ISSN 2348-313X (Print)
International Journal of Life Sciences Research ISSN 2348-3148 (online)
Vol. 12, Issue 4, pp: (19-29), Month: October - December 2024, Available at: www.researchpublish.com

Morphological and Genetic Identification of Moringa Plants (Moringa Oleifera L.) For Procurement Quality Seeds In Tanambulava District Central Sulawesi

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DOI: https://doi.org/10.5281/zenodo.14022733

Published Date: 01-November-2024

Abstract: **The Moringa plant (*Moringa oleifera* L.) is a type of tropical plant that is easy to grow in tropical areas such as Indonesia. This research was conducted to obtain quality seeds through morphological analysis and continued with seed viability analysis to obtain high viability seeds, then continued with genetic analysis to obtain quality seed candidates. The first stage is morphological identification using descriptive methods with a survey. directly to the location used for research. The second stage is testing seed viability on selected accessions using the Completely Randomized Design (CRD) method at the seeding stage in the Seed Laboratory of the Faculty of Agriculture. with one seed source factor from the results of the first stage of research. A seeding test was carried out using a Randomized Block Design (Rack) method based on plant height with one factor, namely the selected seed source, planting was carried out in the Experimental Field of the Faculty of Agriculture, Tadulako University. This research was carried out from June 2023 to August 2023. The results of the research show that there are seven Moringa accessions with different morphologies, namely the Moringa accessions Sibowi 1, Sibowi 4, Sibowi 6, Sibowi 7, Sibowi 17, Sibowi 21, and Sibowi 23. The distinguishing morphological characteristics are plant height, stem diameter, canopy diameter canopy shape, leaf blade shape, leaf stalk length, leaf stalk width, pod length. Seed viability tests in the nursery showed that there were differences in the viability of Moringa seeds from different seed sources, however, the seed source of**

Keywords: **Sibowi, moringa.**

I. INTRODUCTION

Indonesia is a country that has a variety of plant types. One of the many plants in Indonesia is Moringa (Moringa oleifera) which is often found in Aceh, Kalimantan, Sulawesi and Kupang. Moringa oleifera is a tropical food plant that has nutritional, therapeutic, industrial, agricultural and high socio-economic value. Moringa oleifera is called "The Miracle Plant" because it is known as a plant that has many benefits in all parts of the plant. Seed quality is indicated by viability and vigor. Seed viability and vigor are influenced by the level of seed maturity. According to Ichsan et.al., (2013) seed maturity affects germination capacity and growth speed. Seeds that are harvested before physiological maturity do not have sufficient food reserves and the embryos are not yet perfect.

So far, moringa management in Central Sulawesi is still carried out traditionally and has been passed down from generation to generation. Changing the mindset and habits of moringa farmers is needed, because current farmers still think that moringa does not need care. In fact, cultivation factors determine the quality of Moringa to be marketed. Tree planting distance and intensive care patterns must be considered. Apart from that, handling pests and fungi must also be anticipated. This aims to encourage increased moringa productivity. Moringa plants are a viable option to develop as a source of food and energy. Therefore, it is hoped that the cultivation of this plant will be able to provide an alternative or substitute fuel source, can improve the standard of living and increase the income of the community (especially farmers), can overcome poverty and increase foreign exchange earnings, and improve the environment, as well as supporting sources of food and medicine. (Bambang, 2017). One of the factors that plays a very important role in the cultivation of Moringa plants is that the use of quality seeds is very necessary to increase the productivity of Moringa plants and the success of rehabilitation of people's plantations. Information on seed quality is very important in the Moringa cultivation system because seeds have become a trade commodity, both at national and international levels. Seeds determine the success of cultivating annual plants such as Moringa plants. Determining the parent tree can be obtained through exploratory research on the diversity of Moringa accessions and then testing the viability of each selected accession. The mother tree that will be used as a seed producer is obtained through identifying the morphology of the Moringa plant and pods so that the relationship between Moringa accessions will be known, which will ultimately result in finding Moringa accessions that have a high level of viability and can be used as a seed source (Aminah et al., 2015)

