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Original Article

Agronomy character of Purun Bajang in humid tropical habitat

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Abstract

Purun bajang (*Eleocharis sp.*) grows abundantly in swamps and peatlands. The research aims to identify the agronomic characteristics of purun bajang which are influenced by differences in the natural habitat where it grows. The research method used descriptive research carried out in five humid tropical natural habitats in Kutai Kartanegara Regency, East Kalimantan. Data was obtained from 25 samples in each habitat. The agronomic character of purun bajang which is influenced by differences in soil pH is the percentage of the number of flowers per clump. The natural habitat with the highest soil pH 5.6, has the lowest average percentage of flowers per clump, 43.40%. The highest average stem length of purun bajang (133.80 cm) and the largest stem diameter (0.39 cm) are found in habitats with a soil pH of 5.6. Improving the soil pH value can be considered to lengthen and enlarge the stems. The characteristics of the natural habitat for the growth of purun bajang are waterlogged land with a height of 26.8-36 cm, water pH 4.5-6, soil pH 3.4-5.6, pyrite content of 0.06%-0.26%, and open land without shade.

Keywords: East Kalimantan, grass, peatlandm pyrite, swamp
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Introduction

Purun plants, including purun bajang (*Eleocharis sp.*), are wild plants that thrive in swamp and peatland areas. Purun has high ecological and economic value. Specifically, purun bajang has not been widely utilized by the community and is increasingly under pressure from population loss due to the degradation of its natural habitat. There is limited research reporting information on purun bajang plants. Generally, purun plants have ecological benefits as raw materials for organic fertilizers, biofilters, and phytoremediation because they can absorb heavy metals such as lead (Pb), cadmium (Cd), and zinc (Zn) (Dhonanto et al. 2022) (Asikin & Thamrin 2012). They can also be used as pest trap plants and as habitats for natural enemies (Asikin & Thamrin 2012) (Prihatini et al. 2011) (Adhi 2018). Purun plants are very useful as accumulators of lead found in water. Lead is accumulated through the absorption process of the purun plant roots, which produce specific peptide compounds called phytochelatins. The lead content in purun plants serves as a bioindicator of water pollution (Prihatini et al. 2011).

In addition to their ecological benefits, the economic benefits of purun plants can also be harnessed by the community using purun stems and flowers. There are three types of purun commonly utilized by the community in South and Central Kalimantan as raw materials for weaving, namely purun tikus (*Eleocharis dulcis* Burm. f. Hanschel), purun danau (*Lepironia articulata* Retz. Domin), and purun bajang (*Eleocharis sp.*) (Harsono 2013, Dhonanto et al. 2022). These three types of purun plants—purun danau, purun tikus, and purun bajang—are well-adapted to peatland habitats and grow wild and abundantly in many underutilized areas (Irawan et al. 2014). The habitat of purun plants is predominantly found in South Kalimantan, Central Kalimantan, West Kalimantan, East Kalimantan, South Sumatra, and Riau (Konsorsium PETUAH 2018).

Kalimantan island has several peatlands still consisting of forests (mangrove, peat swamp, and Industrial Plantation Forest (HTI)) and shrublands covering an area of 2,402,362 ha (49.9%) and 1,373,563 ha (28.6%) respectively. East Kalimantan has peatlands covering an area of 332,265 ha, which is 6.96% of the total area of East Kalimantan (Ritung et al. 2011). The largest peatland area is in Kutai Kartanegara Regency, East Kalimantan, covering 235,862 ha (Bioma 2013).

The natural habitat of peatland and flooded swamps as the growing area for purun bajang in East Kalimantan is greatly influenced by humid tropical climate conditions. A humid tropical climate is a condition in wet tropical regions located between 15^0 N and 15^0 S latitudes. The humid tropical climate area is characterized by relatively high humidity, ranging from 75-90%, high rainfall, and an average annual temperature ranging between 23-36^0C in both the Northern and Southern Hemispheres (Subagiyo et al. 2019). This is reflected in habitat conditions through soil acidity (pH) and the content of macro and micronutrients in the soil, making the natural humid tropical habitat generally characterized by low soil pH, low chemical content, and low soil fertility. These specific humid tropical habitat conditions are favorable for the growth of the three types of purun. Therefore, exploration and identification research on the agronomic characteristics of purun bajang in different habitats in the humid tropical regions of Kutai Kartanegara Regency, East Kalimantan, Indonesia, is conducted to obtain information on the agronomic characteristics of purun bajang growing in its natural habitat.

