VARIABILITY OF FRUIT MORPHOLOGY, YIELD, AND QUALITY IN THE TAGNANAN POPULATION AS MATAG POLLEN SOURCE

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ABSTRACT

The male parent of the MATAG hybrid, Tagnanan, is an allogamous tall type, with substantial variation thus, contributing to the possible inconsistency in MATAG hybrid production and consequently lowering the efficiency of genuine MATAG production. Therefore, the selection and improvement of homogeneous Tagnanan individuals as pollen sources must be made to ensure the production of high-quality MATAG. This study aimed to describe the variation and evaluate the Tagnanan population currently utilized as the main pollen source for MATAG production based on fruit yield and quality components. A quantitative descriptive study of the growth and coconut yield attributes was done on the 13-year-old Tagnanan population at DOA Teluk Bharu, Perak. The results revealed that fruits come in three colors: gold, green, and reddish-orange. Furthermore, the morphological appearance of fruits varies in the polar and equatorial view shapes of fruits, with round polar and equatorial view forms of fruits recording the largest number of fruits compared to the other view shapes of fruits. The weight of fruits showed substantial variance in descriptive statistics and PCA, and descriptive statics analysis suggests that shell thickness is one of the fruit attributes with the lowest variation. The low variation and no significant parameters are the parameters that can be taken into consideration for future decisions in producing good quality MATAG seed production regardless of the color of the fruits.

Keywords: *Tagnanan, tall variety, MATAG, variability pollen source*

INTRODUCTION

Coconut has been grown in about 90 countries as an essential oil and food crop, with Asia, the Pacific Islands, and South America receiving the most attention. Among the leading coconut-producing countries are India, Indonesia, the Philippines, Brazil, Sri Lanka, Papua New Guinea, Vietnam, Mexico, Thailand, and Malaysia (Then K.H, 2018). Since 2010, Indonesia, the Philippines, and India have been the top three coconut-producing countries, with around 27%, 23%, and 22% production dominance in 2019. Currently, Asia makes up 80% of the worldwide coconut supply, making it a vital source of income for many countries. Malaysia ranked 12th in 2018, ranking 10th in 2019 with 0.8% of global production, following Thailand and Vietnam (Mohd et al., 2022). According to several experts, the low production of high-quality coconut varieties output is due to a lack of operational control of the coconut hybrid, particularly during harvesting (Man & Shah, 2020), the scarcity of studies on coconut genetic enhancement (Arumugam & Hatta, 2022), shortage of skilled labor (Omar et al., 2020) and seedling producers struggling to meet high demand due to low supply of good quality coconuts (Che'Ya et al., 2022). In Malaysia, MATAG was reported to have good traits that can increase coconut production in Malaysia. This statement was supported by research from (Yusuf et al., 2018) stating that the MATAG variety shows a high production of nuts with approximately 25,000 to 30,000 nuts per hectare per year which is more than the normal or other hybrid coconut varieties.

MATAG variety is a hybrid of Malayan Yellow/Red Dwarf (MYD/MRD) with Tagnanan Tall. This variety showed an early bearing with commencing flowering at 36 months and the young nuts can be harvested at 48 months after planting. The most recent propagation method of MATAG is via seed-nut production (Zawawi et al., 2021). Some of the issues studied concerning

MATAG coconut hybrids include the physicochemical qualities of coconut water and flesh (Ab Mutalib & Jailani, 2022), the antibacterial activity of coconut (Nor et al., 2023), and genetic contribution to population diversity (Yousefi et al., 2023). However, little research has been done on the variability of fruit morphology, yield, and quality of the Tagnanan variety. Research by (Sivakumar et al., 2020) on genetic variability, heritability, and genetic advance analysis has been done. Nevertheless, research has been done on different coconut varieties. To improve MATAG hybrid production, in vitro, cloning could be considered to reduce variability in MATAG production. Nonetheless, this approach is prohibitively costly, especially for smallholders. The male parent of the MATAG hybrid, the Tagnanan tall, is accountable for the hybrid's diversity.

