

Evaluation of Emergence and Vigority of Some Genotypes of Tropical Minor Legume Landraces

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ABSTRACT

Various tropical pulses such as velvet bean, lima bean, and jack bean are leguminous plants that have legumes cultivated and are found in Indonesia. Legumes are a source of vegetable protein with a protein content ranging from 18% to 25%. The aim of study is to evaluate, assess, and identify genotypes of tropical minor legume landraces that show high emergence and vigor through this research, understanding genetic diversity in populations of tropical minor legume landraces can be obtained. This supports efforts to conserve plant genetic diversity, which is important for maintaining long-term food security and ensuring the survival of ecologically and culturally valuable plant species. The research was carried out at the Hydroponic Screen House, Faculty of Agriculture, University of Asahan, from December 2023 to February 2024. This research aims to evaluate the level of emergence or growth and identify genotypes of tropical minor legume landraces that show high emergence and vigor. The data design in this study used Complete Randomized Design (CRD) which was replicated in 3 replications and analyzed using Analysis of Variant (ANOVA) supported by the Tukey test at the 5% level, also to assist in the process of creating diagrams using the Microsoft Excel application in the insert menu, namely pivotTable, and all data analysis used SPSS application, the observed variables include: emergence, germination rate, vigor index, simultancity growth. Based on the Tukey analysis, the highest emergence is K5, P3, K4, B2, K3, B1, B4, P5, and the lowest is B3. The genotypes with the highest germination capacity were P1, P2, K1, K2, P3, P5, B1, B2, while P4, B4, K3, K4, K5, B3, B5 is the genotypes with the lowest values. The genotype with the highest vigor index is B3, P4, while the lowest is B1, P3. The genotypes with the highest growth uniformity were the P1, P2, P5, P3, B1 genotypes, and the lowest were the genotypes P4, B3, B5, K1.

Keywords: emergence, tropical legumes, velvet bean, jack bean, lima bean

INTRODUCTION

Based on data from the Directorate General of Agricultural Product Processing and Marketing (2014), various legume plants such as velvet bean, lima bean, and jack bean are legume plants that have been cultivated and are found in Indonesia.

Legumes are a source of vegetable protein with a protein content ranging from 18% to 25% (Purwanto, 2007).

High-quality seeds are free from seed-borne diseases and show high purity, viability, and seed

strength levels. The capacity to grow in the field, store well, and initiate and coordinate germination are indicators of healthy seeds. As a measure of seed quality, vigor tests are more accurate than germination tests in identifying seed degradation (Ilyas, 2012). Therefore, various vigor tests have been developed to detect the physiological quality of seeds.

The radicle emergence (RE) test is one of the indicators of seed health. The percentage of seeds that have emerged radicles with a minimum length of 2 mm in one observation at the beginning of germination is calculated to conduct the RE test. The measure of the strength of a seed is its RE value. A low RE value in the seed plot indicates slow germination, which is the main cause of reduced seed strength and is an early physiological manifestation of seed aging. Seed aging determines how long it takes for the radicle to develop (Onwimol et al., 2012). According to Matthews and Powell (2011), the RE test is closely correlated with the mean germination time (MGT), the lower the MGT value, the faster the time needed for the seeds to germinate.

According to Subantoro and Prabowo (2013), vigor is a healthy seed condition, if planted directly germinates quickly, simultaneously, and uniformly in different environments and then experiences rapid growth in normal conditions in

the field. Vigor seeds have the following characteristics: 1) have a high germination rate, 2) have good germination, growth, and development uniformity in different environments, 3) have the ability to emerge on crusted soil, 4) Have the ability to germinate and emerge in cold, wet, diseased and unsuitable temperatures (under stress conditions), 5) Sprouts can develop normally, 6) Parameters of plant appearance and yield, 7) Good storability in non-optimal conditions. The capacity of plants to grow early has a significant impact on their growth and production. Plant development and yield will be greatly supported by similar germination power and strong seed strength.