This is certainly a very tempting business opportunity if it can be implemented in Indonesia. The development of moringa leaf agribusiness requires capital support and strong commitment, while the capital and management capabilities of moringa entrepreneurs, such as decision making in marketing strategies for moringa to carry out moringa agribusiness activities, are still limited. (Komariyah, 2015). One of them is the Moringa leaf industry managed by CV Tri Utami Jaya which has the largest, first and only international standard Moringa leaf processing factory in NTB. Currently the Tri Utami Jaya factory has a production capacity of 200 tons per day. Not only that, the factory's Moringa tea leaf products have also been marketed to almost 13 countries in the United States (US) and Europe. Most recently, Tri Utami Jaya is preparing to export Moringa tea leaves to Madrid. The formulation of the problem in this research is to find out 1. What are the morphological and genetic characteristics of Moringa plants (Moringa oleifera L) in various accessions? 2. Can the results of morphological and genetic identification of Moringa be obtained from mother trees producing quality seeds? The aim of this research is that the aim of this research is to identify Moringa plants to be used as mother trees as a source of quality seeds.

II. METHODOLOGY

This research took place in Tanambulava District, Central Sulawesi and at the Seed Science and Technology Laboratory, Faculty of Agriculture, Tadulako University, Palu. This research was carried out from June 2023 to August 2023. The tools that will be used in this research are meters, label paper, ruler, digital camera, GPS type Montana 650, Android (auto distance), stationery, machetes, sacks, and the materials that will be used are Moringa seeds, sand, and Aquades. The research was carried out in two stages, namely, three stages, namely the first stage of morphological identification, the second stage of viability testing in the nursery, and the viability test in the nursery.

Stage 1. Morphological Identification Test Moringa plant morphological observation parameters were carried out by visual observation based on the method used by Munirah (2013) which was modified to include the shape, size and color of the organ parts in the mature phase by observing the physical characteristics of each accession observed in the research. these are as follows: Plant Descriptiona.Tree Names, Labels are taken from the initials of the name of the village where the accession is located and then sorted from 1 to 30 from each location. b.The growing location, according to the village, sub-district, district, grows the Moringa plants used as research samples. c.The name of the owner of the place is known from interviews d. The age of the plant is known from the results of interviews with the owners of the Moringa plants used as research samples. e. Plant height (m), measured from the ground surface to the top of the Moringa plant. f. Fruiting period, known from the results of interviews with selectors of the kloer plants used as research samples. g. Maximum number of fruit/period, known from interviews with the owners of the Moringa plants used as samples. h. The origin of the seeds is known from interviews with the owners of Moringa seeds.

Descriptive Bar a.The shape of the stem is known by observing the shape of the sample stem in the categories round, wavy, oval. b.The color of the stem is known by observing the color of the sample stem in the categories of cream, brownish, dirty white. c.The surface of the stem, known by observing the surface of the sampled stem, is categorized as smooth/smooth, rough, broken. d.Stem diameter (cm), measured 50cm from the ground surface. e.The branching form is known by observing the branches of the Moringa plant in the categories of horizontal and vertical branching forms. f.The shape of the canopy is known from observations that are sampled in the categories pyramid, blunt pyramid, umbrella. Leaf Description a.The shape of the leaves is known by observing the shape of Moringa leaves in the categories long, ovate, round. b.The length of the leaf (cm) is determined by measuring the leaf from the base to the tip of the leaf. c. Leaf blade width (cm), measured from the leaf width point. d.Leaf tip shape, observation of the leaf tip in categories, blunt, pointed, rounded. e.The basic shape of the leaf, with observations sampled in the categories sharp, blunt, pointed, circular.

f. The upper leaf bones with observations of the sampled leaves, in the categories very clear, clear and unclear. g.The lower leaf bones, with observations that were sampled, were categorized as very clear, clear and unclear. h The number of leaves (strands) is known by counting the leaves sampled.

