BIODIVERSITAS
Volume 24, Number 3, March 2023
Pages: 1650-1658

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d240338

Assessment of turf quality in *Paspalum vaginatum* Sw. accessions of Sumatra, Java, and Bali (Indonesia) with clay and amended sand growing media

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Manuscript received: 16 January 2023. Revision accepted: 15 March 2023.

Abstract. *Rahayu, Ariyanto DP, Usrotin AH, Hatami FR, Mo YG. 2023. Assessment of turf quality in* Paspalum vaginatum *Sw. accessions of Sumatra, Java, and Bali (Indonesia) with clay and amended sand growing media. Biodiversitas 24: 1650-1658.* Seashore paspalum (*Paspalum vaginatum* Sw.) is a selected turfgrass species in the FIFA football world cup Qatar 2022. The choice considers its turf quality, growth habit, quick recovery from damage, tolerance in warm conditions, and low water consumption. Since the breeding program of seashore paspalum worldwide still needs to be improved and is yet to start in Indonesia, we suppose that in the future, seashore paspalum will become a favorite turfgrass industry. Previous studies showed that Indonesia has many accessions to the germplasm of seashore paspalum. This study aimed to find superior mother lines of Indonesian germplasm accession by select of visual and functional quality using clay soil of vertisol and vertisol-amended sand as growing media for quality evaluation. This study was a wild-type collection followed by a plot experiment using Randomized Complete Block Design. In this experiment, the control was using a commercialized cultivar. Seashore paspalum accessions were collected from Java, Bali, and Sumatra Indonesian islands. Observation of variables were visual qualities, i.e., tiller density, color, leaf texture, uniformity, and functional quality, i.e., surface covering, recoverability, clippings dry weight, root length, root dry weight. The National Turfgrass Evaluation Program (NTEP) rated those qualities by scoring. The quality index of turfgrass used a rating score formulated from a visual and functional quality score. The data were analyzed using DMRT and T-test. Results showed that growing paspalum in clay-amended sand media showed a better recovery rate than the accessions grown in vertisol media. Mowing the grass can reduce plant height and leaf texture, and increases the clipping dry weight. Sand amendment to vertisol soil can improve the seashore paspalum visual qualities, i.e., leaf texture, tiller density, color score, and functional quality, such as root length. Seashore paspalum accessions vary in quality, i.e., visual and functional. Native accessions have a better recovery rate, higher tiller density, and uniformity than the control but a higher clipping yield. Bogor accession had faster soil surface coverage, Siak accession had a high recovery rate. Rumbei accession was the highest clipping dry weight, fast land cover, and high root dry weight. The accessions of Siak and Rumbei have higher quality index than the control after mowing. Siak accession performed better in vertisol, whereas Rumbei accession performed better in vertisol-amended sand. The performance of Rumbai and Siak accessions showed that seashore paspalum from Sumatra has better characteristics than Java and Bali and is promising for further cultivar development.

Keywords: Cultivar, grass visual and functional quality, *Paspalum vaginatum* Sw., sand amendment

INTRODUCTION

Seashore paspalum is one of the species of turfgrass exclusively used for the FIFA world cup 2022 Qatar (Ozkan and Kir 2021). The species is perennial turfgrass with excellent resistance to salinity, drought, and low temperature (Wu et al. 2018), suitable for a wide range of soil conditions and pH levels, and tolerance to pests, disease, and shade (Zong et al. 2015; Acuña et al. 2019). Growing seashore paspalum requires low fertilizer and pesticide inputs (Guo et al. 2016). Seashore paspalum can produce high-quality grasses in soil types that vary in texture, moisture content, aeration, pH, and salinity but are sensitive to winter (Jespersen et al. 2019). In Indonesia, seashore paspalum species exist as accessions in many places and grow naturally in seaside, grassland, roadside, and farmland areas (Rahayu et al. 2020).

The benefit of seashore paspalum germplasm is an option for selection for breeding and creating cultivars that can adapt to the local environment, which will help develop future turfgrass industries. High morphological variability becomes a desire for germplasm conservation and parents' selection in breeding programs (Khadivi-Khub et al. 2014). Assessment of the morphology characteristics of seashore paspalum indicates a potential to improve resistance in future turfgrass cultivars (Katuwal et al. 2021). Therefore, the leaf size of turfgrass affects evapotranspiration and is related to water consumption (Xu et al. 2013). Leaf width and turfgrass area become criteria for turfgrass stress resistance selection (Głąb et al. 2015). Selecting germplasm by analyzing the genetic diversity for further use is essential. Together with environmental factors, its genetic composition can influence variance in morphological analysis. Liu et al. (2019) reported that molecular marker cluster and morphological analysis were used to analyze the diversity of Chinese genetic seashore paspalum resources. Growth characteristics of wild-type turfgrass can help with turfgrass selection. Growth characteristics of prostrate turf and dwarf are common criteria for turfgrass selection (Li et al. 2016). Prostrate turf has advantages over upright turf in low mowing tolerance, more traffic resistance, improved heat resistance, and better ground coverage, while dwarf turfgrass advantages lower mowing costs and less irrigation and fertilization. Low mowing height tolerance can improve turf density, leaf texture, and turf quality, where the narrower leaves result in a better visual appearance after low mowing (Chen et al. 2016). Root morphological characteristics are also essential to turfgrass drought resistance (Zhang et al. 2019). There is a different ability to utilize drought resistance mechanisms among wild collections and commercial cultivars. Commercial cultivars have higher acquisition area and length per unit root dry weight investment, whereas wild accession benefits by allocating more dry weight to root production (Katuwal et al. 2021).

