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Research Article
Character Seedling Assessment of Various Oil Palm Varieties Grew Grown on Some Marginal Media

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Abstract
Background and Objective: The cultivation of oil palm commences with a seedling phase, wherein planting material is introduced as oil palm seedlings. The produced seedlings must meet the requirements for healthy seedling growth. The purpose of this study is to select some adaptable seeds from various palm varieties grown on the ameliorating media based on the soil fertility index from various marginal soils. **Materials and Methods:** This study used a factorial Randomized Complete Block Design (RCBD) consisting of 2 factors: First, various oil palm varieties namely PPKS 1 and 2, ASD bakrie 1 and 2, icalix and TS and; second, various marginal soils namely M1: 0-50 cm subsoil, M2: 51-100 cm subsoil, M3: 101-150 cm subsoil, M4: Histosol and M5: Entisol, thus obtaining 90 experimental units. Research data on different varieties and treatments of marginal soils were analyzed using ANOVA when F-tests showed significant effects, differences were further examined using 5 and 1% SD tests. **Results:** The results of the study showed that the interaction between various varieties and various soil media on soil fertility values had a very significant effect on the growth characteristics of root volume, root length root weight and a significant effect on the number of leaves and wet weight of stover. **Conclusion:** The interaction between the Themba variety and the sub-ultisol growing medium at a depth of 0-50 cm (V4M1) on soil fertility values had a very significant effect on seedling characteristics, namely the number of leaves, wet weight of shoots root weight.

Key words: Marginal, oil palm varieties, soil fertility value

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq) is an important crop that is closely related to the needs of people in Indonesia. The oil palm commodity has a high economic value. Oil palm plantations directly and indirectly employ 16 mL people. In 2021, oil palm plantations will produce 59.65 mL tons of palm oil and palm kernel, consisting of 49.71 mL tons of Crude Palm Oil (CPO) and 9.94 mL tons of Palm Kernel Oil (PKO). As a sustainable commodity, it is required to obtain superior oil palm seedlings. The appearance of oil palm seedlings is very important to consider in achieving production, affecting the quantity and quality of CPO.

Based on data from the Central Statistics Agency[1] for 2019, production was 47.12 mL tons CPO palm oil production in Indonesia in 2020 was 44.8 mL tons, which was a significant decline. One of the factors for the decline in CPO production is that the availability of quality seeds is still very low, especially for smallholder plantations. The use of non-standard seedlings, such as wild tenera varieties, affects production. The high demand for seedlings is due to the increase in plantation expansion and oil palm replanting in Indonesia, thus requiring quality oil palm seedlings. In line with the opinion of Ariyanti *et al*.[2], the seeds used must come from superior and certified seeds. Meanwhile, Putra[3] explained that the use of superior varieties is an important factor in determining the increase and decrease in production per unit area of an oil palm plantation. The need for oil palm seedlings in Indonesia has increased every year by 1 to 1.17% of seedlings.

Testing and selecting various palm varieties that will be planted in the field aims to determine the character of the seedlings produced at the time of nursery. The results of research by Putri *et al*.[4] on the treatment of 5 varieties, namely Avros 540, PPKS 239, Simalungun, Langkat PPKS Avros 718 on subsoil planting media, showed that the PPKS Avros 718 variety was the best in increasing the height of oil palm plants, while the Simalungun variety was the best in increasing stem diameter. The explanation of Gunawan *et al*.[5] testing six palm varieties, consisting of Simalungun, Yangambi, Dumpy, PPKS 540, Langkat PPKS 239, against saline conditions and the application of humic acid shows that Yangambi can increase plant height growth, number of leaves, root volume root dry weight.

Testing various varieties in different environments produces variations in genetic biodiversity towards different adaptability. The selection of genetic biodiversity in unfavorable environmental conditions allows differences between individuals within the species. The opinion of Salgotra and Chauhan[6] genetic diversity allows individuals to adjust to various biotic and abiotic stresses facing environmental changes. Different plant varieties can survive due to genetic variation in adapting to the environment, especially on marginal land. Marginal land is identical to land that has low quality and is less productive. Rozen *et al*.[7] stated that suboptimal land has a very low soil pH (4.09), low N nutrient content (0.11%), very low available P content (0.45 ppm), very low K content (0.42 me), very low C-organic content (0.94%), very low Ca content (0.75 me), high Fe content (8.95 ppm) and very high Al content (4.168 me). Marginal lands consist of acidic drylands, arid drylands, tidal lands, lebak swamps peatlands.

According to Al-Mizory and Hammo[8], modifying the growing media has an important role in obtaining maximum plant quality and quantity. Providing organic matter has an important role in improving soil properties on marginal land, especially on ultisol and oxisol mineral soils. Research by Hidayat *et al*.[9] stated that the application of 5% cow dung can increase the availability of organic matter, cation exchange capacity nutrients in subsoil media. Research by Imanda and Suketi[10] shows that a medium with a mixture of soil, manure husk charcoal at 70% and the IPB 3 (G1) genotype at 70.91% produced the highest papaya germination rate. Furthermore, the results of research by Sinaga *et al*.[11] showed that the charcoal husk medium treatment resulted in the Dompu genotype being the fastest to flower, while the Merah genotype had the highest yield in okra plants.