Stage 2. Seed Viability Test This research method used a one-factor Completely Randomized Design (CRD) which was repeated 3 times with selected Moringa seed sources and their viability was tested at the Seed Science and Technology Laboratory, Faculty of Agriculture, Tadulako University. Observation variables for seed viability tests in the nursery a. Seed preparation Moringa seeds that are physiologically mature are characterized by a brownish green color taken from mature Moringa trees, and have produced approximately 3 times. The Moringa plant pods to be sampled are wrapped in banana leaves to maintain the freshness of the Moringa pods, then put in a cardboard box and labeled. Furthermore, the analysis was carried out at the Seed Technology Laboratory, Faculty of Agriculture, Tadulako University. b. Preparation of planting media Prepare 21 sprout tubs and fill them with fine, sterilized sand. In each sprout tub there are 100 seeds ready to germinate. c. Seed treatment Seeds that have been selected are extracted by separating the seeds from their skins, then cleaning them from dirt that is still attached to the seeds and washing them in running water. d. Seeding and maintenance Sowing seeds is done by planting 100 seeds in a sprout tub, planted horizontally in a row. The seeds are planted to a depth of 1 cm after which the seeds are covered with sand. Watering is done every day to maintain seed moisture. Observations were made every day on viability parameters. What was observed in this research was as follows:

1. Germination Test (%)

Germination power calculations were carried out from the first to the 14th day after sowing. Germination capacity is calculated by observing the appearance of the plumule and radicle on the seed. Calculated using the formula (Sadjad, 1993).

$$DB = \frac{Number\ of\ normal\ sprouts}{number\ of\ seed\ germinated} x\ 100$$

2. Seed Water Content Test (%)

Measuring the water content of seeds is carried out to determine the water content of the seeds. Water content is measured using the formula according to Sadjad (1993), as follows:

$$KA = \frac{Wet\ Weight - Dry\ Weight}{Wet\ Weight} x\ 100$$

3. Maximum Growth Potential Test (%)

Maximum growth potential is calculated from germination until the seeds are ready to be transferred to the nursery (Sadjad et al, 1999).

4. Germination Speed (%/etmal)

Germination speed is calculated based on the number of normal sprouts on the first day to the fourteenth day using the following formula:

$$\text{Kc} = \frac{\%\text{KN1}}{\text{Etmal 1}} + \frac{\%\text{KN2}}{\text{etmal 2}} + \ldots\ldots + \frac{\%\text{KN14}}{\text{etmal 14}}$$

Test seeds in the nursery

This research method uses a Randomized Block Design (RAK) with one factor, namely the selected seed source. The seeds sampled were tested for vigor at the Experimental Farm, Faculty of Agriculture, Tadulako University.

Observation variables for seed viability tests in nurseries. Quality seeds have several indicators that are tested both in the laboratory and in the field. Testing refers to the International Seed Testing Association (ISTA) Rules (International Seed Testing Association Regulations) which include:

a. Plant height

The increase in plant height, measured in centimeters starting from the base of the stem to the tip of the seedling shoot, was observed every week for six weeks. Observations were made by calculating the difference in plant height from the previous week.

b. Number of leaf stalks

The increase in the number of leaf stalks, the calculation of the increase in the number of leaf stalks in stalk units, the leaves observed were leaves that were completely open, observed every week for six weeks. Observations were made by calculating the difference in plant height from the previous week.

c. Plant Dry Weight (g)

Dry weight was obtained by weighing normal sprouts at 7 DAP which had been dried in an oven at 1050C for 18 hours.

III. DISCUSSION

1. Plant Morphology

Cluster analysis in the form of a dendogram (Figure 2) based on morphological observations of Moringa plants shows that at a euclidean distance of 0.566, 3 groups with different genetic characteristics were obtained, each group represented by group 1 (SBW 17, SBW07 and SBW21) group 2 (SBW6 and SBW01) group 3 (SBW04 and SBW23) there are two accessions that are similar (related), namely Moringa accessions SBW27 and SBW10. At a distance of 0.632 there are two accessions that are similar, namely SBW29 and SBW12.

At a distance there are two related accessions 0.663 SBW28, and SBW27. At a distance of 0.693 there are several related accessions, namely Moringa accessions SBW26, SBW15, SBW29, SBW20, SBW28 and SBW22. At a distance of 0.748 there are two related accessions SBW19 and SBW8. at a distance of 0.775 there are two related accessions at SBW25 and SBW16.

At a distance of 0.800 there are several related accessions, namely Moringa accessions SBW9, SBW26, SBW29, SBW13, SBW28, SBW25, and SBW19. At a distance of 0.825 there are two accessions, namely SBW13 and SBW24. At a distance of 0.849 there are three Moringa accessions that are related to SBW5, SBW13 and SBW11. At a distance of 0.72 there are two related accessions, namely SBW2 and SBW5.