Developing turf on heavy clay soil requires much effort since growing has many limitations. Vertisol is a heavy clay soil that has a swell shrinkage character. Therefore, managing turfgrass in vertisol has a particular chance for rooting development of seashore paspalum. Vertisol has a clay texture with high negative colloid, thus having a high cation exchange capacity (Özcan et al. 2018; Dudek et al. 2019). The soil has a moderate total N of 0.21%, a high CEC of 25.1 Me/100g, and a high clay content dominated by type 2:1 clay minerals (Hailu et al. 2015). Globally, vertisol soils cover about 3.5 million km^2. Alvisol exists in almost semi-arid tropics and subtropics (Dasog and Mermut 2013), where 60% occur in the tropical belt, 30% in subtropics, and 10 % outside of both regions (Kovda 2020). The elevation of vertisols varies from the sea level up to 3,000 masl (Elias et al. 2022). This study aims to find the qualified wild-type seashore paspalum accession by checking the seashore paspalum growth in vertisol and compared to vertisol-amended sand.

MATERIALS AND METHODS

Study area

The study was an exploration survey, exploring wild-type accession of seashore paspalum, and quality evaluation using plot experiments in the field. The accession survey was a predicted exploration randomly located in Java, Bali, and Sumatra (Table 1). The grasses were collected in the stolon, packed in plastic bags, and grown in the pot. The grass was grown in pots for two months. The stolon and tillers were harvested from the pots and then planted in the plot experiment. The plot experiment was in Kesongo Village, Mojolaban Subdistrict, Sukoharjo District (7°36'40.0"S, 110°50'01.9"E), which has an altitude of 104 masl and an average rainfall of 183.33 mm/year (BPS 2018). The soil was vertisol and had a loamy loam texture with a climate regime belonging to udic vertisols. The intensity of solar occupation was measured using the solar radiation calculator Lux Apps. The solar radiation measured at 9.00 AM, 23476 ± 2008 Lux; noon at 12.00 AM, 39131 ± 3139 Lux; and afternoon at 3.00 PM, 25141 ± 948 Lux, every three days for six weeks.

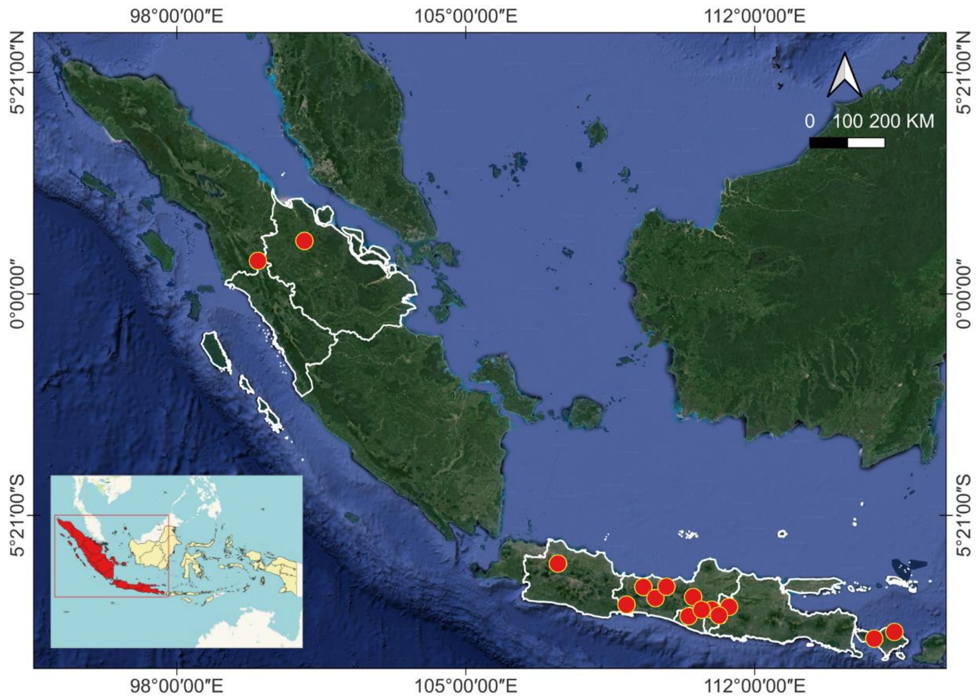

Figure 1. Location of survey and sampling sites of seashore paspalum grass collected from seven provinces in Indonesia.