This research has relevance to produce genetic population performance in different growing environments. The interaction between the two is that the population can adapt to environmental changes. This study aims to select various varieties of oil palm with different planting media conditions. Another objective is to study the character of oil palm seedlings, both agronomic and physiological aspects, through the combination of superior varieties and marginal soil on soil fertility values. The value is used as an indicator for the addition of ameliorant materials such as animal manure fertilizer, bokashi, compost dolomite to the planting media. Engineering nursery media must refer to the soil fertility values that have been analyzed. Planting media engineering in the form of soil composition with various organic materials plays an important role in plant growth and development.

MATERIALS AND METHODS

Materials and time of research: This research was conducted in Sukomulyo I Village, Tugumulyo District, Musi Rawas Regency, at an altitude of 82.50 m above sea level (masl). The time of the research was from January, 2025 to May, 2025. Materials used in the study, 6 varieties of oil palm sprouts, namely 1) V1: Superior Variety PPKS 1, V2: Superior Variety

PPKS 2, V3: Superior Variety ASD Bakrie 1, V4: Superior Variety ASD Bakrie 2, V5: Superior Variety ASL and V6: Superior Variety TS; and ultisol subsoil media with a depth of 0-50 cm (M1), 51-100 cm (M2) and 101-150 cm (M3), histosol soil (M4) and entisol soil (M5) as well as cow manure and dolomite fertilizer.

Research methods: This research method uses an experimental method with a factorial Randomized Complete Group Design (RCGD) consisting of 2 treatment factors, namely various varieties and various types of marginal soils, resulting in 30 treatment combinations with 3 replications there are 90 experimental units with 2 sample plants. The total number of samples was 180. Research during the pre-nursery nursery period until the age of seedlings, ± 4 months.

Observed parameters: The variables observed in this study include agronomic aspects and physiological aspects: (1) Plant height (cm), by measuring from the base of the stem to the longest leaf blade, (2) Number of leaflets (blade), by counting all the leaf blades that have fully opened, (3) Number of stomata (mm^2), by taking the lower part of the leaf that has been treated with nail polish and taped with insulation, then observing it using a microscope with 40x magnification, (4) Leaf chlorophyll (SPAD), by measuring the middle part of the leaf using a chlorophyll meter (SPAD unit), (5) Bold diameter (mm), by measuring the palm trunk using a caliper, (6) Plant wet weight (g), by measuring the entire plant using a digital scale, (7) Root volume (mm), by cutting the cleaned palm root, then placing it in a 200 mL measuring cup containing 100 mL of water, resulting in an increase in volume, (8) Root length (cm), by measuring from the base of the root to the tip of the root using a measuring tape and (9) Wet root weight (g), by measuring the entire root section using a digital scale[12,13].

Statistical analysis: Assessment of soil fertility status. The formula used for the assessment of soil fertility index (SFI) used in this study is as follows: SFI = (H CEC*B)+(H N*B)+(H C*B)+(H P*B)+(H K*B)+(H Ca*B)+(H Mg*B)-(H Al*B). Fertility index classification is divided into five classes: High, moderately high, medium, moderately low low, with class range based on a uniform interval method. This method is determined based on the equation: Class interval = (maximum value-minimum value)/number of classes. Based on this method, the classes were obtained: -High = 241-280, -Somewhat high = 201-240, -Medium = 161-200, -Somewhat Low = 121-160,-Low = 80-120.

The research data on the treatment of various varieties and types of marginal soils were analyzed using Analysis of Variance (ANOVA) to determine the effect of each treatment, tested using diversity analysis. If the F-test results showed a very significant and significant effect, then a 5% and 1% level of the Significant Difference Test (SD) was conducted. If the F-count value is smaller than the F table value of 5%, then the treatment is declared to have no significant effect. If the F-count value is greater than the F table value of 5% but smaller than the F table value of 1%, then the treatment is declared to have a significant effect. If the F-count value is greater than the F table 1%, then the treatment is declared to have a very significant effect.

RESULTS AND DISCUSSION

Analysis of soil chemical properties: Based on the results of the analysis of various marginal soils in Table 1 shows that peat soil types (M4) have the highest C-organic content, nutrients N, P, K pH 3.27 with very acidic soil status. While sub-ultisol soil with a soil depth of 100-150 cm (M3) has the lowest nutrient content in nutrients P, K Ca with acidic soil status. The soil analysis data obtained in the laboratory were processed using the formula for the assessment of soil fertility index (SFI) are shown in Fig. 1.