The tall coconut cultivar is cross-pollinating, heterozygous, and has an extended lifespan as well as maturing slowly. The substantial genetic heterogeneity among seedlings with a long life span is a significant challenge in producing uniformly performing progeny (Zawawi et al., 2021). However, there is little to no studies have been conducted specifically on the tall variety of coconut, especially regarding its variability and relationships among traits. According to Subramanian et al., 2019, the high heritability and genetic advance for nut yield per palm every year implies that additive gene action is operational in the trait's inheritance. As a result, selecting based on qualities may produce superior results. This is because a solid selection of Tagnanan's tall features may improve the chances of developing a high-quality MATAG hybrid. Therefore, this study aims to describe the variability of Tagnanan tall palms based on growth, fruit yield, and quality of fruits.

MATERIALS AND METHOD

The research was carried out on 100 coconut genotypes obtained from the Tagnanan Tall palm variety. In 2010, the Department of Agriculture (DOA) Teluk Bharu, Sungai Sumun, Perak planted Tagnanan Tall coconut tree populations. As illustrated in Figure 1, the Tagnanan Tall region was placed in Block F, while the other blocks were planted with other coconut varieties such as MATAG, Pandan, and Malayan Dwarf coconut varieties. Tagnanan tall was planted in an equilateral triangle design with 8.5m2 spacing and a planting density of 340 palms separated into five chambers. On the first site visit, we noticed an important difference in the color of the fruits, and three different colors of fruits were detected in the plot area. The fruits are gold, green, and reddish-orange.

Figure 1: Blok Areas in Department of Agriculture (DOA) Teluk Bharu, Perak

Figure 2 illustrates the shape of fruits in a polar view. The side view of a coconut is the polar view. Coconut features four different polar views: round, egg-shaped, pear-shaped, and elliptic. The round shape is typically larger than the other polar shapes of the fruits. The egg-shaped fruits have a larger surface area around the stem and a smaller surface area at the bottom, but the pear-shaped fruits have a larger surface area in the middle of the polar view of the fruits. The elliptic shape resembles an elongated circle stretched into an oval shape.

Figure 2: Polar View Shape of Fruits

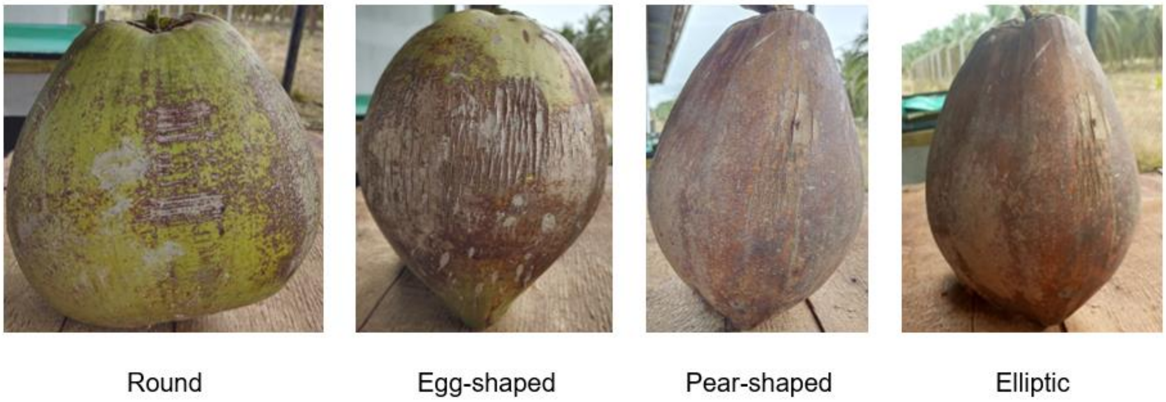


Figure 3 displays the fruits' equatorial perspective form. The equatorial aspect of coconut is where the stems emerge. Fruits are classified into three types according to their equatorial shape: round, angular, and flat. The round is formed like a portion of a spherical. Fruits have solid angles, many corners, and a few soft curves that create an angular view shape. On the surface view of the fruits, the flat shape displays nearly little thickness.