Table 1. Data from collected seashore paspalum and sampling site

Accession	Specific sample collection site					
	Location	Province	Site	Altitude (m)	Latitude	Longitude
P1	Kebumen	Central Java	Ground	20	7° 40' 09.47" S	109° 30' 05.05" E
P2	Tanah Lot	Bali	Beach	4	8° 37' 16.37" S	115° 05' 12.51" E
P3	Rumbai	West Sumatra	Roadside	5	0° 33' 8.23" N	101° 26' 2.78" E
P4	Siak	Riau	Roadside	11	0° 54' 25.84" N	102° 09' 06.89" E
P5	Ponorogo	East Java	Lawn	98	7° 54' 20.13" S	111° 27' 27.57" E
P6	Salam	Control	-	-	-	-
P7	Temanggung	Central Java	Arable land	1150	7° 15' 01.52" S	110° 01' 42.12" E
P8	Klaten	Central Java	Lawn	350	7° 42' 20.99" S	110° 36' 23" E.
P9	Jepara	Central Java	Seaside	3	6° 33' 55.09" S	110° 39' 35.87" E
P10	Jembrana	Bali	Seaside	3	8° 21' 00.41" S	114° 32' 52.03" E
P11	Bogor	West Java	Golf Course	250	6° 35' 52.85" S	106° 50' 18.48" E
P12	Tasikmadu	Central Java	Roadside	340	7° 34' 28.29" S	110° 55' 4.735" E
P13	Parangtritis	Yogyakarta	Roadside	10	7° 58' 33.94" S	110° 19' 00.30" E
P14	Ngawi	East Java	Lawn	74	7° 22' 15.28" S	111° 10' 22.49" E
P15	Magelang	Central Java	Golf course	390	7° 29' 36.67" S	110° 12' 48.08" E

Procedures

The plot experiment was a factorial Complete Randomized Block Design (RBD) consisting of two factors, i.e., the seashore paspalum accession and growing media. The vertisol soil (T0) characteristics are shown in Table 2. The soil had pH H_2O 6.98 (neutral), available-P 2.39 ppm (very low), available K-0.15 (low), organic matter content 2.03% (low), electrical conductivity 1.55 dS m^{-1} (low), clay loam texture, and cation exchange capacity 25.1 me/100g (high). The sand amendments (T1) were fine sand with a thickness of 5 cm covering the soil surface, then proceeded with stirring as tillage. The sand used for the amendment was collected from Mount Merapi and had a pH of H_2O 6.3 (neutral), an organic matter content of 2.0% (low), a permeability of 7.2 cm h-1 (fast), and an electrical conductivity of 0.011 dS m^{-1} (low).

The seashore paspalum accessions were 15 collected from several regions in Indonesia (Table 1), including commercial cultivars as the control (Salam, P6). The planting media were vertisol soil (T0), and vertisols amended sand (T1). Each accession plot was replicated by four replication. Thus the unit experiment was 60 units. The plot size was 1 m x 1 m, and the distance between the unit plot was 50 cm. The turfgrass was planted in a hole point using three tillers, and each tiller has a stolon with three nodes in length. The distance of each hole point was 7 cm intervals. Thus every plot has 196 points. The grass was fertilized with an NPK ratio of 4: 1: 3 with the same volume as 5-gram N per m^2 monthly. The turfgrass was mowed in 3 cm mowing high after covering the soil surface was 100 %. The mowing was held three times with intervals of 14 days. During establishment, the grass was irrigated using fresh water every three days.

Data analysis

Variables observed in this study were turfgrass growth, plant height every week, tiller density, color score, shoot weight after mowing, root length, root weight after six months, recovery after low mowing every 14 days for three times observation, and leaf texture every month. Data analysis used the F test, Duncan's Multiple Range Test (DMRT), and the T-test to compare the variable between growing media (Table 3). The variable observation is during 18 Weeks After Planting (WAP). Leaf color was measured using Munsell Plant Tissue Color Charts, scoring light to dark green; score 1 for 2.5 GY 6/6, 2 for 2.5 GY 6/4, and 3 for 2.5 GY 5/6 score 4 for 2.5 GY 5/4, and score 5 for 2.5 GY 5/2. The quality index of turfgrass is rated using the scoring index, as shown in Table 3.

RESULTS AND DISCUSSION

The visual quality of seashore paspalum

The result of variance analysis showed that seashore paspalum accessions were significantly different from tiller density (Table 4), whereas T growing media test had no significant effect. The tiller density of all seashore paspalum accession was low. Klaten accession (51 tillers/100 cm^2) showed the highest tiller density. The native accessions had a higher tiller density than the Salam cultivar as the control.

Leaf texture is a measure of leaf width on grass plants. Beard (1973) divides the leaf texture into five categories, i.e., <0.1 cm (very smooth), 0.1-0.2 (smooth), 0.2-0.3 (medium), 0.3-0.4 (Rough), and > 0.4 (very rough). Grass with good texture has more narrow-shaped leaves. Data analysis showed that paspalum accessions significantly have different textures ($P<0.05$), even though there was no different texture due to growing media. Mowing caused finer texture, where the average before mowing was 3.83 mm, with the first mowing becoming 3.43 mm and the third mowing 3.32 mm (Table 4). Table 4 shows that the Siak and Parang Tritis accessions are dark green with a value of 4.25. The average yield of leaf color was in the range of 3.1. Total N content in vertisols was moderate rate and could affect plant vegetative growth, especially leaf growth and color.