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Methods

Time and location

The research was carried out from May to August 2022. The research location consisted of five natural habitats where purun bajang grows, specifically in flooded swamp areas located in Tenggarong District, Kutai Kartanegara Regency. The analysis of soil pyrite content was carried out in the Soil Science Laboratory, Faculty of Agriculture, Mulawarman University.

Research tools and materials

The tools used included a camera, GPS, measuring tape, ruler, caliper, digital pH meter, color table, magnifying glass, raffia string, sticks, soil auger, digital scales, test tubes, digestion tubes and digestion block, centrifuge, flame photometer, AAS, and UV-VIS spectrophotometer. The materials used were purun bajang plant samples and soil samples from each purun bajang habitat.

Research methods

The determination of the research locations was done purposively, i.e., deliberately. The locations were chosen based on the presence of purun bajang growing in those areas. The selection of locations began with an exploration of purun bajang habitats. The selection of the research location is based on the extent of the peat swamp area naturally covered by purun bajang. The area included in the observation category must have a minimum size of 100m², with purun bajang grows naturally. Next, after five natural habitats where purun bajang grows were identified, and observation points for sample collection were determined by creating blocks or plots/quadrants of 5m x 5m in each habitat. Five sample points were then selected within each habitat (Figure 1). Each habitat location had five sample points, totaling 25 samples. The total number of purun bajang plant samples from the five habitats was 125 samples.

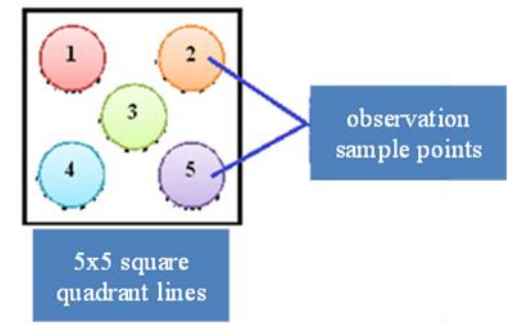

Figure 1. Determination of observation points for purun bajang plant samples

The observation of agronomic characteristics in purun plants was carried out using two observation methods, namely quantitative and qualitative methods, based on the observation needs for each plant organ, including roots, stems, leaves, flowers, and stolons. In addition to observing the agronomic characteristics of purun bajang, observations were also made on the biophysical conditions of the natural habitats, which included location coordinates, the presence of shade plants, soil pH, water pH, soil pyrite content, water inundation height, and the presence of other dominant vegetation or plants.

To determine the category of Purun vegetation population, the first step was to survey and quantify the population using methods like the transect method or quadrat sampling. In this process, researchers counted the number of Purun plants (e.g., Eleocharis species) within a fixed area, typically in square meter plots. The next step was to assess the density of the vegetation. A "very dense" population was characterized by Purun plants occupying more than 75% of the sampled area, indicated a continuous or nearly continuous cover of Purun plants, while a "moderately dense and spaced " population covered around 50-75% of the area, implied a slightly less dense but still substantial coverage. A " sparsely dense and spaced" population was one where Purun plants occupied less than 50% of the area and were spaced out, the distribution of Purun with noticeable gaps between plants. A "sporadic" population referred to individual plants scattered sparsely over the area. This classification was supported by studies such as those by Kushwaha et al. (2003) and Denny & Wiegert (1986), which highlighted how environmental conditions, particularly in wetland ecosystems, influenced the density and distribution of plants like Purun.

Data analysis

Data analysis was conducted descriptively, both quantitatively and qualitatively. The data were presented in the form of frequency distribution tables, histograms, and standard deviation values. The use of descriptive analysis in this research aimed to simplify and obtain an overall picture of purun bajang plants in their natural conditions as observed in the field. The standard deviation (SD) value was determined using the following formula:

$$S = \sqrt{\frac{\sum(\mathrm{Xi} - \bar{\mathrm{X}})^2}{n-1}}$$

where *S* is Standard deviation, **Xi** is the i-th data point, $\bar{X}$ is the mean of the data, and **n** is the number of samples

Results

Agronomic characteristics of Purun Bajang plants

The research results, including the average number of stems per clump, stem length, and stem diameter of purun bajang, are presented in Table 1.

