weight. Meanwhile, different seedling media treatments significantly affected tomato seed viability and vigor. Furthermore, there was a significant interaction between seed age treatments and media types on all parameters of tomato seed viability and vigor.

Keywords: *seedling media, seed age, and germinator*

Abstrak

Tujuan dari penelitian ini adalah untuk mengetahui pengaruh perlakuan umur benih dan jenis media semai yang berbeda terhadap viabilitas benih dan vigor benih tomat. Hasil menunjukkan bahwa perlakuan umur benih berpengaruh nyata terhadap daya kecambah, indeks vigor, keserempakan tumbuh, kecepatan tumbuh, panjang kecambah normal, dan berat basah kecambah normal. Sementara itu, perlakuan media semai yang berbeda memberikan pengaruh yang sangat nyata terhadap viabilitas dan vigor benih tomat. Selain itu, terdapat interaksi yang nyata antara perlakuan umur benih dan jenis media yang berbeda terhadap semua parameter viabilitas benih dan vigor benih tomat.

Kata kunci: media semai, umur benih, dan germinator.

INTRODUCTION

Seed quality is the primary factor in determining the success of plant cultivation. (Bahtiar, *et al.*, 2020). Quality seeds are characterized by, among other things, high germination and seedling growth rates (Stanisavljevic *et al.*, 2020; Kumar *et al.*, 2016), resistance to climate change, high antioxidant levels, and membrane integrity during germination (Kumar *et al.*, 2016).

To increase tomato productivity, high-quality seeds are needed. Seed quality can also decline due to improper storage or because seeds have passed their useful life (expiration date)



(Ernawati *et al.*, 2017). One frequently observed obstacle is the rotation of seeds whose activity time has exceeded the specified limit, i.e., expired seeds.

Decreased seed quality can be indicated by increased numbers of abnormal sprouts, reduced germination capacity, and reduced tolerance to optimal germination conditions (Ilyas, 2012). Expired seeds can reduce seed viability, and seed germination capacity will also decrease. Several factors, including seed maturity at harvest, the pre-harvest environment, the environment during seed storage, and the initial viability of the seeds, can also influence seed viability (Ernawati *et al.*, 2017).

According to Iqbal's (2019), research, seedling media treatment significantly affects the germination rate of expired red chili seeds, with rice husks yielding the highest germination rate. The planting medium is also an external factor influencing germination. Selecting the appropriate germination medium is crucial for developing seed viability testing methods, ensuring standardization (Rusmin *et al.*, 2014).

Seed germinators maintain environmental conditions that meet germination requirements. The F&F Manual Germinator is a tool that helps seeds germinate optimally under ideal environmental conditions. Seed testing under normal field conditions is suboptimal because results cannot be consistently reproduced. Therefore, laboratory testing is conducted by adjusting environmental conditions to achieve consistent, rapid, and complete germination in most seed samples (Nurhafidah *et al.*, 2021).

In addition to reducing germination and growth in laboratory seed testing, suboptimal laboratory conditions, expensive methods and media, and a lack of equipment for seed germination testing often result in seeds failing to germinate correctly or accurately. The F&F Manual Germinator seed germination tool can improve the germination of rice, corn, and soybean seeds, thereby increasing their viability and vigor. (Faisal *et al.*, 2022). Therefore, it is necessary to test tomato seeds of different ages and use the F&F Manual Germinator seed germination tool to provide optimal conditions for seed germination and increase germination rates (Faisal *et al.*, 2022). This study aims to determine tomato seed germination across various seed ages and seedling media using the F&F germinator tool.

RESEARCH METHODS

Place and Time of Research

This research was conducted at the Agroecotechnology Laboratory, Faculty of Agriculture, Universitas Malikussaleh, in Reuleut Timu Village, Muara Batu District, North Aceh Regency. The study was conducted in March 2025.

Research Materials and Tools

The materials used in this study are: rice paper, tissue paper, opaque paper, tomato seeds with expiration dates of 3 and 6 months, fresh tomato seeds, and clean water. The tools used in this study include a manual germinator (F&F), scissors, stationery, a measuring tape, a bottle of *hand spray*, tweezers, an analytical balance, a camera, and other supporting equipment.