Table 2. Characteristic of vertisols soil

Parameter	Unit	Result	Value
pH H_2O	-	6.98	Neutral
Organic C	%	1.59	Low
Organic Matter	%	2.03	Low**
CEC	Me/100g	25.1	High
Total N	%	0.21	Medium
Available P	Ppm	2.39	Very low
Available K	Me/100g	0.15	Low
EC	dS/m	1.55	Low
Sand	%	26	Clay loam
Silt	%	42	
Clay	%	32	

Note: **) Value according to *PPTA* Bogor in Rosmarkam and Yuwono (2002)

Table 3. Quality score assessment of turfgrass

Parameter	Score	Range
Tiller density	1	<30
	2	30-40
	3	41-50
	4	>50
Leaf texture (cm)	1	>0.3
	2	0.2-0.3
Leaf color	1	<2
	2	2-2.9
	3	3-3.9
	4	4
Texture	1	<4
	2	4-4,9
	3	5-5.9
	4	>6
Density	1	4
	2	4.1-4.9
	3	5-5.9
	4	>6
Color	1	4.5
	2	4.6-5.9
	3	>6
Duration of land cover (days)	1	>80
	2	70-79
	3	60-69
	4	>60
Recovery ability (%)	1	<80
	2	80-99
	3	100
Dry weight grass clippings (kg /1 m^2)	1	<0.25
	2	0.25-0.35
	3	>0.35
Root length (cm)	1	10-14
	2	14.1-18
	3	18.1-23
	4	>23
Dry weight roots (g /100 cm^2)	1	<3
	2	3.1-7
	3	>7

The result of variance analysis (Table 5) showed that seashore paspalum accessions varied significantly on texture uniformity, density, and color (P<0.05). Uniformity is commonly calculated using the NTEP (National Turfgrass Evaluation Program) scoring method between 0-9. Tanah Lot accession (P2) has the best texturing and color uniformity scores of 6.00 and 6.50, while the Rumbei accession (P3) has the best density uniformity of 6.00 (Table 6). This result indicates that both local accessions have better uniformity than Salam (P6) cultivar as the control. Mowing the grass can reduce the accession leaf texture (Figure 2).

Functional quality

In this study, seashore paspalum accession varied in soil surface coverage rate (Table 6). Bogor accession (P11) was 24 days faster than the Salam cultivar as the control (P6). Siak accession (P4) had the best recovery rate at 100%, while the Salam (P6) had 95% (Table 6). There was a change in the turf recovery rate after mowing three times (Table 7). The local accessions used in this study were from several places with different growing environmental conditions. Commonly native accessions have higher adaptability around beaches, golf courses, roadsides, and even courtyards, increasing recovery ability.

The result of variance analysis showed that seashore paspalum accessions were not significantly different from the dry weight of grass clippings. In contrast, T-test results showed that media affected clipping dry weight after the fourth mowing (P <0.05). Rumbei accession has the highest yield of clipping dry weight at 0.136 g/10 cm^2 (Table 6). Mowing significantly increased the clipping dry weight (P=0.0001) from 0.11 g/10 cm^2 on average to 0.33 g/10 cm^2 (Table 7), and each accession trend increased the clipping (Figure 3).

The clipping dry weight showed that it in T0 media had higher yields, with an average of 0.36 g/10 cm^2, compared to T1, with an average of 0.31 g/10 cm^2. This study shows the CEC vertisol (T0) was higher than that of vertisol that amended sand (T1). However, Indonesian grass accession was still higher clipping than Salam cultivar. Moreover, the amendment of sand to vertisol improved root length above 10 cm on average as 18.07 cm compared to growth in vertisol. In addition, Rumbei accessions (P3) had the highest root dry weight of 9.00 g/10 cm^2, whereas the Salam cultivar had about 2.88 g/10 cm^2.

Effect of media on the growth of seashore paspalum

The paspalum grown in vertisol (T0) showed a higher texture were Tasikmadu accession (P12) of 4 mm and Salam (P6) of 3 mm (Figure 2). In contrast, vertisol-amended sand, Bogor accession (P11) showed the highest texture (4.8 mm) compared to the Salam accession (P6) with 3.8 mm. That proves native Indonesian accession is potentially in quality and can compete with the Salam cultivar as the control. Frequent mowing reduced the leaf texture. The average leaf texture at the first mowing in T1 was higher (3.64 mm) than the average T0 (3.31 mm). After the third mowing, the Tanah Lot and Jembrana accessions showed the smallest leaf texture than others of 2.9 mm with a medium leaf texture category. In contrast, the imported Siam accession had a rough leaf texture with a leaf width of 3.3 mm.