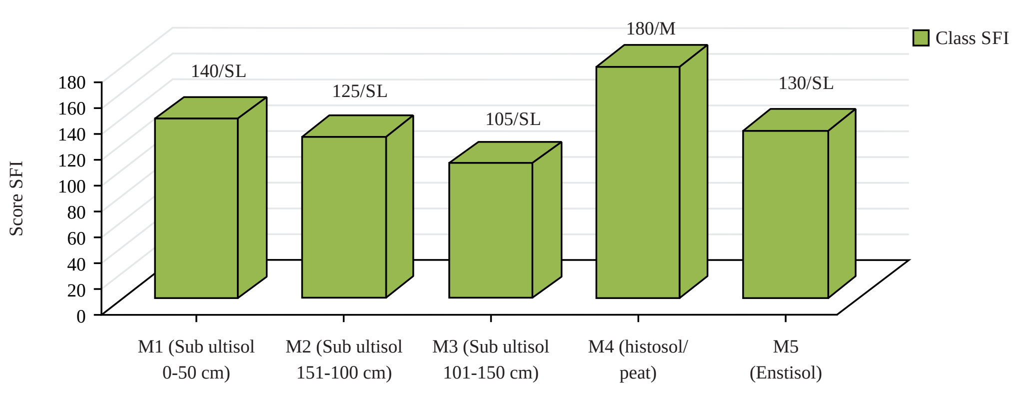

Fig 1: Fertility index of various marginal soils

Table 1: Research data from the assessment of marginal soil fertility

				(me/100 g)					
Soil type marginal (M)	C (%)	N (%)	P (ppm)	K	Ca	Mg	Al	CEC	pH
M1 (Subultisol 0-50 cm)	1.41	0.09	5.31	0.36	0.22	0.44	3.32	9.80	4.77
M2 (Subultisol 51-100 cm)	1.34	0.12	4.97	0.24	0.21	0.33	2.77	16.06	4.82
M3 (Subultisol 100-150 cm)	0.96	0.07	0.45	0.20	0.19	0.21	2.16	18.91	4.65
M4 (Peat/Histosol)	26.75	0.32	9.09	0.35	0.65	0.07	4.81	128.92	3.27
M5 (Entisol)	0.53	0.06	3.85	0.31	1.81	0.18	0.37	7.31	7.34

C: Carbon, N: Nitrogen, P: Phosphorus, K: Potassium, Ca: Calcium, Mg: Magnesium, Al: Aluminium, CEC: Cation exchange capacity and pH: Potential of hydrogen

Table 2: ANOVA of the results of the research on treatment various varieties and treatment various types of marginal soils on oil palm seed variables

		Treatment			
Number	Parameters observed	V	M	I	CoV (%)
1	Plant height	16.90**	12.45**	0.72ns	10.90
2	Number of leaves	0.91ns	7.15**	1.79*	9.57
3	Leaf chlorophyll	1.23ns	1.71ns	1.67ns	12.85
4	Stem diameter	1.44ns	6.64**	0.80ns	35.91
5	Wet weight of the stalks	1.59ns	14.32**	2.01*	28.66
6	Root volume	1.82ns	10.59**	2.45**	36.42
7	Root length	1.69ns	8.34**	2.34**	1.15
8	Root weight	3.03*	8.75**	3.05**	33.06

V: Palm variety treatment, M: Marginal soil treatment, I: Interaction of palm variety and marginal soil, **: Very significant effect, *Significant Effect, ns: Not significant effect and CoV: Coefficient of variance

Table 3: SD Test results of the seedling height (cm) of various oil palm varieties on various types of soil

	Factor marginal (M)					
Factor varieties (V)	M1 (Subsoil 0-50 cm)	M2 (Subsoil 51-100 cm)	M3 (Subsoil 101-150 cm)	M4 (Histosol)	M5 (Entisol)	Average
V1(PPKS 1)	30.13	25.08	23.03	29.85	24.00	26.42a
V2 (PPKS 2)	30.80	27.90	23.88	30.78	27.40	28.15a
V3 (ASD Bakrie 1)	34.27	30.95	27.43	38.25	31.50	32.48b
V4 (ASD Bakrie 1)	34.65	29.88	30.18	35.67	31.55	32.39b
V5 (ASL)	33.93	36.30	35.62	40.37	35.82	36.41c
V6 (TS)	38.13	32.38	28.90	36.77	31.17	33.47b
Average M	33.65b	30.42a	28.17a	35.28b	30.24a	
SD V&M 1% = 3.00						

Numbers followed by the same letter in the same column are read vertically and the same row is read horizontally means that the numbers are not significantly different at the 1% test level. PPKS: PT. Pusat penelitian kelapa sawit, ASD: PT. Astra agro lestari, ASL: PT. Aneka sawit lestari, TS: PT tania selatan and SD: Significant difference

Improvement of soil chemical properties can be done by adding organic matter in the form of cow dung fertilizer to each planting medium according to the standard indicators of soil physical and chemical properties suggested by the Soil Research Center. The dose of cow dung fertilizer given in this study, each planting media varied with a dose scale of 1.5-2.5% equivalent to 75-125 grams per polybag. The addition of organic matter and dolomite to each planting media is able to increase soil pH 1-1.5 points, which correlates with increasing soil cation exchange capacity and soil can absorb and provide nutrients for plants.

The results of the Analysis of Variance (ANOVA) of growth studies of different varieties of oil palm seedlings and different soil types on soil fertility indices are listed in Table 2.

The results of the analysis of variance in Table 2 show that the treatment of several varieties of palms (V) had with F-count value a very significant effect on plant height (16.90) and a significant effect on root weight (3.03). Marginal soil treatment (M) had with F-count value a very significant effect on plant height (12.45), number of leaves (7.15), stem diameter (6.64), wet weight of the stalks (14.32), root volume (10.59), root length (1.69) and root weight (8.75). While the interaction between the treatment of various palm varieties and various marginal soils (I) with F-count value very significantly effect on root volume (2.45), root length (2.34) root weight (3.05), there was a significantly effect on the number of leaves (1.79) and Wet weight of the stalks (2.01).