The objectives of this study were: 1) To evaluate the emergence or early growth rate of several tropical minor legume landrace genotypes. By understanding the emergence rate. 2) To assess the vigor of several tropical minor legume landrace genotypes. Vigority includes the strength and vitality of the plant in the early stages of its growth. This assessment helps to understand the overall health and growth potential of the plant. 3) To identify tropical minor legume landrace genotypes that show high emergence and vigor. Identification of superior genotypes is important in the development of superior varieties that can increase plant productivity and resistance.

RESEARCH METHODS

Research Location

The research was conducted in the campus of Asahan University, precisely in the experimental garden field of the Faculty of Agriculture, Asahan University, Asahan Regency, North Sumatra Province with an altitude of ± 25 meters above sea level. The implementation of this research began in December 2023 to February 2024.

Materials and Tools

The tools used include: petri dishes, cotton, hygrometers, and stationery. The materials used in this study were sword bean seeds (*C. ensiformis*), keratok bean seeds (*P. lunatus* L.), and benguk

bean seeds (*M. pruriens* L.), each of which had 5 seed genotypes, some of which were landraces and some of which were seeds sold on the market, as well as water to wet the cotton so that the seeds could grow.

Methods

Before the research was conducted, the seeds were weighed in grams. Prepare a digital scale to weigh how many grams per hundred seeds, starting from the jack bean, lima bean, and velvet bean seeds from various genotypes, and record the gram results that have been obtained.

In carrying out this research, many stages must be prepared and carried out, first, prepare and

sterilize the tools and materials used. Arrange and place the Petri dishes in a row and according to the order of the seeds to be observed starting from the jack bean, lima bean, and velvet bean. Place 2 sheets of make-up remover cotton in the petri dish. After that, wet the cotton with clean water but do not let it pool, select 10 seeds. Then place them in the petri dish that already contains the moistened cotton. Pay attention to the water in the cotton every day so that it does not dry out. Record the emergence and vigor of each genotype that has appeared.

In the preparation of the research location, many things must be considered and prepared, starting from the preparation of the place to be the petri dish. Then a shelter is made with a size of 4x10 meters using bamboo frame supports and the cover is made of glass plastic and parent plastic. And check the temperature of the shelter with a hygrometer. Prepare a petridish as a planting container which is then inserted with cotton which is then given a little water until it is not so stagnant. The seeds that have been prepared are then placed on the petri dish that has been given cotton and water.

Plants are observed to find out the seed cracking and always pay attention to the water so that it does not dry out and remains wet or moist. The room temperature is measured twice a week at 06.00 WIB in the morning and 13.00 WIB in the afternoon to find out the minimum and maximum temperatures using a temperature-measuring device called a hygrometer.

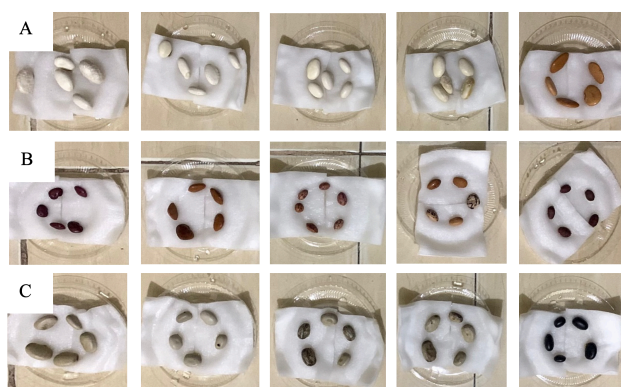


Figure 1. Placing seeds in the growing medium, A (genotype of jack bean), B (genotype of lima bean), C (genotype of velvet bean)

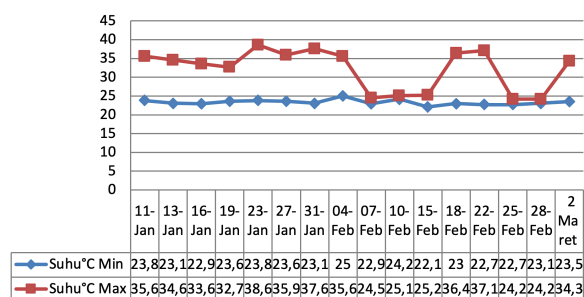


Figure 2. Minimum and maximum temperature data (January-March 2024) in the research area in °C