Table 4. Quality score assessment of turfgrass

Accession treatment	Tiller density (tiller/100cm^2)	Leaf width Before mowing (mm)	After first mowing (mm)	After 3rd mowing (mm)	Leaf color
Kebumen	32 ab	3.6 abcd	3.1 ab	3.0 ab	2.25 a
Tanah Lot	40 abc	3.0 a	2.8 a	2.9 a	3.5 a
Rumbai	43 abc	3.6 abcd	3.3 abc	3.1 abc	2.25 a
Siak	45 abc	3.8 abcde	3.0 a	3.0 ab	4.25 a
Ponorogo	33 ab	3.3 ab	3.1 ab	3.0 ab	3 a
Salam	38 abc	3.8 abcde	3.5 abcd	3.3 abc	3.25 a
Temanggung	33 ab	4.4 cde	4.0 cd	3.6 bcd	2.5 a
Klaten	51 c	4.1 abcde	3.5 abcd	3.4 abcd	3 a
Jepara	44 abc	3.5 abcd	3.4 abcd	3.4 abcd	2.75 a
Jembrana	31 ab	3.4 abc	3.1 ab	2.9 a	3.5 a
Bogor	39 abc	4.0 abcde	3.5 abcd	3.5 abcd	3.75 a
Tasikmadu	29 a	4.3 bcde	3.9 bcd	3.8 cd	2.25 a
Parangtritis	45abc	3.4 abc	3.3 abc	3.1 abc	4.25 a
Ngawi	43 abc	4.8 e	4.1 d	4.0 d	3.25 a
Magelang	31 ab	4.5 de	3.9 bcd	3.8 cd	2.75 a

Note: P1 (Kebumen), P2 (Tanah Lot), P3 (Rumbei), P4 (Siak), P5 (Ponorogo), P6 (Salam), P7 (Temanggung), P8 (Klaten), P9 (Jepara), P10 (Jembrana), P11 (Bogor), P12 (Tasikmadu), P13 (Parang Tritis), P14 (Ngawi), P15 (Magelang). Numbers followed by the same letters in the same column showed no significant differences based on the DMRT level of 5%

Table 5. Quality score assessment of turfgrass

Accession treatment	Texture	Density	Color
Kebumen	4.25 abcd	4.25 a	4.25 a
Tanah Lot	6.00 e	5.25 ab	6.50 d
Rumbai	5.25 de	6.00 b	6.25 cd
Siak	5.25 de	5.00 ab	6.00 bcd
Ponorogo	4.50 abcd	6.00 b	6.00 bcd
Salam	3.75 abc	4.50 ab	4.25 a
Temanggung	5.00 cde	4.00 a	5.25 abcd
Klaten	4.00 abcd	4.50 ab	5.00 abcd
Jepara	4.25 abcd	4.25 a	5.00 abcd
Jembrana	3.50 ab	4.25 a	5.25 abcd
Bogor	4.00 abcd	4.25 a	4.50 ab
Tasikmadu	4.75 bcde	4.50 ab	4.50 ab
Parangtritis	3.25 a	3.75 a	4.75 abc
Ngawi	4.25 abcd	4.50 ab	5.00 abcd
Magelang	3.75 abc	4.25 a	5.00 abcd

Note: P1 (Kebumen), P2 (Tanah Lot), P3 (Rumbei), P4 (Siak), P5 (Ponorogo), P6 (Salam), P7 (Temanggung), P8 (Klaten), P9 (Jepara), P10 (Jembrana), P11 (Bogor), P12 (Tasikmadu), P13 (Parang Tritis), P14 (Ngawi), P15 (Magelang). Numbers followed by the same letters in the same column showed no significant differences based on the DMRT level of 5%

Table 7. Quality score assessment of turfgrass

Variable	Mowing 1	Mowing 2	Mowing 3	P value
Leaf texture (mm)	3.71	3.50	3.22	0.009 *
Clipping dry weight (g/10 cm^2)	0.33	0.11	0.33	0.001
Recovery rate (%)	67.3	65.3	90.7	0.009 *

Note: * ($p<0.05$)

Clipping dry weight in T0 media was higher than in T1 (Figure 3). The clipping dry weight at mowing 1 and 2 was significant for both media types (Table 8). However, the amendment of sand to vertisol significantly affected the reduction of clipping dry weight compared to vertisol soil, from 0.363 (g) to 0.304 (g) in the first and second, while in the third and fourth mowing from 0.362 (g) to 0.310 (g), respectively. Growing paspalum in T1 media showed a better recovery rate than the accessions grown using T0 media.

Table 8 shows that there is no difference in leaf color, root dry weight (P=0.45), leaf texture (P=0.063), and clipping dry weight of paspalum (P=0.31) between To and T1 growing media. However, adding sand to vertisol significantly increased the tiller density (P=0.05) from 35.8 to 40.4 /10cm^2. Figure 4 shows that seashore paspalum accessions are best found in Siak (P4T0) with a value of 32. Based on observations, intensive watering was performed when the initial planting at 1-day intervals accelerates the growth of Siak accessions compared with other accessions in vertisol (T0). In the medium amended sand (T1), the best seashore paspalum accession was in Rumbei accession (P3T1), with a value of 33. Rumbei accession (P3T1) had the fastest land cover time of 54 days. It is related to sand media that increases the rate of grass density because the roots are easily formed after mowing.