At a distance of 0.894 there are several related accessions, namely SBW3, SBW29, SBW2, SBW23, and SBW21. At a distance of 0.917 there are three moringa relationships at SBW29, SBW14, and SBW18. At a distance of 0.938, three accessions are related, namely SBW7, SBW29, and SBW23. At a distance of 0.980 there are two accessions, namely SBW23 and SBW1. At a distance of 1000 there are two accessions that are related, namely SBW6 and SBW23. At a distance of 1.020 there are two Moringa accessions that are related, namely SBW6 and SBW17. At a distance of 1,039 in distance there are also two Moringa accessions that are related, namely SBW6 and SBW4.

Cutting at a euclidean distance of 0.830 obtained seven different moringa accessions which were taken randomly and then tested for viability to be used as a seed source, namely moringa accessions SBW17, SBW7, SBW21, SBW6, SBW1, SBW4 and SBW23

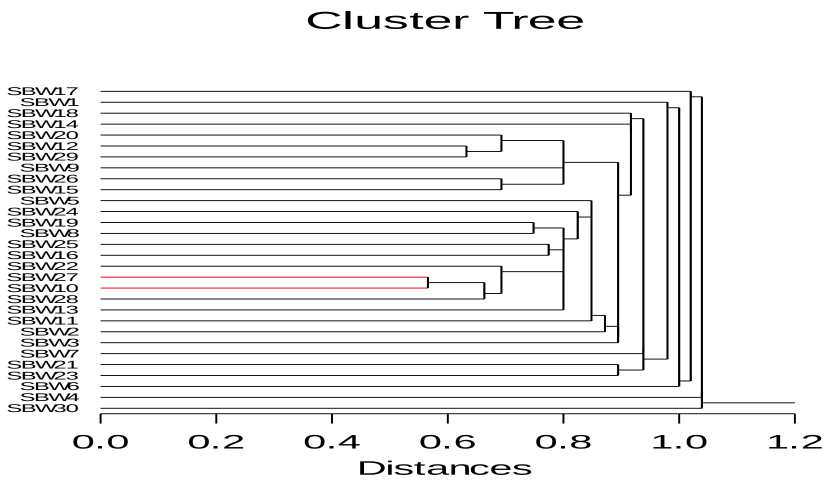

Figure 2. Moringa grouping based on cluster analysis

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International Journal of Life Sciences Research ISSN 2348-3148 (online)
Vol. 12, Issue 4, pp: (19-29), Month: October - December 2024, Available at: www.researchpublish.com

2. Seed Viability Test in the Nursery

a. Seed moisture content (%)

The results of measuring seed moisture content are shown in Appendix Table 2a, and the variance is shown in Appendix Table 2b. Variety testing shows that the correct source of Moringa seeds has a significant effect on the water content of the seeds. The average seed moisture content is shown in Table 2.

Table 2. Average Percentage of Moringa Seed Water Content in Different Accessions.

Perlakuan	Rata-rata
SBW 1	42,46[a]
SBW 4	46,83[b]
SBW 6	43,35[a]
SBW 7	31,05[a]
SBW 17	37,84[a]
SBW 21	32,68[a]
SBW 23	45,96[b]
BNJ 5%	13,05%

Table 2. Shows that the SBW4 Moringa accession treatment tends to have a higher percentage of seed water content with a value of 46.83 compared to other Moringa accessions, where the SBW 7 Moringa accession is smaller with a value of 31.05%.

b. Germination power

Germination power is shown in Appendix Table 3a, and the variance is shown in Appendix Table 3b. The variance test showed that the seed source treatment had no significant effect on seed germination but was not significantly different. The average germination capacity of seeds is shown in Figure 4.