Experimental Design

This study used a Completely Randomized Design (CRD) with a factorial pattern, with 2 factors and 3 replications each. Two factors were studied: the seed factor (B), with 3 levels: new tomato seeds (B1), 3-month-expired tomato seeds (B2), and 6-month-expired tomato seeds (B3). The second factor, namely the seeding media factor (M), has 3 levels: rice straw media (M1), towel tissue media (M2), and opaque paper media (M3). Thus, 9 experimental combinations were obtained, with 3 repetitions, for a total of 27 experimental units. Furthermore, the data were analyzed using the Duncan Multiple Range Test.

RESULTS AND DISCUSSION

Research result

Maximum Seed Growth Potential (%)

The analysis of variance showed that the seed age treatment did not have a significant effect. In contrast, seedling media treatment had a highly significant effect on the observed maximum seed growth potential. The average results of observations on the seed growth potential value after testing using DMRT at the 5% level are presented in Table 1.

Table 1. Average maximum growth potential value of tomato seeds due to different treatments of expired seed age and different types of seedling media.

Seed Age (B)	Type of Seeding Media (M)			Average B
	M1	M2	M3	
B1 (New Seed)	89.33 b A	97.33 a A	97.33 a A	89.78 a
B2 (Seed Expiration 3 months)	82.67 b B	93.33 a A	82.67 b B	86.67 a
B3 (Seed Expiration 6 months)	63.33 b C	93.33 a A	82.67 b B	86.22 a
Ratan M	79.11 c	94.67 a	88.89 b	

Description: Numbers followed by the same lowercase letter in the same row and numbers followed by the same uppercase letter in the same column are not significantly different in the DMRT test at the 5% level.

The results of the DMRT test at the 5% level, presented in Table 1, show that seed age treatment did not significantly affect the observed seed growth potential. However, the new seed treatment (B1) tended to yield the highest maximum seed growth potential, namely 89.78%. Meanwhile, treatments with different types of seedling media significantly affected seed growth potential. The highest seed growth potential was observed in the tissue towel seedling media treatment (M2), at 94.67%. In comparison, the lowest seed growth potential was observed in the rice straw paper seedling media treatment (M1), at 79.11%.

Table 1 shows that the interaction between seed age and different types of seedling media significantly affects seedling growth potential. The best new seed treatment (B1) was found at the tissue towel (M2) and opaque paper (M3) seedling media levels. For seeds with a 3-month expiration date (B2), the best results were observed in the tissue towel (M2) seedling media,



which differed significantly from the old treatment levels in other seedling media. Meanwhile, for seeds with a 6-month expiration date (B3), the best results were observed in the tissue towel (M2) seedling media, with a higher growth potential value than the other treatments.

Seed Germination Power (%)

The analysis of variance results showed that different seed age treatments and seedling media types significantly affected seed germination. The average observed seed germination values after DMRT testing at the 5% level are presented in Table 2.

Table 2. Average germination value of tomato seeds due to different seed age treatments and types of seedling media.

Seed Age (B)	Type of Seeding Media (M)			Average B
	M1	M2	M3	
B1 (New seeds)	74.67 c A	86.67 a A	81.33 b A	80.89 a
B2 (Seed Expiration 3 months)	72.00 c A	84.00 a AB	77.33 b B	77.78 b
B3 (Seed Expiration 6 months)	68.00 c B	80.00 a B	60.00 b C	69.33 c
Ratan M	71.56 b	83.56 a	72.89 b	

Description: Numbers followed by the same lowercase letter in the same row and numbers followed by the same uppercase letter in the same column are not significantly different in the DMRT test at the 5% level.

Table 2 shows that seed age treatment significantly affected the observed seed germination rate. The highest seed germination rate was observed in the new seed treatment (B1) at 80.89%, while the lowest was in the 6-month-expired seed treatment (B3) at 69.33%. Meanwhile, different seeding media treatments significantly affected the observed seed germination rate. The highest seed germination rate was observed in the tissue towel seeding treatment (M2), at 83.56%. In comparison, the lowest value was observed in the rice straw paper seeding media treatment (M1; 72.56%), but it was not significantly different from the opaque paper seeding media (M3).

Table 2 also shows that the interaction between expired seed age and different seeding media significantly affected observed seed germination rates. The best new seed treatment (B1) was found at the tissue towel seeding media level (M2), which was significantly different from the other seeding media treatments. For 3-month-old seeds (B2), the best results were observed at the tissue towel seeding media level (M2), which showed the highest germination. Meanwhile, for 6-month-expired seed treatment (B3), the best results were obtained with tissue towel seeding media (M2) and opaque paper seeding media (M3).