The average number of stems (purun bajang) per clump was highest in habitat 4 (LP4) with 19.16 stems per clump and a standard deviation (SD) of ±4.62. The longest average stem length was found in habitat 3 (LP3), measuring 133.80 cm with an SD of ±10.62. The largest average stem diameter was also in habitat 3 (LP3), at 0.39 cm with an SD of ±0.01 (Table 1). However, the average stem diameter did not differ significantly across habitats, indicating that the stem diameter of purun bajang is relatively consistent between clumps.

Table 1. Average number of stems per clump, average stem length, and average stem diameter of purun bajang

Habitats	Average number of stems per clump	Average stem length (cm)	Average stem diameter (cm)
	.....per clump.....	.....cm.....	
LP1	8.40±3.34	111.90±13.67	0.31±0.02
LP2	9.28±4.04	103.66±14.68	0.34±0.02
LP3	16.48±3.17	133.80±10.23	0.39±0.01
LP4	19.16±4.62	68.19±17.13	0.25±0.02
LP5	16.60±3.42	9.75±6.59	0.29±0.02

Note: LP1 = Habitat 1, LP2 = Habitat 2, LP3 = Habitat 3, LP4 = Habitat 4, LP5 = Habitat 5

Purun bajang is classified as a monocotyledonous plant. According to Tjitrosoepomo (2009), purun belongs to the monocotyledoneae group, which generally has stems with minimal diameter variation from base to tip. Purun stems can grow to lengths of 50−200 cm (Rahmah 2021) and stem diameters of 2−8 mm (Steenis 2003).

The average number of leaves per clump and the leaf length of purun bajang are shown in Table 2, while the data on purun bajang flowers, including the length of the inflorescence and the number of flowers per clump, are presented in Table 3. The average number of stolons, stolon length, and stolon diameter of purun bajang are shown in Table 4.

Table 2. Average number of leaves per clum and average leaf length of purun bajang

Habitats	Average number of leaves per clump	Average leaf length
	.....per clump……	.....cm……
LP1	5.44±1.22	29.16±2.45
LP2	9.28±4.04	24.38±2.76
LP3	16.48±3.17	41.96±1.00
LP4	19.16±4.62	17.84±3.53
LP5	16.60±3.42	18.70±1.51

Note: LP1 = Habitat 1, LP2 = Habitat 2, LP3 = Habitat 3, LP4 = Habitat 4, LP5 = Habitat 5

The average number of leaves per clump was highest in habitat 4 (LP4) with 19.16 leaves per clump and a standard deviation (SD) of ±4.62. The longest average leaf length was found in habitat 3 (LP3), measuring 41.96 cm with an SD of ±1.00 (Table 2). The leaves of purun plants are reduced to sheaths shaped like tubes, resembling membranes that enclose the base of the stem. Sometimes, they have rudimentary leaf blades, with asymmetrical tips, reddish-brown to purple in color, and lack a ligule (Steenis 2003). The base of the purun stem is covered by single leaves growing perpendicularly like a membranous sheath covering the base, without a ligule. The leaves have parallel veins that are rigid and follow the shape of the stem (Tjitrosoepomo 2009). Purun bajang leaves are shown in Figure 2.

The longest average length of the inflorescence was found in habitat 1 (LP1), measuring 3.22 cm with a standard deviation (SD) of ±0.44. The highest average number of flowers per clump was observed in habitat 4 (LP4), with 8.88 flowers per clump and an SD of ±1.49 (Table 3).

The fewer the number of flowers per clump, the longer the flower length tends to be. The number of flowers is influenced by the number of stems; the more stems, the greater the potential number of flowers. The average percentage of flowers per clump ranges from 43.40% to 61.54%. This suggests that the percentage of flowers per clump is influenced by soil pH. Habitat 3 (LP3), with the highest soil pH of 5.6, had the lowest average percentage of flowers at 43.40% per clump.