Discussion

Screening genotypes of native germplasm of the breeding process is useful for identifying superior parental lines and hybrids with wide adaptation. Genetic variability is essential in developing selected cultivars using the breeding program to perform accurate selections for some traits. Genetic variances were observed across nurseries and locations (Gouveia et al. 2020). Furthermore, various locations in different environments result in unstable genotype behavior (Mickelbart et al. 2015). Turfgrass selection also uses visual ratings with several evaluators to get accuracy variation (Bell et al. 2009). Therefore, evaluators use the same interpretation of the NTEP rating scale to ensure the results of digital image analysis (Karcher and Richardson 2003). In this study, the wild-type genotype selection uses different growing media with opposite texture characteristics, such as heavy clay soil and amended sand of vertisol soil, and the rate of visual and functional quality and index quality rating. This study aims to get a superior wild type for a further breeding program with commercial seashore paspalum cultivars as a referent.

Table 6. Quality score assessment of turfgrass

Accession treatment	Duration of land cover (day)	Recovery Ability		Dry weight grass clippings		Root length (cm)	Dry weight roots ($g/100cm^2$)
		Recovery ability 1 (%)	Recovery ability 4 (%)	Before mowing ($kg/1m^2$)	After mowing ($kg/1m^2$)		
Kebumen	72 abc	95 bc	95 ab	0.410 a	0.106	17.3 ab	2.88 abc
Tanah Lot	59 a	100 c	100 b	0.617 a	0.102	19.7 ab	6.25 bcd
Rumbai	54 a	100 c	95 ab	0.614 a	0.136	21.0 ab	9.0 d
Siak	61 a	100 c	100 b	0.660 a	0.122	15.0 ab	4.23 abc
Ponorogo	68 ab	95 bc	100 b	0.596 a	0.111	14.2 a	1.50 ab
Salam	63 a	100 c	95 ab	0.582 a	0.112	18.0 ab	2.88 abc
Temanggung	57 a	100 c	90 ab	0.610 a	0.120	24.7 b	2.88 abc
Klaten	63 a	100 c	90 ab	0.588 a	0.098	18.9 ab	5.38 abcd
Jepara	73 abc	90 bc	85 a	0.462 a	0.121	18.3 ab	3.88 abc
Jembrana	69 abc	95 bc	90 ab	0.465 a	0.087	15.7 ab	1.13 a
Bogor	87 c	80 a	90 ab	0.307 a	0.112	15.6 ab	6.63 cd
Tasikmadu	61 a	100 c	85 a	0.401 a	0.117	20.1 ab	2.33 abc
Parangtritis	85 bc	85 ab	90 ab	0.386 a	0.120	17.8 ab	2.0 abc
Ngawi	69 abc	100 c	85 a	0.468 a	0.114	19.2 ab	2.75 abc
Magelang	66 a	95 bc	85 a	0.445 a	0.116	15.6 ab	1.18 a

Notes: P1 (Kebumen), P2 (Tanah Lot), P3 (Rumbei), P4 (Siak), P5 (Ponorogo), P6 (Salam), P7 (Temanggung), P8 (Klaten), P9 (Jepara), P10 (Jembrana), P11 (Bogor), P12 (Tasikmadu), P13 (Parang Tritis), P14 (Ngawi), P15 (Magelang). Numbers followed by the same letters in the same column showed no significant differences based on the DMRT level of 5%

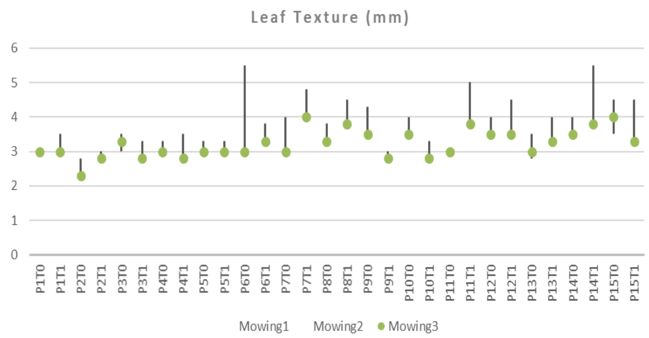

Figure 2. Changes in leaf texture of seashore paspalum by mowing three times. Note: P1 (Kebumen), P2 (Tanah Lot), P3 (Rumbei), P4 (Siak), P5 (Ponorogo), P6 (Salam), P7 (Temanggung), P8 (Klaten), P9 (Jepara), P10 (Jembrana), P11 (Bogor), P12 (Tasikmadu), P13 (Parang Tritis), P14 (Ngawi), P15 (Magelang). T0 (Vertisols soil), T1 (Vertisols with a mixture of high sand 5 cm)

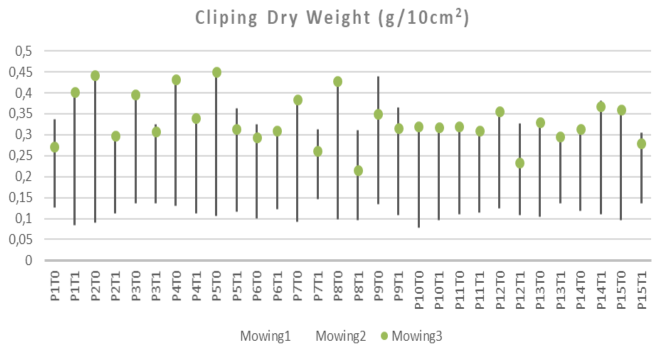

Figure 3. Changes to clipping dry weight by mowing three times. Note: P1 (Kebumen), P2 (Tanah Lot), P3 (Rumbei), P4 (Siak), P5 (Ponorogo), P6 (Salam), P7 (Temanggung), P8 (Klaten), P9 (Jepara), P10 (Jembrana), P11 (Bogor), P12 (Tasikmadu), P13 (Parang Tritis), P14 (Ngawi), P15 (Magelang). T0 (Vertisols soil), T1 (Vertisols with a mixture of high sand 5 cm)