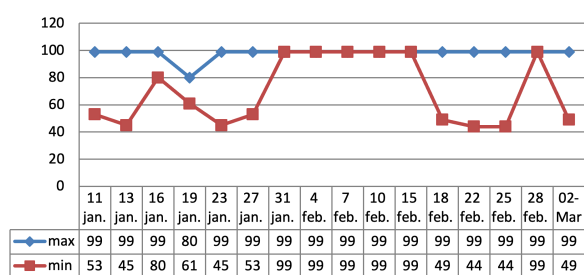


Figure 3. Minimum and maximum humidity data (January-March 2024) in the research area in %

It is known from the picture above, there is a significant difference between temperature and humidity. Serhat and Mut (2007) stated that the effect of germination temperature on germination power is important to study because the variation in optimal germination temperature requirements depends on the plant species.

Research Parameters

Emergence of Seedling

Germination is the beginning of embryo growth activity which is marked by the rupture of the seed coat and the emergence of new individual plant candidates. Seeds that have been tested are planted to determine which types of seeds have the potential to grow faster and to balance seed planting so that they grow uniformly. The radicle emergence (RE) test is a rapid vigor testing method that has been validated for corn seeds (ISTA, 2021) and soybean seeds (Astuti et al., 2020).

Germination Rate (%)

Germination rate is the ability of seeds to undergo the germination process, namely growing into new shoots or embryos. This includes various processes such as germination, root elongation, and growth of the upper part of the plant. Germination

power is an important indicator of seed viability and the potential for early plant growth. Germination power is determined by calculating the number of seeds that germinate normally using the ISTA formula (1972)

Vigor Index (%)

The measure of plant strength and vitality in the early growth phase is called the vigor index. This indicates the ability of plants to grow healthily and quickly after germination, as well as the ability to adapt to various environmental factors. Vigor index observations are carried out on the number of normal sprouts in the first count (ISTA. 2010).

Growth Simultaneity (%)

Matrix to assess how non-uniform or erratic a plant population grows. It states how non-uniform some characteristics are in a population, such as plant height, leaf size, root growth, or distribution of

growth among different plants. Calculations on seeds for growth uniformity were carried out on the 8th day. Seed growth uniformity was calculated using the formula according to Tefa (2017).

Data Analysis

The data design in this study used a completely randomized design (CRD) replicated 3 times and analyzed by analysis of variance (ANOVA). Continued with the Tukey test at the 5% level. To help provide an understanding of the analysis that has been used, a diagram was created using the Microsoft Excel application on the insert menu, namely pivotTable, and all data analysis used the SPSS application version 16.0 (SPSS, Chicago, United States).

RESULTS AND DISCUSSION

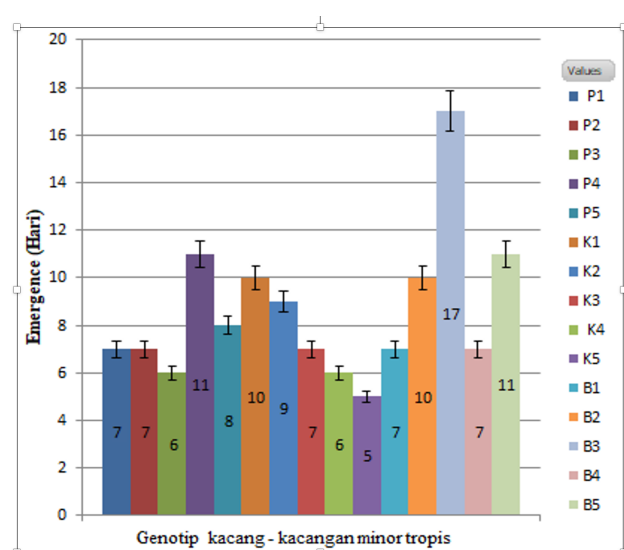
Emergence

Data from Figure 4 observation results show that each genotype of jack bean, lima bean, and velvet bean has different growth results. The principle of the RE test is that seeds that germinate slowly indicate that the seeds are experiencing physiological decline which causes a decrease in seed vigor (International Seed Testing Association, 2014). The first seeds to germinate only occurred on the 5th day after the seeds were sown, while the last seeds to germinate were on the 17th day after the seeds were sown. On average, it is known that seeds that germinate well grow in the first week.