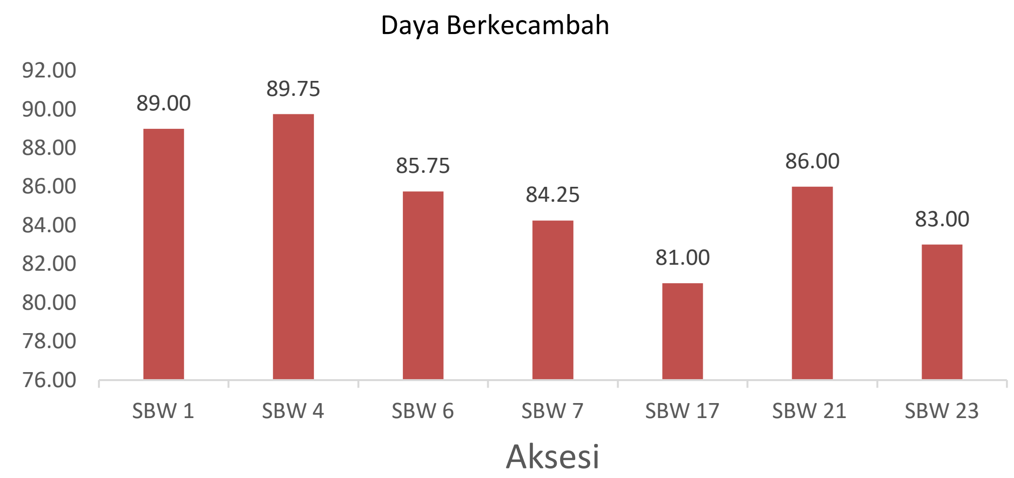


Figure 4. Average percentage of germination power of Moringa seeds in different sessions.

Figure 4 shows that the Moringa accession SBW4, Moringa accession SBW1 and Moringa accession SBW21 tend to have higher germination capacity (SBW4 89.75%, SBW1 89.00%, and SBW21 83.00%) compared to other Moringa accessions.

c. Maximum Growth Potential

Maximum growth potential is shown in Appendix Table 4a, variance is shown in Appendix Table 4b. Variant fingerprinting showed that seed source treatment had no significant effect on maximum growth potential. Average growth potential is shown in Figure 5

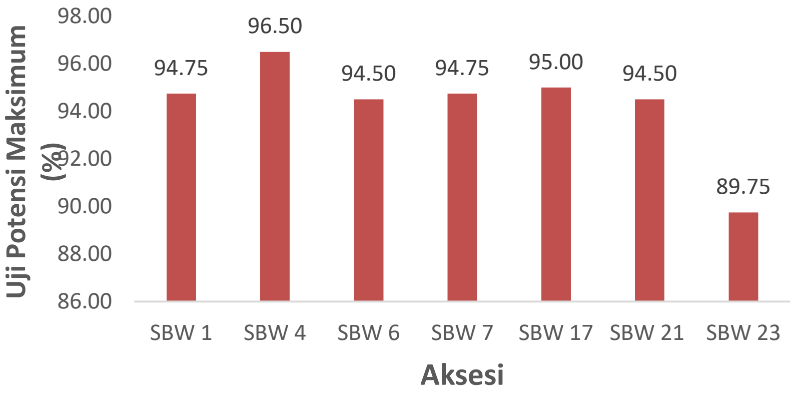


Figure 5. Average percentage of maximum growth potential of Moringa seeds in different accessions.

Figure 5 shows that the SBW4 Moringa accession treatment tends to have better growth potential (96.50%/etmal) compared to other Moringa accessions such as SBW23 which has the lowest growth potential of 89.75%.

d. Germination Speed

The average speed of Moringa germination from various seed sources is shown in Appendix Table 5a, the variance is shown in Appendix Table 5b, the variance shows that the seed source treatment has no significant effect on germination speed. Average germination speed is shown in Figure 6.