Seed Vigor Index (%)

The analysis of variance results showed that different seed age treatments and seedling media types significantly affected the observed seed vigor index values. The average observed seed vigor index values after DMRT testing at the 5% level are presented in Table 3.



Table 3. Average value of tomato seed vigor index due to different seed age treatments and types of seedling media

Seed Age (B)	Type of Seeding Media (M)			Average B
	M1	M2	M3	
B1 (New Seed)	42.67 b A	64.00 a A	41.33 b B	49.33 a
B2 (Seed Expiration 3 months)	34.67 b C	41.33 a A	42.67 a A	39.56 b
B3 (Seed Expiration 6 months)	30.67 c B	37.33 a A	33.33 b B	33.78 c
Ratan M	36.00 c	47.56 a	39.11 b	

Description: Numbers followed by the same lowercase letter in the same row and numbers followed by the same uppercase letter in the same column are not significantly different in the DMRT test at the 5% level.

The results of the DMRT test at the 5% level, presented in Table 3, show that seed age treatment has a highly significant effect on the observed seed vigor index. The highest seed vigor index value was found in the new seed treatment (B1) at 49.33%, while the lowest vigor index value was found in the 6-month expired seed treatment (B3) at 33.78%. Meanwhile, the treatment with different seed media types had a highly significant effect on the observed seed germination rate. The highest seed vigor index value was found in the tissue towel seedling treatment (M2) with a value of 47.56%, while the lowest vigor index value was found in the rice straw paper seedling treatment (M1) with a value of 36.00%.

Table 3 also shows that the interaction between seed age and seedling media types significantly affected observed seed germination. The best new seed treatment (B1) was found at the tissue towel seedling media level (M2), which was significantly different from the other seedling media treatment levels. For seeds with a 3-month expiration date (B2), the best results were found at the tissue towel seedling media level (M2) and the cotton wound seedling media level (M3). Meanwhile, for seeds with a 6-month expiration date (B3), the best results were observed in the tissue towel seedling media (M2), which showed the highest growth potential.

Seed Growth Simultaneity (%)

The results of the analysis of variance showed that different seed age treatments and seedling media types had very significant effects on the observed seed growth simultaneity values. The average results of observations on seed growth simultaneity values after testing using DMRT at the 5% level are presented in Table 4.

The results of the DMRT test at the 5% level, presented in Table 4, show that the seed age treatment significantly influenced the observed seed growth simultaneity values. The highest seed growth simultaneity value was observed in the new seed treatment (B1) at 70.67%, while the lowest was observed in the 6-month-expired seed treatment (B3) at 58.67%. Meanwhile, the treatment of different seed media types significantly influenced the observed seed growth simultaneity values. The highest seed growth simultaneity value was observed in the tissue towel seedling treatment (M2; 69.78%), while the lowest was observed in the rice straw paper seedling treatment (M1; 56.00%).



Table 4. Average value of simultaneity of tomato seed growth due to different seed age treatments and types of seedling media.

Seed Age (B)	Type of Seeding Media (M)			Average B
	M1	M2	M3	
B1 (New Seed)	65.33 b A	78.67 a A	68.00 b B	70.67 a
B2 (Seed Expiration 3 months)	44.00 b C	65.33 a A	66.67 a A	58.67 b
B3 (Seed Expiration 6 months)	58.67 b B	65.33 a A	52.00 b B	58.67 b
Ratan M	56.00 c	69.78 a	62.22 b	

Description: Numbers followed by the same lowercase letter in the same row and numbers followed by the same uppercase letter in the same column are not significantly different in the DMRT test at the 5% level.

Table 4 also shows that the interaction between seed age and different types of seedling media significantly affected the observed simultaneity of seedling growth. The best treatment for new seeds (B1) was found at the tissue towel seedling media level (M2), which was significantly different from the other seedling media treatment levels. For seeds with a 3-month expiration date (B2), the best results were found at the tissue towel seedling media level (M1) and opaque paper media level (M3). Meanwhile, for seeds with a 6-month expiration date (B3), the best results were obtained in the tissue-towel seedling medium (M2).

Seed Growth Rate (%)

The analysis of variance showed that different seed age treatments and seedling media types had significant effects on observed seed growth rates. The average results of DMRT tests on seed growth rates at the 5% level are presented in Table 5.

Table 5. Average growth rate of tomato seeds due to different seed age treatments and types of seedling media.