Figure 3: Equatorial View Shape of Fruits

A total of one hundred palms were collected to represent the Tagnanan population, including 50 gold, 40 green, and 10 reddish-orange palms. Growth data such as stem length at 11 leaf scar, stem circumferences at 20 cm and 1.5 m from the ground, and number of fruits per palm were obtained from this. Fruit sample characteristics included fruit weight, husk weight, nut weight, volume of water, split nut weight, meat weight, dry matter, fruit size, shell thickness, and copra thickness.

Data Analysis

Data from observations and measurements were analyzed. Descriptive statistics such as the mean, range, variance, standard error of the mean, and coefficient of variance were used to analyze the quantitative data. The principal component analysis was performed using the RStudio version 4.2.2 program to determine associations among traits.

RESULTS AND DISCUSSION

Variation on Morphological Appearance of Tagnanan Fruit

Figure 4 displays the distribution of polar view fruit shapes of 100 Tagnanan sample individuals.

On all three colors of the fruits, the polar view of the fruit with a round shape performed significantly better than the other shapes of fruits. In the round polar view shape, for example, the round shape has the highest total number of fruits (35% of the total number of fruits), whereas the egg, pear, and elliptic shapes have a lesser total number of fruits. The discovery demonstrates that the round polar view form of fruits is the most prevalent polar view shape of fruits found in the plot area. The highest total number of fruits with polar view fruit forms for the round seems to be 50% reddish-orange, 52.5% green, and 18% gold.

Figure 4: Distribution of Polar View Fruit Shape of 100 Tagnanan Sample Individuals.