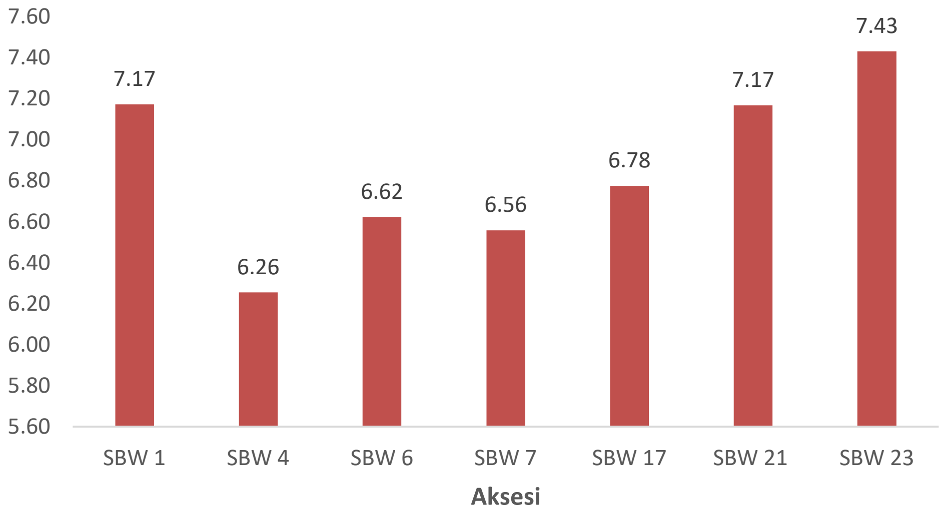


Figure 6. Average percentage of Moringa germination speed in different accessions

Figure 6. Shows that the Moringa accessions SBW23, SBW1 and SBW 21 tend to have faster germination rates than other Moringa accessions.

e. Germination Simultaneity

The average synchronization of Moringa germination from various seed sources is shown in Appendix Table 6a, the variance is shown in Appendix Table 6b, the variance shows that the seed source treatment has no significant effect on germination speed. Average Simultaneity of germination is shown in Figure 7.

Figure 7. Average percentage of seed synchrony in different accessions.

Figure 7 shows that the Moringa accessions SBW6 with a value of 7.0% and SBW17 8.0% tend to have faster germination synchronization compared to other Moringa accessions with values of 5.0% and 6.0%.

3. Seed viability test in the nursery a.

a. Plant height

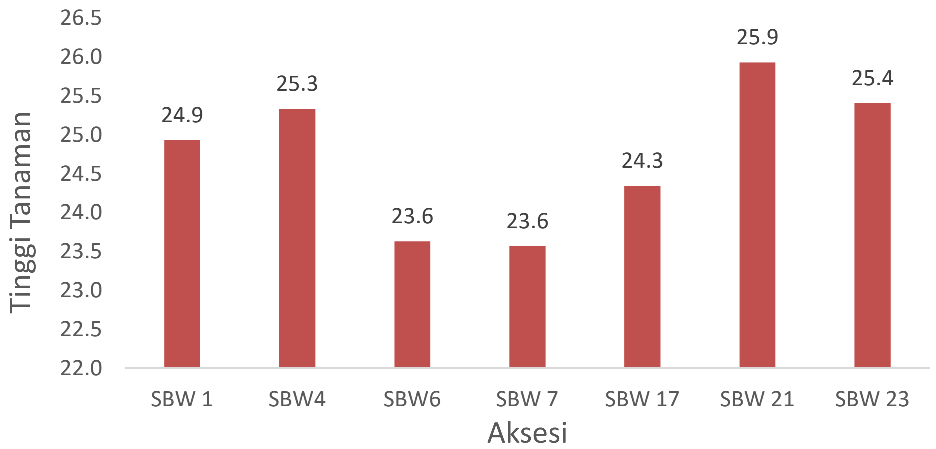
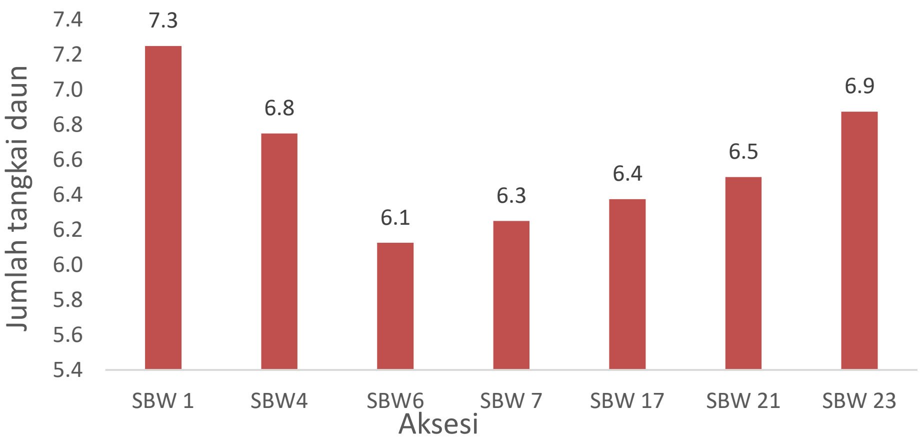