Seed Age (B)	Type of Seeding Media (M)			Average B
	M1	M2	M3	
B1 (Non-Expired Seeds)	57.11 b A	74.00 a A	57.78 b B	62.96 a
B2 (Seed Expiration 3 months)	40.67 b B	58.22 a A	59.56 a A	52.81 b
B3 (Seed Expiration 6 months)	49.11 b C	57.56 a A	45.33 b B	50.67 b
Ratan M	48.96 c	63.26	54.22 b	

Description: Numbers followed by the same lowercase letter in the same row and numbers followed by the same uppercase letter in the same column are not significantly different in the DMRT test at the 5% level.

The results of the DMRT test at the 5% level, presented in Table 5, show that the seed age treatment significantly affects the observed seed growth rate. The highest seed growth rate was found in the new seed treatment (B1) at 62.96%, while the lowest seed growth rate was found in the 6-month expired seed treatment (B3) at 50.67%. Meanwhile, the treatment with different



seedling media types had a highly significant effect on the observed seed growth rate. The highest seed growth rate was found in the tissue towel seedling treatment (M2) with a value of 63.26%, while the lowest seed growth rate was found in the rice straw paper seedling treatment (M1) with a value of 48.96%.

Table 5 also shows that the interaction between seed age and seedling media types significantly affected observed seedling growth rates. The best treatment for new seeds (B1) was towel tissue seedling media (M2), which was significantly different from the other seedling media treatments. For seeds with a 3-month expiration date (B2), the best results were obtained in the towel tissue seedling media (M2) and the wound cotton media (M3). Meanwhile, for seeds with a 6-month expiration date (B3), the best results were observed in the towel tissue seedling media (M2) and the rice straw paper media (M1), which showed higher seedling growth rates.

Normal Dry Weight of Sprouts (mg)

The analysis of variance showed that different seed age treatments and seedling media types had a highly significant effect on the observed dry weights of normal seedlings. The average dry-weight results for normal seedlings after DMRT testing at the 5% level are presented in Table 6.

Table 6. Average dry weight value of normal sprouts due to different seed age treatments and types of seedling media

Seed Age (B)	Type of Seeding Media (M)			Average B
	M1	M2	M3	
B1 (Seed)	1.47 b B	1.67 a A	1.59 b B	1.57 a
B2 (Seed Expiration 3 months)	1.17 b A	1.50 b A	1.94 a B	1.54 a
B3 (Seed Expiration 6 months)	1.17 b C	1.91 a A	1.45 a A	1.51 a
Ratan M	1.27 b	1.69 a	1.66 a	

Description: Numbers followed by the same lowercase letter in the same row and numbers followed by the same uppercase letter in the same column are not significantly different in the DMRT test at the 5% level.

The results of the DMRT test at the 5% level, presented in Table 13, show that seed age treatment did not have a significant effect on the observed dry weight of normal seedlings. Meanwhile, the treatment with different types of seedling media had a highly significant effect on the observed dry weight of normal seedlings. The highest dry weight value of normal seedlings was found in the treatment of the tissue towel seedling media type (M2) with a value of 1.69 mg and the wound cotton seedling media (M3) with a value of 1.66 mg. In comparison, the lowest dry weight value for normal seedlings was observed in the rice straw paper seedling media (M1), at 1.27 mg.

From Table 14, it can be seen that the interaction between the age of expired seeds and the different types of seedling media has a highly significant effect on the observed dry weight of normal seedlings. The best treatment for new seeds (B1) was towel tissue seedling media (M2),



which was significantly different from the other seedling media treatments. For seeds stored for 3 months (B2), the best results were obtained in the wound cotton seedling medium (M3). Meanwhile, the best treatment for 6-month-old expired seeds (B3) was found in the towel tissue seedling media (M2) and the wound cotton seedling media (M3), which showed higher seed growth rates.

Discussion

Based on the research data, seed age treatment has a significant effect on seed germination, seed vigor index, seed growth simultaneity, seed growth rate, and the dry weight of normal seedlings observed. This is suspected because the longer the seed expiration period, the lower the level of seed viability and vigor, and the observed growth rate of seedlings. Meanwhile, the treatment of different types of seedling media also provides significant differences in all observed seed viability and vigor benchmarks.