Table 4: Results of SD number of leaves (strands) of various oil palm varieties on various types of soil

	Factor marginal (M)					
Factor varieties (V)	M1 (Subsoil 0-50 cm)	M2 (Subsoil 51-100 cm)	M3 (Subsoil 101-150 cm)	M4 (Histosol)	M5 (Entisol)	Average V
V1(PPKS 1)	7.00[d]	6.67[bc]	6.00[b]	7.67[e]	6.33[b]	6.73
V2 (PPKS 2)	6.83[c]	6.83[c]	5.00[a]	7.83[e]	7.50[e]	6.80
V3 (ASD Bakrie 1)	6.83[c]	6.83[c]	7.00[d]	7.17[d]	6.50[c]	6.87
V4 (ASD Bakrie 1)	7.67[d]	6.67[c]	6.50[c]	7.00[d]	7.33[d]	7.03
V5 (ASL)	7.33[d]	7.33[d]	6.33[c]	7.17[d]	6.50[c]	6.93
V6 (TS)	7.33[d]	6.50[c]	7.00[d]	7.67[e]	7.50[e]	7.20
Average M	7.17[b]	6.81[ab]	6.31[a]	7.42[b]	6.94[b]	
SD M 1% = 0.58	SD I 5% = 0,44					

Numbers followed by the same letter in the same column are read vertically and the same row is read horizontally means that the numbers are not significantly different at the 5 and 1% test level. PPKS: PT. Pusat penelitian kelapa sawit, ASD: PT. Astra agro lestari, ASL: PT. Aneka sawit lestari, TS: PT tania selatan and SD: Significant difference

Table 5: Results of analysis of leaf chlorophyll (SPAD) of various oil palm varieties on various types of soil

	Factor marginal (M)					
Factor varieties (V)	M1 (Subsoil 0-50 cm)	M2 (Subsoil 51-100 cm)	M3 (Subsoil 101-150 cm)	M4 (Histosol)	M5 (Entisol)	Average V
V1(PPKS 1)	51.63	50.68	44.90	52.70	52.56	50.49
V2 (PPKS 2)	50.50	50.47	43.72	43.50	55.45	48.73
V3 (ASD Bakrie 1)	56.12	48.87	50.90	55.28	60.33	54.30
V4 (ASD Bakrie 1)	53.42	53.07	55.05	53.12	47.63	52.46
V5 (ASL)	57.35	55.68	51.30	52.47	39.90	51.34
V6 (TS)	58.15	54.18	51.62	45.97	43.87	50.76
Average M	54.53	52.16	49.58	50.51	49.96	

PPKS: PT. Pusat penelitian kelapa sawit, ASD: PT. Astra agro lestari, ASL: PT. Aneka sawit lestari and TS: PT tania selatan

Plant height (cm): The analysis of variance showed that the treatment of various varieties (V) had a very significant effect on plant height, the treatment of various marginal soils (M) had a very significant effect on plant height, while the interaction (I) between the treatment of varieties and marginal soils had no significant effect on plant height. The results of the Significant Difference (SD) test at the 1% level of plant height can be seen in Table 3.

Based on the 1% SD test in Table 3, it is known that the treatment of V5 (36.41 cm) varieties is significantly different in all treatments while the treatment of marginal soil M4 (35.28 cm) is significantly different from the treatment of M2 (30.42 cm), M3 (28.17 cm) and M5 (30.24 cm) and is not significantly different from the treatment of M1 (33.65 cm).

Number of leaves (strands): The results of the analysis of variance showed that the treatment of various varieties (V) had no significant effect on the number of leaves, the treatment of various marginal soils (M) had a very significant effect on the number of leaves, while the interaction (I) between the treatment of varieties and marginal soils had a significant effect on the number of leaves. The SD test results and tabulated data on the number of leaves can be seen in Table 4.

Based on the 5% SD test in Table 4. it is known that the interaction treatment between various varieties and various marginal soils in the 5% SD test showed that the V1M4 (7.67 strands) treatment was significantly different in all treatments. Treatment V2M4 (7.83 strands) was significantly different in all treatments and not significantly different in treatment V2M5 (7.50 strands). Treatment V3M4 (7.17 strands) was significantly different in all treatments except for treatment V3M3 (7.00 strands), where it was not significantly different. Treatment V4M1 (7.67 strands) was significantly different in treatments V4M2 (6.67 strands) and V4M3 (6.50 strands) and not significantly different in other treatments. Treatment V5M1 (7.33 strands), V5M2 (7.33 strands) and V5M4 (7.17 strands) were significantly different in treatments V5M3 (6.33 strands) and V5M5 (6.50 strands). and treatment V6M4 (7.67 strands) was significantly different in all treatments and not significantly different in treatment V6M5 (7.50 strands).

Leaf chlorophyll (SPAD): The results of the analysis of variance showed that the treatment of various varieties (V), treatment of various marginal soils (M) interaction (I) between the treatment of varieties and marginal soils had no significant effect on leaf chlorophyll can be seen in Table 5.

Based on the results of tabulated data on leaf chlorophyll parameters, the treatment interaction V3M5 produced the largest leaf chlorophyll of 60.33 SPAD and the smallest V2M4 of 43.50 SPAD.