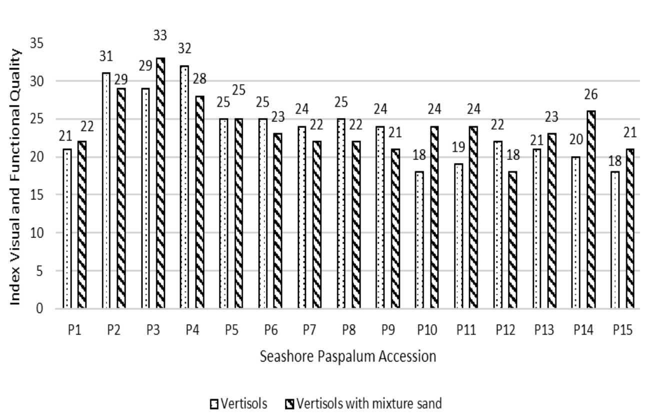

Figure 4. Index quality of seashore paspalum accession

Table 8. Variable growth in vertisol and amended vertisol by sand based on T-Test

Variable	T0	T1	P value
Leaf texture (mm)	3.5	3.92	0.063
Tiller density ($count/10cm^2$)	35.8	40.43	0.050*
Color score (1-5)	3.28	3.0	0.230
Root length (cm)	16.8	19.2	0.068
Root dry weight (g)	3.74	3.62	0.453
Total clipping dry weight (g)	4.63	4.40	0.317
Cutting clipping 1 (g)	0.332	0.324	0.306
Cutting clipping 2 (g)	0.110	0.115	0.180
Cutting clipping 3 (g)	0.363	0.304	0.002**
Cutting clipping 4 (g)	0.362	0.310	0.009**

Note: ** ($p<0.01$); * ($p<0,05$). T0: Vertisols soil, T1: Vertisols with a mixture of high sand 5 cm

In this study, the highest tiller density has resulted in a cultivar from Klaten (51 tillers/100cm^2). This result is lower than a study by Confortin et al. (2017) which showed an average tiller density of seashore paspalum of 93.24 tillers/100 cm^2 in clay alfisol media. According to Beard (1973), tiller count density per 100 cm^2 is classified into three, i.e., high > 200, medium 100-200, and low <100. Commonly, more tiller means high photosynthetic efficiency to show the stability of good turfgrass management, especially in tropical regions (Da Silva et al. 2015). Paspalum grown on vertisol with sand amendments (T1) showed a rougher leaf texture than those on vertisol (T0). According to Steketee et al. (2016), a rough leaf texture means it has better resistance, such as spot disease, than smooth leaf textured species and can be a candidate for developing more pathogen-resistant paspalum germplasm. Therefore, turfgrass, with a narrow to medium leaf texture, is an ideal candidate for breeding programs use (Steketee et al. 2017). Pereira et al. (2017) stated that a finer leaf texture is preferred and has the potential to use grass in high-value landscapes, while Głąb et al. (2015) reported that leaf width and leaf area are indicators of turfgrass resistance to drought stress. Mowing affects leaf texture; after mowing three times, the seashore paspalum leaf texture became smoother, on average, from 3.83 mm to 3.32 mm. This result is in line with Wang et al. (2019), who stated that mowing 1 to 2 times per month promoted tiller formation and improved the density and texture of turfgrass.

The leaf color of seashore paspalum in clay media (T0) and amendment sand (T1) have not significantly different. However, wild-type paspalum showed greener leaf color and uniformity than the controls. Wild-types possibility has better adaptation than imported cultivars. According to Lee et al. (2016), genetics by the environment affects the germplasm adapted to others. Turfgrass management as a whole can help native grass adaptability to become more dominant and take on many climate and ecosystem changes (Toledo et al. 2014). Taher et al. (2023) reported that, in general, the leaf color and uniformity of paspalum grass are not much different when grown in various clay media but are significant by fertilizers and nutrients. The greener color is produced from grass chlorophyll, reflecting green light (Cao et al. 2018). Nitrogen is the essential nutrient responsible for the green color of grass (Gazola et al. 2016).

Evaluation for turfgrass quality also refers to the time of covering the grass to the surface. Long periods of rapid land cover can indicate that the accession is good in its growth. In this study, wild-type accession seashore paspalum has higher recovery rates after mowing than the control. Furthermore, mowing could positively impact the paspalum recovery process, with an average of 90.7% after the third mowing. Carroll et al. (2021) reported that the recovery rate of Bermuda grass and annual bluegrass increases by 50% after mowing, even though the recovery rate is different. A high turfgrass recovery rate can be affected by good environmental conditions (Turgeon 2004), influenced by several things like day length, light intensity, and nitrogen status in the soil (Juliantika and Wicaksono 2018). The faster recovery rate of native wild-type as results of this study is in line with Smith and Fellowes (2014), that reported native grass showed a better recovery rate and results after mowing than non-native grass.