Different treatments for seed age and seedling media types have significantly different effects on the maximum seed growth potential. Thus, the treatment of expired seed age does not significantly affect the seed growth potential value. This is because the length of time required for the emergence of the radicle or plumule in the seed is influenced by the seed's ability to absorb water and the ability of the embryo to emerge and germinate (Ramadhani *et al.*, 2014). Meanwhile, the treatment of different types of seedling media significantly affects seed growth potential. In the study by Sajad *et al.* (2008), it was stated that the germination media and both time and environmental conditions must be optimal to meet all the seed's needs, ensuring its potential growth under optimal field conditions.

Treatment of seed expiration dates significantly impacts seed germination. Seed quality testing conducted using the F&F Manual Germinator is also important because it can support good seed germination. All tested seed types showed good germination, indicating they were in good condition. According to Kartasapoetra (2003), high-quality seeds have a germination rate of more than 80%. With 80% seed quality, plants can grow normally under suboptimal conditions and produce optimally.

There was a significant effect on yields across seedling media treatments, with towel tissue yielding the highest. This is because the tissue has high and good water absorption, requiring humidity and temperature to be regulated to maintain moisture (Septia *et al.*, 2020). According to Ardian (2008), germination cannot occur if the seeds cannot absorb water and air from the environment.

The age of expired seeds significantly affected the seed vigor index, with unexpired seeds (B1) achieving the highest value. Seeds with high germination vigor indicate sufficient food reserves in the endosperm, which serve as an energy source for the seed during germination (Iqbal, 2019). Optimal conditions can also influence seedling growth. Pratama *et al.* (2014), stated that supportive equipment will influence seed growth.

The results of different seedling media treatments significantly affected the seed vigor index. The highest value was found in the tissue towel (M2) seedling medium. This is due to the towel's good absorbency and cavities, which allow it to retain seed moisture in the germination



apparatus. Research by Zanzibar *et al.* (2009), found that high-vigor seeds germinate faster and have a longer shelf life, even under adverse conditions.

The results of the expired seed age treatment have a significant effect on the value of seed growth simultaneity. The highest value is found in the treatment of unexpired seeds (B1). This is possible because the seeds and media are in good condition, allowing them to germinate and grow quickly and synchronously. According to Lesilolo (2013), good seeds are those that can grow quickly and synchronously. The value of seed growth simultaneity indicates the potential of seeds to grow quickly, appear uniform, and develop normal seedlings in various field conditions. In Fatihkhasari's (2022), research, high seed growth simultaneity indicates high absolute growth strength, as a group of seeds shows synchronous, vigorous growth.

The results of treating different types of seedling media have a significant effect on the value of seed growth simultaneity. This is because the media used is in good condition, allowing the seeds to germinate well and synchronously. This shows that the F&F Manual Germinator tool can increase seed vigor and viability by providing optimal germination conditions, enabling seeds to grow and exhibit strong germination performance. This aligns with the findings of Faisal *et al.* (2022), who reported that using the F&F Manual Germinator tool can improve seed germination performance.

The age of the seeds significantly affected the germination rate. The highest value was observed in the unexpired seed treatment (B1), while the lowest was in the 6-month-expired seed treatment (B3). In Iqbal's (2019), previous study, the longer the germination time of expired seeds, the more days were required, and the lower the germination rate index value. Furthermore, the treatment of different seedling media significantly affected the seed germination rate. In the seed germination rate results, the tissue towel seedling media treatment (B2) had the highest value, as tissue towel has good water absorption and high moisture resistance. Purcell (2014) explained that roots are the first structures to appear during germination. Optimal roots are needed to support plant life, as they function as nutrient absorbers. In plants, it is closely related to the plant's ability to distribute water and nutrients absorbed by the roots to all parts of the plant (Nijse, 2001).

The dry weight of normal seedlings showed that the seed age treatment did not significantly affect dry weight. Meanwhile, different seedling media treatments significantly affected the dry weight of normal seedlings. According to Nurussintani (2012), high-vigor seeds can quickly form and translocate raw materials into the embryonic cavity, thereby increasing dry matter accumulation. A high dry weight can indicate efficient use of food reserves in seeds.

CONCLUSION

1. Seed age treatment affects the benchmarks for germination power, vigor index, growth simultaneity, and seed growth speed.
2. Different types of seedling media treatments affected all observed seed viability and vigor measures. The best seedling media was found to be towel tissue.



3. There was an interaction between seed age treatment and different media types on all benchmarks of seed viability and vigor. The interaction between media treatment and expired seed age was best found for the towel tissue.

Suggestion

Based on the research results, it is suggested that towel tissue be used to germinate expired tomato seeds to improve growth, and that further research use other media.

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