Table 6: Results of SD test for the stem diameter (mm) of various oil palm varieties on various types of soil

	Factor marginal (M)					
Factor varieties (V)	M1 (Subsoil 0-50 cm)	M2 (Subsoil 51-100 cm)	M3 (Subsoil 101-150 cm)	M4 (Histosol)	M5 (Entisol)	Average V
V1(PPKS 1)	17.28	13.77	9.42	19.12	13.28	14.57
V2 (PPKS 2)	17.75	14.48	8.72	12.65	19.10	14.54
V3 (ASD Bakrie 1)	21.90	11.28	10.90	23.87	13.85	16.36
V4 (ASD Bakrie 1)	22.60	14.58	11.82	21.75	21.48	18.45
V5 (ASL)	15.77	20.92	15.13	23.28	17.78	18.58
V6 (TS)	18.30	15.17	11.23	21.33	23.33	17.87
Average M	18.93[b]	15.03[ab]	11.20[a]	20.33[b]	18.14[b]	
SD M 1% = 5.24						

Numbers followed by the same letter in the same row is read horizontally means that the numbers are not significantly different at the 1% test level. PPKS: PT. Pusat penelitian kelapa Sawit, ASD: PT. Astra agro lestari, ASL: PT. Aneka sawit lestari, TS: PT tania selatan and SD: Significant difference

Table 7: Results of SD test for the wet weight of stem (g) of various oil palm varieties on various types of soil

	Factor marginal (M)					
Factor varieties (V)	M1 (Subsoil 0-50 cm)	M2 (Subsoil 51-100 cm)	M3 (Subsoil 101-150 cm)	M4 (Histosol)	M5 (Entisol)	Average V
V1(PPKS 1)	30.63[d]	26.77[c]	11.20[a]	25.47[c]	22.17[b]	23.25
V2 (PPKS 2)	25.70[b]	17.80[b]	15.03[a]	26.10[c]	26.43[c]	22.21
V3 (ASD Bakrie 1)	34.60[e]	15.17[a]	18.37[b]	38.93[e]	26.93[c]	26.80
V4 (ASD Bakrie 1)	37.47[e]	15.47[a]	15.27[a]	31.83[d]	31.27[c]	26.26
V5 (ASL)	23.47[c]	28.13[c]	17.37[a]	37.83[e]	28.57[d]	27.07
V6 (TS)	25.53[c]	19.58[b]	10.83[a]	24.88[c]	30.70[d]	22.30
Average M	29.57[b]	20.49[a]	14.68[a]	30.84[b]	27.68[b]	
SD M 1% = 6.17	SD I 5% = 4.71					

Numbers followed by the same letter in the same column are read vertically and the same row is read horizontally means that the numbers are not significantly different at the 5 and 1% test level. PPKS: PT. Pusat penelitian kelapa sawit, ASD: PT. Astra agro lestari, ASL: PT. Aneka sawit lestari, TS: PT tania selatan and SD: Significant difference

Stem diameter (mm): The results of the analysis of variance showed that the treatment of various marginal soils (M) had a very significant effect on stem diameter, while the treatment of various varieties (V) and the interaction (I) between the treatment of varieties and marginal soils had no significant effect on stem diameter. The results of SD test at 1% level of stem diameter can be seen in Table 6.

The 1% SD test in Table 6, it is known that the marginal soil treatment M4 (20.33 mm) is significantly different from the M3 (11.20 mm) treatment and is not significantly different from all treatments.

Wet weight of the stalk (g): The results of the analysis of variance showed that the treatment of various varieties (V) had no significant effect on the wet weight of the stalk, the treatment of various marginal soils (M) had a very significant effect on the wet weight of the stalk, while the interaction (I) between the treatment of varieties and marginal soils had a significant effect on the wet weight of the stalk. The results of the SD test at the 1% and 5% levels of wet weight of stover can be seen in Table 7.

Based on the 5% SD test in Table 7. It is known that the interaction treatment between various varieties and various marginal soils, treatment V1M1 (30,63 g) was significantly different from all treatments. Treatment V2M5 (26.43 g) was significantly different from all treatments and not significantly different from treatment V2M4 (26.10 g). Treatment V3M4 (38.93 g) was significantly different in all treatments and not significantly different in treatment V3M1 (34.60 g). Treatment V4M1 (37.47 g) was significantly different in all treatments. Treatment V5M4 (37.83 g) was significantly different in all treatments. Treatment V6M5 (30.70 g) was significantly different in all treatments.

Root volume (mL): The results of the analysis of variance showed that the treatment of various varieties (V) had no significant effect on root volume, the treatment of various marginal soils (M) and the interaction (I) between the treatment of varieties and marginal soils had a very significant effect on root volume. The results of SD test at 1% level of root volume can be seen in Table 8.

Based on the 1% SD test in Table 8. it is known that the interaction treatment between various varieties and various marginal soils, treatment V1M4 (8.00 mL), was very significantly different in all treatments. Treatment V2M5 (8.33 ml) was very significantly different in treatment V2M2 (5.67 mL) but not significantly different in all treatments. Treatment V3M4 (13.00 mL) was significantly different in all

Table 8: Results of SD test for the root volume (mL) of various oil palm varieties on various types of soil

	Factor marginal (M)					
Factor varieties (V)	M1 (Subsoil 0-50 cm)	M2 (Subsoil 51-100 cm)	M3 (Subsoil 101-150 cm)	M4 (Histosol)	M5 (Entisol)	Average V
V1(PPKS 1)	4.67^{b}	6.00^{b}	4.33^{a}	8.00^{c}	4.67^{b}	5.53
V2 (PPKS 2)	6.67^{c}	5.67^{b}	7.00^{c}	8.00^{c}	8.33^{c}	7.13
V3 (ASD Bakrie 1)	11.00^{d}	2.00^{a}	4.67^{b}	13.00^{de}	5.67^{b}	7.27
V4 (ASD Bakrie 1)	8.67^{c}	4.00^{a}	4.67^{b}	8.33^{c}	11.33^{d}	7.40
V5 (ASL)	6.67^{c}	8.00^{c}	4.33^{b}	14.33^{e}	8.33^{c}	8.33
V6 (TS)	7.00^{c}	5.33^{b}	6.33^{b}	7.33^{c}	11.00^{d}	7.40
Average M	7.45^{ab}	5.17^{a}	5.22^{a}	9.83^{b}	8.22^{b}	
SD M and I 1% = 2.28						