Figure 8. Average percentage of Moringa plant height in different accessions

b. Number of Petioles



c. Plant Dry Weight

Based on the results of cluster analysis, the morphology of Moringa plants growing in Tanambulava District shows morphological differences. This can be seen from the analysis of 30 clusters of Moringa plant samples obtained, 7 Moringa accessions with different morphologies, namely Moringa accessions SBW1, SBW4, SBW6, SBW17, SBW7, SBW21 and SBW23. The morphological diversity of Moringa trees in Tanbulava subdistrict is differentiated based on the characters: plant height, fruiting period, flower color, stem shape, stem color, stem surface, stem diameter, branching shape, crown shape, leaf shape, blade length, leaf width, leaf shape, leaf base shape, upper bone, lower bone, number of leaves, fruit length, fruit diameter, fruit skin texture, number of seeds, seed color, and seed shape. And the morphological characters that distinguish the seven Moringa accessions are 8 characters including plant height (m), stem diameter (cm), canopy diameter (m), canopy shape, leaf blade shape, leaf petiole length (cm), leaf petiole width (cm) and pod length (cm), (Table 1).

Based on these morphological characters, Moringa accession SBW1 has the tallest plant, namely 8.75 meters compared to other accessions with a stem diameter (60cm), canopy diameter (2.3 meters) with an irregular canopy shape, lancet leaf shape, wide stem strands leaves (10 cm), leaf length (18 cm) and pod length (40 cm), this is thought to be because the growing environment of the SBW1 parent tree is not close to other trees and does not shade each other so that the SBW1 parent tree gets more sunlight. lots for photosynthesis. Meanwhile, the Moringa accession SBW 23 has the lowest plant height, namely 6.7 meters compared to other Moringa accessions, with a stem diameter (52 cm), canopy diameter (2.05 meters), with a columnar canopy, elliptical leaf blades, wide leaf stalk length (19 cm), leaf stalk length (30 cm) and pod length (34 cm) where the growing environment of the SBW23 parent tree is close to other trees. This causes the parent tree to receive less sunlight so that the photosynthesis process is not maximum because it is shaded from other trees.

It is suspected that the plant growing environment is an important factor in the plant growth process, with the presence of these factors causing the same type of plant to have the opportunity for differences in the morphological appearance of the plant itself. Based on the results of testing the viability and vigor of Moringa seed accessions in Tanbulava district, both through generative and vegetative viability tests, all accessions showed high viability and vigor values, namely germination capacity reaching the range of 93% to 95.75%, maximum growth potential of 95% to 96.50%, growth speed of 7.17 % to 7.43%/etmal, uniformity of growth is 60.03%, water content is 13.05%, and dry weight is 0.13% to 0.14%, however the seed source of Moringa accession SBW4 tends to have a higher seed water content, namely 46.83%, with potential to grow maximum 96.50%, germination power 89.75% and faster germination speed, namely 6.26%/etmal.

Meanwhile, the seed source of Moringa accession SBW7 has the lowest water content, namely 31.05%, with a maximum growth potential of 94.74%, germination capacity of 90% and slower germination speed, namely 6.56%/etmal. Which shows that these seeds can germinate equally well in conditions where there is minimal light. Therefore, seed quality testing carried out in this laboratory is also important because it is part of seed certification and supports monitoring of seed distribution. The seed viability test in the nursery showed that Moringa accession SBW4 and Moringa accession SBW23 had seed water content, germination capacity, maximum growth potential and germination speed. In general, the Moringa seed coat or Moringa seed coat is not hard, thin and is permeable to water so it is very It is easy for the imbibition process to occur which can speed up the seed germination process. This shows that the SBW accessions tested have seed viability that meets the standards to be used as a seed source, namely germination capacity of 85% and maximum growth potential reaching 100%. (National Standardization Agency, 1995.