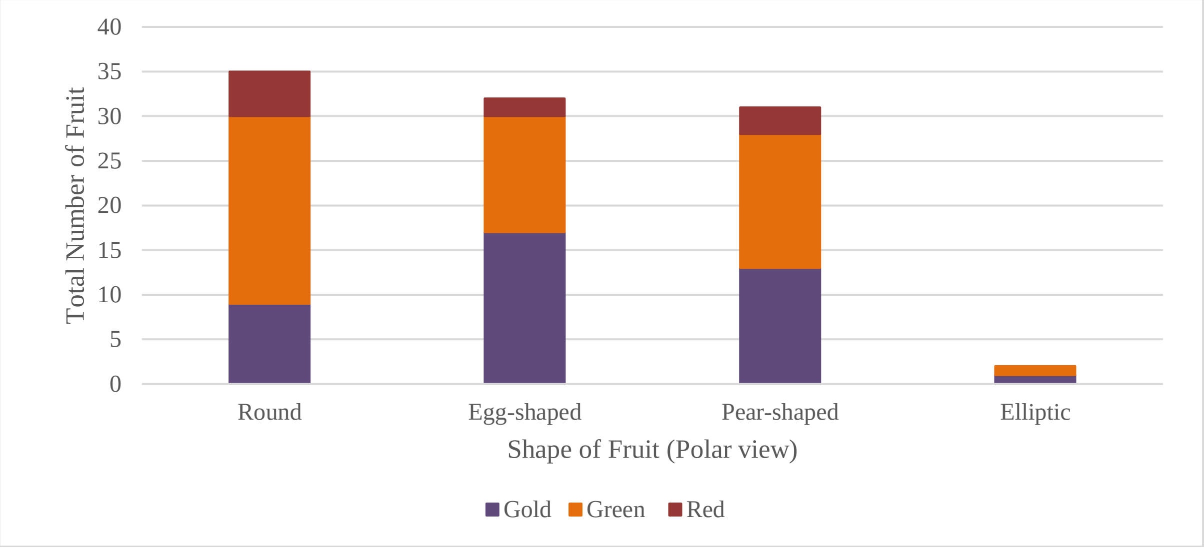
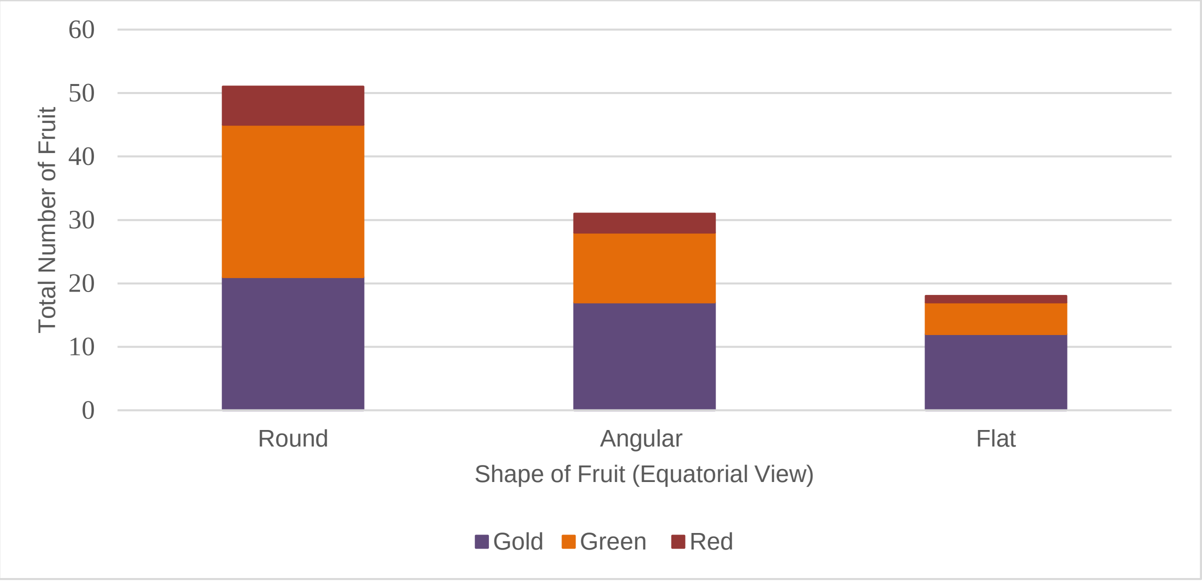


Figure 5 depicts the equatorial view fruit shape distribution of 100 Tagnanan sample individuals.

The equatorial view of fruit for flat shape performed much worse than the other forms of fruits on all three colors of the fruits. For example, in the flat polar view shape, flat has the lowest total number of fruits with just 18% of the total number of fruits, but round and angular shapes have a higher total number of fruits. The finding reveals that the flat equatorial view form of fruits is the least common equatorial view shape of fruits discovered in the Tagnanan plot area. Only 10% reddish-orange, 13% green, and 24% gold appear to yield the fewest total number of fruits with equatorial view shapes for the flat.

Figure 3: Distribution of Equatorial View Fruit Shape of 100 Tagnanan Sample Individuals.