Numbers followed by the same letter in the same column are read vertically and the same row is read horizontally means that the numbers are not significantly different at the 1% test level. PPKS: PT. Pusat penelitian kelapa sawit, ASD: PT. Astra agro lestari, ASL: PT. Aneka sawit lestari, TS: PT tania selatan and SD: Significant difference

Table 9: Results of SD Test for the root length (cm) of various oil palm varieties on various types of soil

	Factor marginal (M)					
Factor varieties (V)	M1 (Subsoil 0-50 cm)	M2 (Subsoil 51-100 cm)	M3 (Subsoil 101-150 cm)	M4 (Histosol)	M5 (Entisol)	Average V
V1(PPKS 1)	32.33^{b}	35.17^{b}	33.17^{b}	43.00^{d}	34.33^{b}	35.60
V2 (PPKS 2)	41.33^{c}	23.83^{a}	33.50^{ab}	38.33^{c}	41.00^{c}	35.60
V3 (ASD Bakrie 1)	44.83^{d}	21.00^{a}	44.00^{d}	46.33^{d}	39.00^{c}	39.03
V4 (ASD Bakrie 1)	42.00^{c}	26.83^{a}	35.67^{c}	38.67^{c}	46.33^{d}	37.90
V5 (ASL)	28.40^{b}	41.33^{c}	42.33^{c}	39.90^{c}	42.17^{c}	38.83
V6 (TS)	35.33^{b}	31.33^{b}	40.00^{c}	43.00^{d}	64.67^{e}	42.87
Average M	37.37^{b}	29.92^{a}	38.11^{bc}	41.54^{bc}	44.58^{c}	
SD M and I 1% = 7.07						

Numbers followed by the same letter in the same column are read vertically and the same row is read horizontally means that the numbers are not significantly different at the 1% test level. PPKS: PT. Pusat penelitian kelapa sawit, ASD: PT. Astra agro lestari, ASL: PT. aneka sawit lestari, TS: PT tania selatan and SD: Significant difference

treatments. Treatment V4M5 (11.33 mL) was significantly different in all treatments. Treatment V5M4 (14.33 mL) was significantly different in all treatments. Treatment V6M5 (11.00 mL) was also significantly different in all treatments.

Root length (cm): The results of the analysis of variance showed that the treatment of various varieties (V) had no significant effect on root length, the treatment of various marginal soils (M) and the interaction (I) between the treatment of varieties and marginal soils had a very significant effect on root length. The results of SD test at 1% level of root length can be seen in Table 9.

Based on the 1% SD test in Table 9. It is known that the interaction treatment between various varieties and various marginal soils, treatment V1M4 (43.00 cm), was significantly different in all treatments. Treatment V2M1 (41.33 cm) was significantly different from treatments V2M2 (23.83 cm) and V2M3 (33.50 cm) but not significantly different from treatments V2M4 (38.33 cm) and V2M5 (41.00 cm). Treatment V3M4 (46.33 cm) was significantly different from treatments V3M2 (21.00 cm) and V3M5(39.00 cm) but not significantly different from treatments V3M1 (44.83 cm) and V3M3 (44.00 cm). Treatment V4M5 (46.33 cm) was significantly different from all treatments. Treatment V5M3 (42.33 cm) differs significantly from treatment V5M1 (28.40 cm) but does not differ significantly from all other treatments. Treatment V6M5 (64.67 cm) differs significantly from all other treatments.

Root weight (g): The results of the analysis of variance showed that the treatment of various varieties (V) significantly affected the root weight, the treatment of various marginal soils (M) and the interaction (I) between the treatment of varieties and marginal soils significantly affected the root weight. The results of SD test at 1% level of root weight can be seen in Table 10.

Based on the 1% SD test in Table 10. It was found that the interaction between different varieties and different marginal soils in treatment V1M4 (5.07 g) was significantly different from all other treatments. Treatment V2M5 (5.40 g) was significantly different in all treatments but not significantly different in treatment V2M1 (5.17 g). Treatment V3M4 (8.80 g) was significantly different in all treatments. Treatment V4M1 (7.63 g) was significantly different in all treatments. Treatment V5M4 (9.90 g) was significantly different in all treatments. Treatment V6M5 (7.03 g) was also significantly different in all treatments.