The main factors that influence the viability of SBW4 and SBW23 Moringa seeds and other seed sources are growing environmental factors and genetic factors. There is a possibility that differences in the environment where the parent tree grows will cause differences in the growth process of the development of the parent tree so that the seeds produced have different water content, size and seed weight, which results in different viability of the seeds. Gairola et al., (2012) stated that germination is determined by the ecological conditions of the habitat, depending on environmental conditions including temperature, humidity and soil fertility. Growth speed is also an indicator of vigor. The higher the growth speed value, the higher the seed vigor (Emerensiana and Anna, 2016). One of the factors that influences plant growth is meeting the water needs of plants, because water is the largest constituent of plant tissue. Water is a very important ingredient for plants to carry out photosynthesis and produce photosynthesis which is then distributed to all parts of the plant. A vigorous mother tree will produce seeds with high viability, this is due to the genetic potential passed on by the mother tree to its offspring.

According to Sadjad (1993), the growth simultaneity value ranges from 40 - 70 percent, where if the growth simultaneity value is greater than 70%, it indicates very high growth vigor and less than 40% indicates a group of seeds that are less vigor. High synchronous seed growth indicates high absolute growth vigor because a group of seeds that show synchronous and strong growth will have high growth strength. These results are also in line with the results obtained on seed growth speed for each seed (appendix 5a). Growth speed indicates the vigor of seed growth because seeds that grow quickly are better able to deal with suboptimal field conditions. Based on the results obtained, these seeds have a strong growth rate. This is in accordance with the opinion of Sadjad (1993), who also provides criteria if seeds have a growth speed greater than 30 percent to have a strong growth speed vigor. The Simultaneous Seed Growth Value which shows the variable value of the seed vigor parameter describes the potential of seeds for fast growth, uniform emergence and normal seed development in various field conditions. Likewise with the seed viability test in the nursery. Based on the results of research on seed viability in the seed vigor test based on variance analysis and the 5% BNJ test, it did not have a real effect. Likewise with the seed viability test in the nursery Moringa accession SBW4 is an accession that has a higher increase in plant height at the age of 3 WAP to 6 WAP and a greater increase in the number of leaf stalks at the age of 2 WAP to 6 WAP compared to other Moringa accessions. SBW 23 is an accession that has a higher increase in plant height at the age of 3 WAP to 6 WAP and a greater increase in the number of leaf stalks at the age of 2 WAP to 6 WAP compared to other Moringa accessions.

Based on the calculation results from all these observations, it can be seen that the SBW4 accession which had high viability at the seedling stage apparently also had high vigor when in nursery. As with seed viability, the influence of the parent tree's growing environment and genetic factors are also the main factors that cause differences in the vigor of each accession. Purnamasari et al., (2015) One of the factors that influence differences in seed vigor and viability is environmental conditions during seed development on the parent plant in the field. Factors that include the environment include the availability of nutrients, light, temperature and water. This will also affect the quality of the seeds that will be produced by the parent plant. Apart from environmental factors, genetic factors also influence differences in seed quality. The ability to absorb nutrients from each variety is different so that you can differentiate the quality of each seed. The seed source from Moringa accession SBW4 showed good growth in the seed viability test in the nursery and also showed good growth in the seed vigor test in the nursery. This shows that the Moringa accession SBW4 has better growth ability accompanied by the ability to utilize energy sources available in its growing environment to support the growth process. Not different from the Moringa accession SBW4, the Moringa accession SBW23 showed high growth in the seed viability test in the nursery and the seed vigor test in the nursery. Moringa accession SBW23 had values that were no different from Moringa accession SBW4 in all observations. This shows that the Moringa accession SBW23 also has high viability and vigor and can be an alternative replacement if Moringa accession SBW4 seeds are not available.

V. CONCLUSION

Based on the research results, it can be concluded that of the 30 Moringa accessions studied in Tanambulava District, there are morphological characters that differentiate them from several test parameters. Then seven different moringa accessions were obtained, namely accessions Sibowi 1, Sibowi4, Sibowi 7, Sibowi 6, Sibowi 17, Sibowi 21 and Sibowi

23. From these seven accessions it can be concluded that accessions Sibowi 4 and Sibowi 23 have higher viability than the other accessions. and can be used as a candidate for quality seeds.

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