Figure 4. Day of plant emergence in various types of tropical minor legume seed genotypes. Description: P1 (Banyumas), P2 (Indramayu), P3 (Malang), P4 (Sidoarjo), P5 (Temanggung), K1 (Sidoarjo), K2 (West Bandung), K3 (Bantul), K4 (Batu City), K5 (Batu City), B1 (Indramayu), B2 (Surabaya), B3 (Wonogiri), B4 (Wonogiri), B5 (Sidoarjo).

From the image above based on the Tukey test, the genotypes with the fastest emergence are K5, P3, K4, B2, K3, B1, B4, and P5, and the slowest is B3.

The analysis was conducted to determine the superior and non-superior genotypes in this emergence observation. This shows that the seeds used have varying levels of viability. This will be very good to show whether the RE value will also vary and correlate. Fast-growing seeds are better able to face suboptimal field conditions, from the analysis obtained the highest and lowest emergence values are known to be the difference in seed size of each variety caused by genetic variation in each variety even though they are planted in a relatively the same environment. The appearance of the character of each variety is largely determined by genetic and environmental factors. Genetic variation for all varieties is smaller than their phenotypic



variation so seed production per plant is still greatly influenced by the environment. The same thing is also found in the heritability values for large, medium, and small seed size variables. Supported by the statement from Soverda et al., (2009) which states that in general, an area has different environmental conditions for genotypes. The genotypic response to these environmental factors is usually seen in the phenotypic appearance of the plants concerned.

Temperature factors are also related to plant growth and development. Plant seeds require optimum temperature to germinate properly. The temperature required for plant growth and development is called cardinal temperature which includes optimum temperature of 34°C, minimum temperature of 10°C, and maximum temperature of 45°C (Bouzo, 2012). Seeds experience high germination when the temperature approaches optimum, and each seed has a different optimum temperature, and according to Tsegay and Gebreslassie, (2014), water imbibition into seeds is the beginning of seed germination. Several factors that affect water imbibition into seeds include seed composition, impermeability of the outer layer of the seed, and water availability. The availability of water for imbibition depends on the cell water potential. The cell water potential is the result of cell wall matrix pressure, cell osmotic concentration, and cell turgor pressure.

Germination Rate (%)

Sudjadi (2006), provides an explanation of germination, namely germination is the process of embryo growth and seed components that can grow normally into new plants. The seed components are the parts of the sprout found in the seed, for example, the radicle and plumule. Seed germination is one of the indicators of seed viability that indicates seed quality.

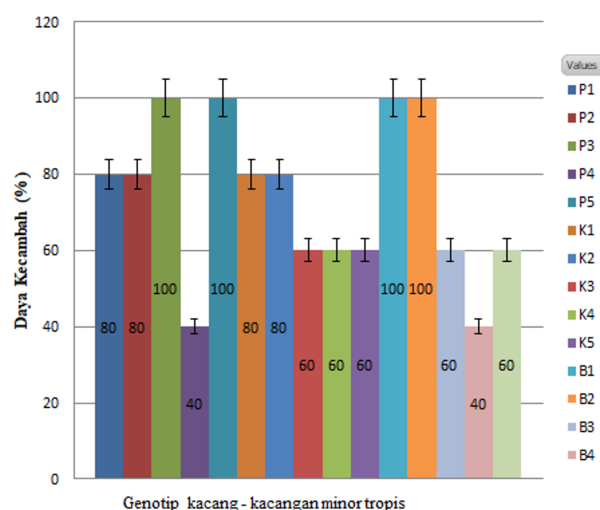


Figure 5. Germination rate is seen in various types of tropical minor legume seed genotypes. Description: P1 (Banyumas), P2 (Indramayu), P3 (Malang), P4 (Sidoarjo), P5 (Temanggung), K1 (Sidoarjo), K2 (West Bandung), K3 (Bantul), K4 (Batu City), K5 (Batu City), B1 (Indramayu), B2 (Surabaya), B3 (Wonogiri), B4 (Sidoarjo), B5 (Sidoarjo).