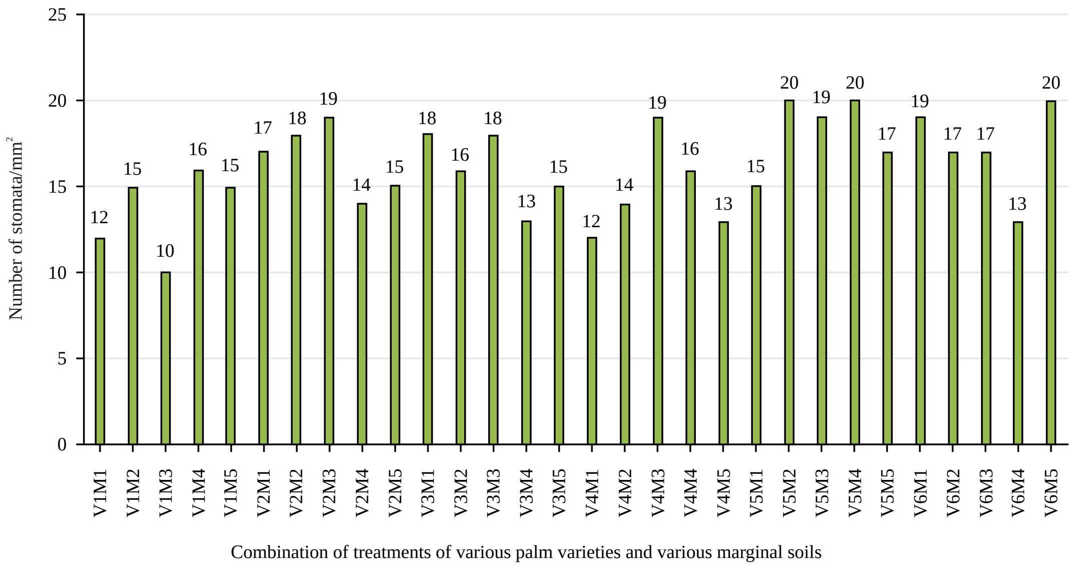

Fig. 2: Number of stomata on leaves of oil palm seedlings

Table 10: Results of SD test for the root weight (g) of various oil palm varieties on various types of soil

	Factor marginal (M)					
Factor varieties (V)	M1 (Subsoil 0-50 cm)	M2 (Subsoil 51-100 cm)	M3 (Subsoil 101-150 cm)	M4 (Histosol)	M5 (Entisol)	Average V
V1(PPKS 1)	3.37[a]	4.27[b]	2.20[a]	5.07[c]	3.30[a]	3.64[a]
V2 (PPKS 2)	5.17[c]	3.07[a]	4.83[b]	4.73[b]	5.40[c]	4.64[a]
V3 (ASD Bakrie 1)	6.83[d]	3.23[a]	4.33[b]	8.80[e]	3.37[a]	5.31[b]
V4 (ASD Bakrie 1)	7.63[d]	2.23[a]	3.63[b]	6.03[c]	6.00[c]	5.10[b]
V5 (ASL)	3.77[b]	6.60[d]	3.30[a]	9.90[e]	5.33[a]	5.78[b]
V6 (TS)	5.37[c]	3.67[b]	4.53[b]	4.53[b]	7.03[d]	5.03[a]
Average M	5.36[b]	3.85[a]	3.80[a]	6.51[b]	5.07[ab]	
SD V 5% = 1.08	SD M and I 1% = 1.42					

Numbers followed by the same letter in the same column are read vertically and the same row is read horizontally means that the numbers are not significantly different at the 5% and 1% test level. PPKS: PT. Pusat penelitian kelapa sawit, ASD: PT. Astra agro lestari, ASL: PT. Aneka sawit lestari, TS: PT tania selatan and SD: Significant difference

Number of stomata (mm^2): The results of the data in Fig. 2 below show that the interaction treatment between various varieties and various marginal soils, treatments V5M2, V5M4 V6M5 have the highest number of stomata at 20 mm^2 and V1M3 has the smallest number of stomata at 10 mm^2.

Based on the data diagram in Fig. 2, the highest number of stomata was obtained in the V5M2, V5M4 and V6M5 treatments, namely 20 mm^2, while the lowest number of stomata in the V1M3 treatment was 10 mm^2.

Growth characteristics of seedlings of various varieties on marginal media: The results of the analysis of variability showed that the treatment of several varieties of oil palm (V) had a very real and real effect on the parameters of plant height and root weight. This is due to the superior response of each palm variety to be used as planting material through variations in gene and allele factors in each palm variety. Observation of morphological characters is the main method for identifying and selecting varieties that are influenced by the environment, resulting in variation. Genetic variation describes the appearance of the morphology of a plant. In line with the opinion of Nasution *et al.*[12], the method of genetic expression on morphology can be used to determine genetic diversity in large populations. Meanwhile, morphology is a plant phenotypic trait that is visible to the five senses at the time of observation. According to Rahmawati[13], the use of various germplasm sources, high genetic variation can help in the formation of new superior varieties (NSV).

Based on the results of the SD test at the 1% level, variety V5 (icalix) gave the best response to the parameters observed. The V5 variety seedlings have the advantage of having genetic variation inherited from the parent palm; this variation contributes to differences in traits between individuals. One example of genetic trait variation inherited in icalix oil palm seedlings is resistance to marginal environmental conditions that experience drought stress and nutrient deficits compared to other varieties. According to Dewi *et al.*[14] oil palm plants planted on marginal land experience drought stress, which clearly has a negative impact on growth and development if this drought is not addressed when developing oil palm commodities using superior varieties.

The choice of growing media material plays an important role. Planting media has a positive influence on the morphological and physiological growth and development of oil palm seedlings. Supported by the explanation of Maulana *et al.*[15] planting media is very important for root growth and development and plant survival. The opinion of Chang *et al.*[16] different physical conditions of the soil cause the availability of water and nutrients absorbed by plants to be different, this has an impact on the growth of oil palm seedlings.