Clipping dry weight can be a benchmark of grass growth that is affected by maintenance, irrigation, fertilization, and other environmental factors. Clipping dry weight in vertisol (T0) showed higher yields with an average of 0.36 kg/m^2 compared to clay-amended sand media (T1) with an average of 0.31 kg/m^2. This result is in line with Sharaf et al. (2017), that clipped the dry weight of turfgrass in a mixture of clay and sand is higher than in sand. As much as 90% of the dry weight of plants is the result of photosynthesis (Moonmoon et al. 2017). However, mowing in the morning is preferable to maximize the clipping dry weight of plants (Tremblay et al. 2014). Moreover, the plants' clipping dry weight is also affected by irrigation (Juliantika and Wicaksono 2018), and soil properties, especially Cation Exchange Capacity (CEC) (Muakhor et al. 2013)

Rooting of turfgrass is also part of turfgrass quality assessment. In this study, the seashore paspalum has a root length of 18.07 cm. In alfisol clay soil, the root of the seashore paspalum was less than 10 cm (Rahayu et al. 2014). Soil conditions affect the depth of the grassroots (Zhu and Zhang 2016). Wangiyana et al. (2018) reported that adding sand helps improve the soil structure of vertisol land, making it more conducive for plant growth, especially in the dry season, and increasing crop establishment. According to Saedi et al. (2021), a sand-growing media has good aeration, especially oxygen, for root development to extend the roots. High aeration pores provide optimum space for root growth and development (Pandiyaraj 2017). Evaluation of rooting also refers to root dry weight beside the root length. Roots' dry weight affects grass productivity and is related to root density (Katuwal et al. 2021). Rapid root growth will support the growth of new rhizomes and stolons. In this study, the root length and land cover recovery in sand amendment media (T1) are better than vertisol media without amendments (T0), which was 19.2 cm, and 54 days after mowing. Rahayu and Zu'amah (2016) showed that the planting medium affects land cover recovery after 15 days of mowing; it also affects the characteristics of the paspalum, especially in texture, color, lateral growth for surface coverage, and root length. Gómez-Ramírez et al. (2017) used the root volume of seashore paspalum for suitability evaluation in the stability of soil slopes due to the increasing soil cohesion. The root's length, density, and distribution in the soil are important factors in controlling soil erosion on slopes and riverbanks (Carvalho et al. 2020).

Screening genotypes of native germplasm of the breeding process is useful for identifying superior parental lines and hybrids with wide adaptation. Genetic variability is essential in developing selected cultivars using the breeding program to perform accurate selections for some traits. Genetic variances were observed across nurseries and locations (Gouveia et al. 2017). Furthermore, various locations in different environments result in unstable genotype behavior (Mickelbart et al. 2015). Turfgrass selection also uses visual ratings with several evaluators to get accuracy variation (Bell et al. 2009). Therefore, evaluators use the same interpretation of the NTEP rating scale to ensure the results of digital image analysis (Karcher and Richardson 2003). In this study, the wild-type genotype selection uses different growing media with opposite texture characteristics, such as heavy clay soil and amended sand of vertisol soil, and the rate of visual and functional quality and index quality rating. This study aims to get a superior wild type for a further breeding program with commercial seashore paspalum cultivars as a referent.

In this study, the highest tiller density has resulted in a cultivar from Klaten (51 tillers/100 cm^2). This result is lower than a study by Confortin et al. (2017) which showed an average tiller density of seashore paspalum of 93.24 tillers/100 cm^2 in clay alfisol media. According to Beard (1973), tiller count density per 100 cm^2 is classified into three, i.e., high > 200, medium 100-200, and low <100. Commonly, more tiller means high photosynthetic efficiency to show the stability of good turfgrass management, especially in tropical regions (Da Silva et al. 2015). Paspalum grown on vertisol with sand amendments (T1) showed a rougher leaf texture than those on vertisol (T0). According to Steketee et al. (2016), a rough leaf texture means it has better resistance, such as spot disease, than smooth leaf textured species and can be a candidate for developing more pathogen-resistant paspalum germplasm. Therefore, turfgrass, with a narrow to medium leaf texture, is an ideal candidate for breeding programs use (Steketee et al. 2017). Pereira et al. (2017) stated that a finer leaf texture is preferred and has the potential to use grass in high-value landscapes, while Głąb et al. (2015) reported that leaf width and leaf area are indicators of turfgrass resistance to drought stress. Mowing affects leaf texture; after mowing three times, the seashore paspalum leaf texture became smoother, on average, from 3.83 mm to 3.32 mm. This result is in line with Wang et al. (2019), who stated that mowing 1 to 2 times per month promoted tiller formation and improved the density and texture of turfgrass.

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ACKNOWLEDGEMENTS

We would like to gratefully acknowledge the Ministry of Research, Technology, and Higher Education and Sebelas Maret University with the grand program of *KI-UNS* (*Hibah Kolaborasi Internasional*) for the expedition and *PUT* (*Penelitian Unggulan Terapan*) UNS 2021 for the experiment.

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