From the picture above, the genotypes that have the highest percentage of germination power are P1, P2, K1, K2, P3, P5, B1, and B2. While P4, B4, K3, K4, K5, B3, and B5 are the genotypes with the lowest germination power. Water is very much needed by germinating seeds to activate the germination stimulant enzyme. Moreover, the seeds of jack bean, lima bean, and velvet bean are large so they require a lot of water in the germination process. Overall, the physical properties of the best rice paper and stencils, are because they have high absorption power, are uniform, able to retain water, and have a high water absorption rate. Germination media, in both time and environmental conditions, must be optimal to meet everything that the seeds need according to and can present the potential growth of the seeds in optimum field conditions. The statement above is also supported by Pratama et al., (2014) seeds planted in conditions that are quite supportive will increase the ability of the seeds to grow. Water plays an important role in the seed germination process.

In this analysis, the condition of the seeds and the environment must be in harmony to obtain uniform germination power so that there is no difference in growth as in the table above, by using

various types of genotypes from various superior regions. Germination power testing is in principle testing several seeds and determining the percentage of the number of seeds that can grow or can germinate normally within a predetermined period. The germination environment must be made optimal to support germination. Germination power testing should be carried out on pure seeds, namely seeds that have been tested or from a group of seeds with guaranteed purity (Elfiani and Jakoni, 2015).

Vigor Index

Vigor has several seed properties that indicate normal, fast, and uniform growth and development of seedlings in a range of optimum and sub-optimal field conditions (Ilyas, 2015).

Seed vigor index Based on Figure 6, shows that of the 15 genotypes studied, it can be seen that genotype P3 is a genotype that has a healthy and fast-growing system after germination, as well as the ability to adapt to various environmental factors, while genotype B3 has the ability and resistance of unhealthy and fast seeds after germination, as well as the ability to adapt to various environmental factors.

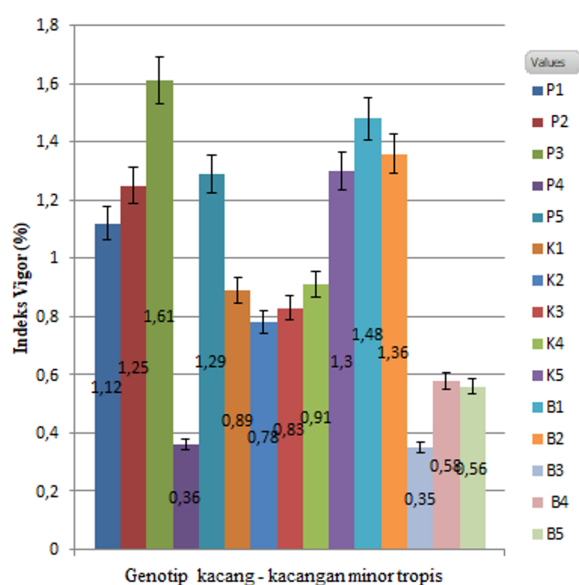


Figure 6. Vigor Index of the 5 genotypes studied. Description P1 (Banyumas), P2 (Indramayu), P3 (Malang), P4 (Sidoarjo), P5 (Temanggung), K1 (Sidoarjo), K2 (West Bandung), K3 (Bantul), K4 (Batu City), K5 (Batu City), B1 (Indramayu), B2 (Surabaya), B3 (Wonogiri), B4 (Wonogiri), B5 (Sidoarjo).

(Sidoarjo), B5 (Sidoarjo)

The genotypes with the highest vigor index are B3 and P4, and the lowest vigor index is B1 and P3. The increase in temperature during storage in the germination process causes high respiration of large-sized seeds. Ramadhani (2016), explained that the increase in temperature in the storage room then causes the respiration rate and the breakdown of food reserves to continue.

Seeds with high vigor from the observations above are more able to survive and grow well in suboptimal conditions. In addition, the advantages of seeds with high vigor can grow faster, as well as longer storage life even in less than ideal conditions (Zanzibar and Pramono, 2009).