The results of the analysis of variance showed that the marginal soil treatment (M) had a very significant effect on the parameters of plant height, number of leaves, stem diameter, wet weight of stalk, root volume, root length root weight[16,17]. The selection of superior palm varieties will produce different advantages and adaptations to the environment by each variety. Understanding the character of seedling growth to determine the stability of height in several varieties and the responsiveness of seedlings to environmental changes, especially in marginal soils. While physiological characters are observed through one of the observations of chlorophyll content and the number of stomata, to distinguish the physiology of various varieties based on the ability of plants to overcome environmental stress. Genotypes that are stable in a wide range of environments and adaptive in certain environments can be identified through multilocation testing (Karuniawan and Maulana)[17]. Furthermore, according to Abebe *et al.*[18], multi-location trials have the potential to identify superior varieties in specific environmental conditions. Therefore, these varieties are worth considering for local adaptation. The results of the fertility index analysis of various types of marginal soils show that each type of marginal soil has a different fertility classification, namely low, rather low medium, shown in Fig. 1. Oil palm nursery media using marginal soil before use are first analyzed to improve the chemical properties of the soil by adding organic matter. Organic matter in the form of animal manure, compost, biochar humic materials can improve texture, soil pH, cation exchange capacity nutrient availability. In the opinion of Liu *et al.*[19], the application of organic ameliorants to the soil is one of the effective strategies to increase soil water retention, improve soil physical, chemical biological properties.

The SD test results at the 1 and 5% levels of marginal soil type M4 (histosol/peat) gave the best response to the parameters observed. Histosol soil comes from the remains of plants and microorganisms that have undergone a decomposition process over a long period contains organic matter. Plant growth will be enhanced by peat structures with a more advanced level of decomposition, resulting in a high level of organic matter[20], the content of organic matter greatly influences the amount of potassium in peat soil. Potassium is an essential nutrient needed by plants. Meanwhile, according to Nasrul *et al.*[21], in peat soil, ash content can be used as a measure of soil fertility because the higher the ash content, the higher the mineral richness in the peat.

The results of the analysis of variance showed that the interaction between the treatments of various palm varieties and various marginal soils (I) a very significant on root volume, root length root weight a significant effect on the number of leaves and wet weight of stalks. The interaction occurs because of the correlation that supports varieties with growing media in increasing the growth of plant vegetative organs. The process of plant growth and development is controlled by genetic and environmental factors through molecular regulatory networks and signaling. These two factors work together to regulate the entire life cycle of plants, from germination to the plant development stages. According to Feng *et al.*[22], transcription factors in plants function in biological and physiological processes, such as plant morphogenesis, responsive mechanisms to various environmental stresses, hormone signal transduction metabolite regulation.

Based on the analysis of variance and the 5 and 1% BNJ tests, as well as the tabulated data, the interaction treatment of the Themba variety and subsoil planting medium (0-50 cm) treatment V4M1 had the best effect on the number of leaves, plant height, stem diameter, wet weight of the seedling root weight of oil palm seedlings. To determine the characteristics of a plant variety, it is important to know how the interaction of genotype and environment functions. When the interaction between the two is high, the variety can adapt to a particular location, but when the value of the interaction between the two is low or completely absent, the variety can be developed as a variety that adapts to different characters. Meanwhile, according to Hassani *et al.*[23] crop yields are determined by genotype, environment genotype-environment interaction (GEI). The GEI plays an important role in determining the stability of genotype yields in various environments. The 90 experimental units of the four-month-old oil palm seedling research at the *pre-nursery* stage are shown in Fig. 3.

Fig. 3: Four-month-old oil palm seedling research at the pre-nursery stage

This research contributes to a theoretical understanding of the interaction between genotype and environment (G×E) under marginal conditions, enabling the selection of superior varieties that are efficient in nutrient utilization and tolerant to abiotic stress. In practical terms, the study of genotypes and the environment supports the development of recommendations for the selection of location-specific varieties for oil palm cultivation on low-fertility soils such as ultisols, sandy soils, peat soils soils with imbalanced nutrient content The main challenges in the process of selecting superior oil palm seeds are the high genetic variation between seeds, seed adaptation to different environments limited human resources to carry out manual selection.

CONCLUSION

The results of the study of the character of seedlings of various varieties of oil palm on marginal media on the value of the soil fertility index concluded: This study resulted in a positive correlation of genetic population performance in different growing environments. The dose of cow dung fertilizer given in this study, each planting media varied with a dose scale of 1.5-2.5% equivalent to 75-125 g per polybag. The addition of organic matter and dolomite to each planting media at least able to increase soil pH 1-1.5 points.

The V5 (icalix) oil palm variety treatment had a very significant and significant effect on seedling growth characteristics in terms of plant height and root weight. The marginal histosol soil (M4) treatment had a very significant effect on seedling characteristics in terms of plant height, number of leaves, stem diameter, wet weight of seedlings, root volume, root length root weigh.

The results of the analysis of the interaction between the treatments of various oil palm varieties and various marginal soils (I) had a very significant effect on root volume, root length root weight, as well as a significant effect on the number of leaves and wet seedling weight. Further testing of BNJ at 5 and 1% interaction between various varieties and various soil media treatments V4M1 (themba variety and subultisol planting media at a depth of 0-50 cm) on soil fertility values had a very significant effect on seedling growth characteristics, number of leaves, wet weight of seedlings root weight.

SIGNIFICANCE STATEMENT

This study discovered the significant interactions between oil palm varieties and marginal soil types that can be beneficial for selecting adaptable seedlings with optimal growth characteristics, including root development, leaf number shoot weight. The findings provide valuable insights into how specific soil-media combinations influence seedling performance. This study will help the researchers to uncover the critical areas of soil–variety adaptability that many researchers were not able to explore. Thus, a new theory on targeted seedling selection for marginal soils may be arrived at.

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