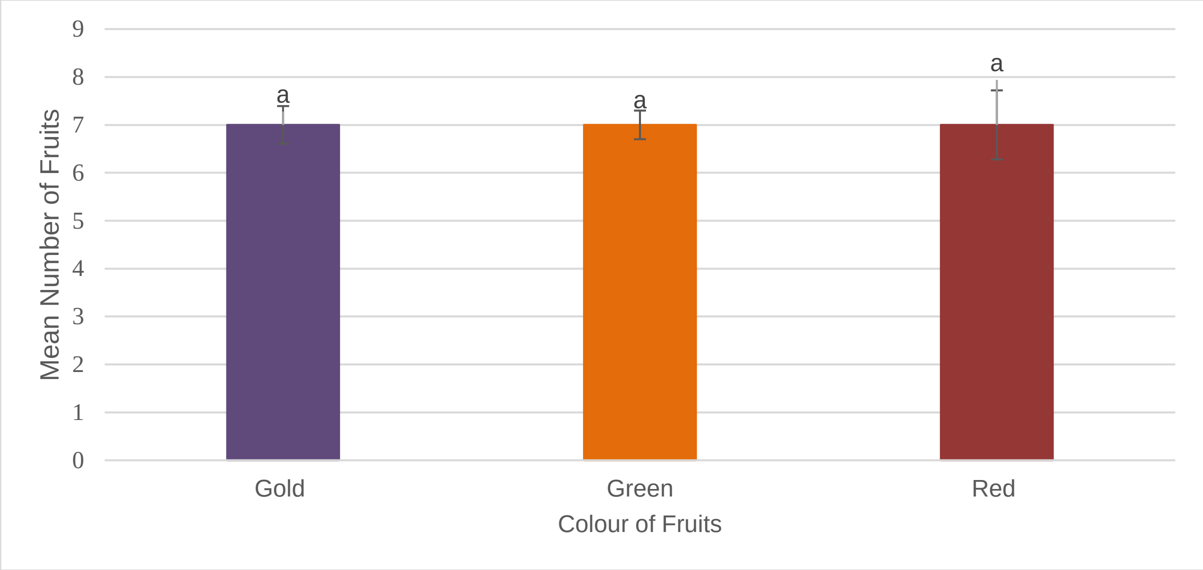


Average Number of Fruits/Bunch of Tagnanan Tall Coconut

Figure 6 shows the average number of fruit/bunches of Tagnanan tall coconut.

The standard deviation for the average number of fruits/bunches is 1.89 for green, 2.8 for gold, and 2.3 for reddish-orange. In the study group, the number of fruits per bunch ranged from 7 to 14, with some variation between individuals. However, for the average quantity of fruits/bunch in Tagnanan tall coconut, there is no significant variation between all three colors of fruits. According to (Novarianto, 2022), coconuts cultivated on fertile soil with adequate water and proper agricultural practices can produce high-quality coconut palms with 14-16 bunches per tree per year for a tall coconut variety. Furthermore, a good coconut palm has a production of at least 12 bunches per tree and yields approximately 84 nuts per year.

Figure 4: Average number of fruit/bunches of Tagnanan Tall Coconut



Variation of Plant Growth, Fruit Yield, and Quality of Tagnanan

Descriptive statistics analysis of traits related to growth and yield of Tagnanan are presented in Table 1. Three characteristics were taken to measure the growth of Tagnanan's tall palms which are the stem circumference at 20 cm, stem circumference at 1.5 m from ground level, and the length of the stem with 11 leaf scars.

One of the main character traits of tall coconut types is having a bole, which is the lower part of the trunk with a larger circumference. The bole circumference or stem circumference at 20 cm above soil level was recorded at 203.3 ± 2.15 cm. The circumference at 1.5 m above ground level is about 97.19 ± 1.09 cm. Theast growth parameter is the height of 11 leaf scars which was recorded at 67.60 ± 1.51 cm. The measurement for 11 leaf scars for Tagnanan that is recorded is slightly shorter than Lampanah tall varieties with the length recorded for 11 leaf scars at 91.10 cm (Novarianto et al., 2017). All three parameters which are the stem measurement at 20cm, 1.5 m, and the height of 11 leaf scars indicate the precocity of the Tagnanan.

Eleven traits are related to the yield of the Tagnanan variety. Traits that are related to the yield of Tagnanan are the weight of fruit, husk weight, nut weight, volume of water, split nut weight, shell weight, meat weight, dry matter, fruit size, shell thickness, and copra thickness.