Temperature also affects the seed vigor index by activating enzymes in different ways. Temperatures that are too hot cause dead enzymes to denature, thus inhibiting the germination process. This is by previous research which found that a temperature treatment of 30°C was more beneficial for the vigor index of corn, peanut, and mung bean seeds compared to a temperature treatment of 35°C (Rini et al., 2005).

The Simultaneity of Growth (%)

The homogenous growth of plants indicates the growth strength of a seed that has a high value (Sadjad, 1994). In Figure 7, the calculation of seeds for growth simultaneity was carried out on the 8th day.

The highest growth simultaneity results were genotypes P1, P2, P5, P3, B1, and the lowest were genotypes P4, B3, B5, K1. The results of the analysis showed that the duration of soaking had a significant effect on the simultaneity of legume seeds. According to Arthawijaya et al., (2022), short seed soaking has an impact on slowing seed metabolism due to lack of water. The simultaneity of seed growth is influenced by the ability of seeds to utilize energy reserves, where in one lot they can utilize energy reserves well so that they can grow into strong seeds simultaneously (Aisyah et al., 2018).

The ability of seeds to grow consistently and quickly is a sign of strong seed vigor. Signs of seed growth simultaneously indicate its benefits.

Variable seed vigor factors characterize the ability of seeds to germinate quickly, appear uniform, and develop into seedlings normally in various field conditions (Lesilolo et al. 2013). One factor that can cause seeds to be unable to grow uniformly is heterogeneous environmental conditions.

According to Sadjad (1993), Simultaneity of growth has a value between 40 and 70%. A group of seeds with low vigor is indicated if the simultaneity of growth is less than 40%, and if it is greater than 70% it indicates very high growth vigor. As seen in the study above, a group of seeds that show synchronous and strong growth will have high growth strength, which indicates high absolute growth strength.

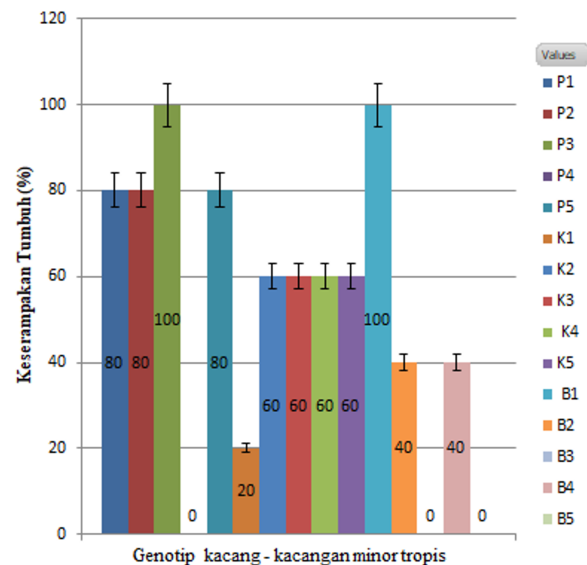


Figure 7. The simultaneity of growth was taken on the 8th day. Description P1 (Banyumas), P2 (Indramayu), P3 (Malang), P4 (Sidoarjo), P5 (Temanggung), K1 (Sidoarjo), K2 (West Bandung), K3 (Bantu), K4 (Batu City), K5 (Batu City), B1 (Indramayu), B2 (Surabaya), B3 (Wonogiri), B4 (Sidoarjo), B5 (Sidoarjo).

CONCLUSION

The genotypes with the fastest emergence are K5, P3, K4, B2, K3, B1, B4, P5. While the slowest is B3. The genotypes with the highest germination rate are P1, P2, K1, K2, P3, P5, B1, and B2. While P4, B4, K3, K4, K5, B3, B5 have the lowest germination rate. The genotypes with the highest vigor index are B3 and P4. The

genotypes with the lowest vigor index are B1 and P3. The genotypes with the highest growth uniformity are genotypes P1, P2, P5, P3, B1. While the genotypes with the lowest growth uniformity are P4, B3, B5, K1.

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