The lowest standard error of the mean and standard deviation was recorded for the shell thickness with only 0.09 and 0.89 respectively. Moreover, the weight of fruits has the largest standard error of the mean at 45.64 and 456.39 for the standard deviation. The variation in weight of fruits can be influenced by the variations of tall palm which are essentially cross-pollinating and considered heterozygous. However, the thickness of the shell has a low standard error of mean and standard deviation due to the slow maturing and flowering of palms which can take around 6 to 10 years after planting. This statement is supported by findings from (Yao et al., 2022) stating that the selection of certain parental palms from the coconut population can cause gene loss, particularly in Tall palms, which are more heterozygote.

Table 1: Descriptive Statistics Analysis of Traits Related to Growth and Yield of Tagnanan

	Mean	Range	Variance	Standard Error of Mean	Standard Deviation	Coefficient of Variation
C20	203.29	100.90	459.24	2.15	21.54	10.59
C1.5	97.19	64.20	118.32	1.09	10.93	11.25
S11	67.60	75.90	224.49	1.51	15.06	22.28
M	1,755.26	3,289.0	206,211.05	45.64	456.39	26.00
HW	589.87	2183.0	97,935.05	31.45	314.52	53.32
NW	1,165.39	1,238.0	56,602.42	23.91	239.11	20.52
VW	401.20	682.0	16,351.14	12.85	128.52	32.03
SNW	764.19	666.0	16,165.77	12.78	127.79	16.72
SW	260.16	462.0	3,473.69	5.92	59.23	22.77
MW	504.75	474.0	8,825.23	9.44	94.42	18.71
DM	3.09	34.45	16.21	0.40	4.05	1.31
FS	38.04	42.90	160.05	1.27	12.71	33.42
ST	4.36	7.61	0.78	0.09	0.89	20.43
CT	11.23	10.49	1.87	0.14	1.37	12.23

Note: stem circumference at 20 cm (C20); stem circumference at 1.5 m from ground level (C1.5); length of the stem with 11 leaf scars (S11), the weight of fruit (M); husk weight (HW); nut weight (NW); the volume of water (VW); split nut weight (SNW); shell weight (SW); meat weight (MW); dry matter (DM); fruit size (FS); shell thickness (ST); copra thickness (CT)

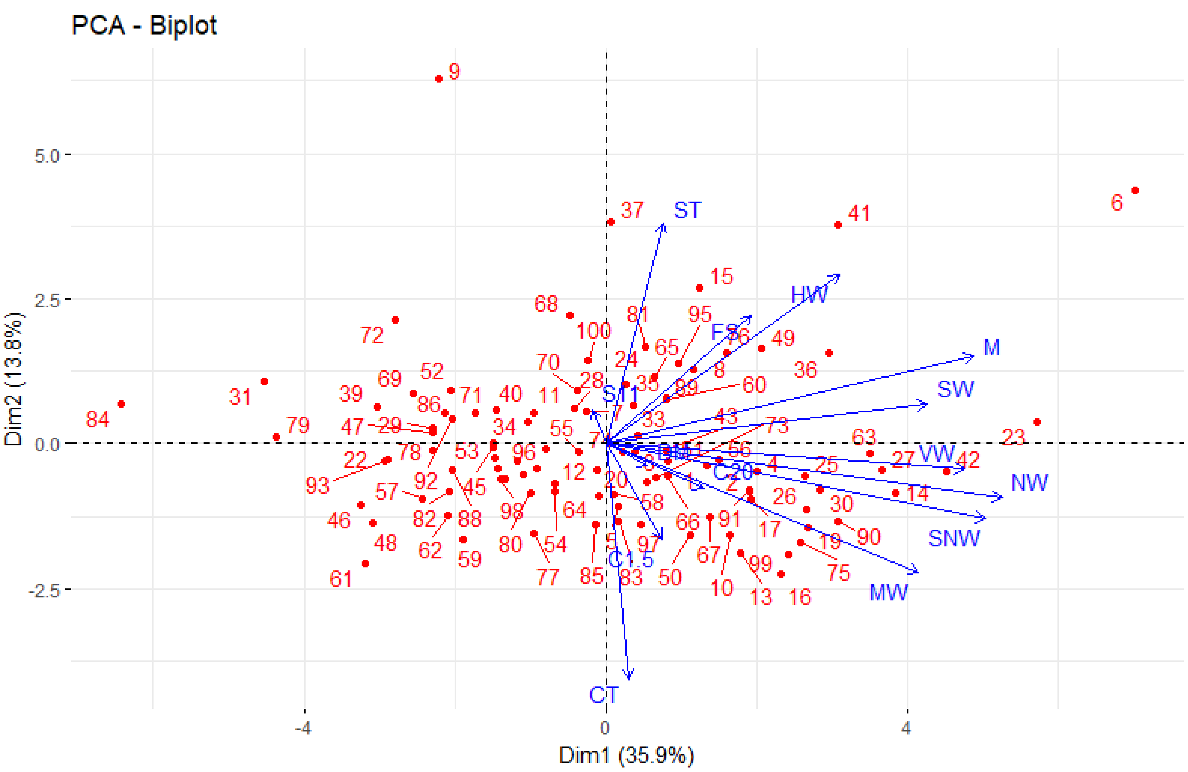
Principle Component Analysis (PCA) of Tagnanan Tall Coconut

The Principal Component Analysis Plot is depicted in Figure 7.

The first two principal components, i.e., PC1 and PC2, explained ~49% of the experiment variation. PC1 accounted for 35.9% and was associated positively with all parameters evaluated except for the length of the stem with 11 leaf scars. PC2 accounted for 13.8% with traits such as length of the stem with 11 leaf scars, shell thickness, fruit size, husk weight, the weight of fruits, and shell weight showing distribution. The angle between the arrows at two variables determined the correlation between the parameters: sharp angles defined positive correlations, squared angles described a null correlation, and obtuse angles illustrated negative correlations (Carvalho-Estrada et al., 2020). In addition, the position over the two dimensions on the graph indicates how variables clustered and revealed that all the fruit characteristics were grouped into two major clusters.

Based on the recorded data, husk weight shows the highest variation followed by fruit size and volume of water. All these three parameters give a positive correlation for PC1 while the fruit size and husk weight give a positive correlation to PC2. Moreover, the weight of fruits shows a high variation in descriptive statistics analysis and this is supported by the PCA where the fruit weight also falls on the second largest source of variation, PC2. However, the length of the stem with 11 leaf scars shows no significance in PC1, while in PC2, low variation parameters that were recorded were the DM, VW, NW, SNW, MW, C20, C1.5, and CT.

Figure 5: Principal Component Analysis (PCA) Plot



Note: stem circumference at 20 cm (C20); stem circumference at 1.5 m from ground level (C1.5); length of the stem with 11 leaf scars (S11), the weight of fruit (M); husk weight (HW); nut weight (NW); the volume of water (VW); split nut weight (SNW); shell weight (SW); meat weight (MW); dry matter (DM); fruit size (FS); shell thickness (ST); copra thickness (CT)

CONCLUSION

At the end of this study, we may conclude that there are differences in the Tagnanan tall population based on fruit color, morphological appearance, descriptive statistics analysis, and PCA. The results revealed that fruits come in three colors: gold, green, and reddish-orange. Furthermore, the morphological appearance of fruits varies in the polar and equatorial view shapes of fruits, with round polar and equatorial view forms of fruits recording the largest number of fruits compared to the other view shapes of fruits. The weight of fruits showed substantial variance in descriptive statistics and PCA, and descriptive statics analysis suggests that shell thickness is one of the fruit attributes with the lowest variation. The low variation and no significant parameters are the parameters that can be taken into consideration for future decisions in producing good quality MATAG seed production regardless of the color of the fruits.

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