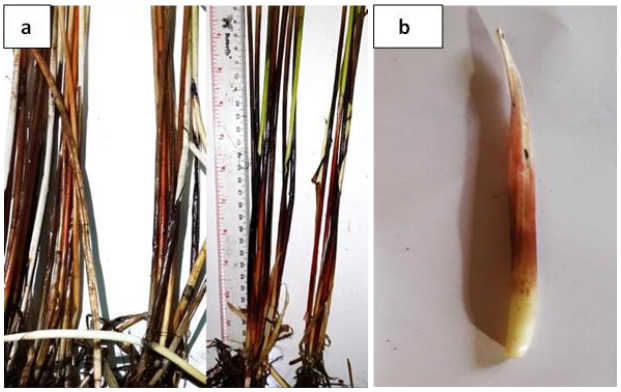

Figure 2. (a) Purun Bajang Leaf Covering the Base of the Purun Stem, and (b) Purun Bajang Stem Shoot with Leaf Layer

Table 3. Average length of compound flowers and average number of compound flowers per clump of purun bajang

Habitats	Average length of compound flowers	Average number of flowers per clump
	.....cm……	.....per clum……
LP1	3.22±0.44	4.04±1.34
LP2	2.70±0.59	5.64±2.43
LP3	2.79±0.47	6.80±1.39
LP4	2.01±0.19	8.88±1.49
LP5	1.64±0.23	8.16±0.98

Note: LP1 = Habitat 1, LP2 = Habitat 2, LP3 = Habitat 3, LP4 = Habitat 4, LP5 = Habitat 5

Table 4. Average number of stolons per clump, average stolon length, and average stolon diameter of purun bajang

Habitats	Average number of stolons per clump	Average stolon length	Average stolon diameter
	.....per clump….....	.....cm….....	
LP1	3.50±1.95	4.63±24.04	0.35±0.19
LP2	1.72±1.08	37.09±21.94	0.33±0.18
LP3	1.54±0.78	32.36±17.91	0.46±0.22
LP4	1.00±0.55	24.50±17.20	0.19±0.18
LP5	2.44±1.17	29.95±2.88	0.25±0.02

Note: LP1 = Habitat 1, LP2 = Habitat 2, LP3 = Habitat 3, LP4 = Habitat 4, LP5 = Habitat 5

The highest average number of stolons per clump of purun bajang was found in habitat 1 (LP1) with 3.50 stolons per clump and a standard deviation (SD) of ±1.95. The longest average stolon length was observed in habitat 2 (LP2), measuring 37.09 cm with an SD of ±21.94, while the largest average stolon diameter was found in habitat 3 (LP3), at 0.58 cm with an SD of ±0.22. A larger stem diameter correlates with a larger stolon diameter, though the number of stolons is not influenced by the number of stems. The data on the number of stolons per clump indicates that the purun bajang observed in the five habitats is a natural regeneration from purun bajang seeds. This suggests that purun bajang can be cultivated through generative propagation using seeds, in addition to using rhizomes as planting material.

References specifically for purun bajang are limited, so the information used here is based on references for other purun species, particularly purun tikus, which shares many agronomic characteristics. Flowers of purun tikus are located at the stem tips, similar to purun bajang. The roots of purun tikus form rhizomes that stand vertically or slant and grow closely with the stems and creeping shoots. At 6-8 weeks, the rhizomes develop tillers (Steenis 2003). Flowers appear after the tillers emerge above the water surface, at a height of about 15 cm. After flowering, purun tikus forms new rhizomes at the tips of the stolons, which are about 12.5 cm long. At 7-8 months, the rhizomes become non-productive, leading to the stems drying and gradually dying (Balitbangtan 2011).

The five purun bajang habitat locations are relatively close to residential areas (around 10-30m), characterized by standing water, and far from river streams. The water levels in these habitats fluctuate due to climatic influences such as rainfall, drainage, and variations in the land elevation of the swamps. The water height in the five habitats ranges between 26.80-36.00 cm. Three habitats (LP2, LP4, and LP5) have the same water pH of 6, indicating slightly acidic conditions (Neina, 2019). These locations also have the highest water pH levels. The soil pH varies from 3.4 to 5.6, and the pyrite content in the soil ranges from 0.06% to 0.26%. This indicates that purun bajang habitats are swampy areas with low soil pH. Swampy land is characterized by periodic or continuous flooding, either naturally or due to poor drainage, yet still supports vegetation growth. Flooding in swamps can be caused by tidal seawater, rainwater accumulation, or river overflow (Najiyati et al., 2005). Habitat 1 has the lowest soil pH at 3.4 (very acidic) and the highest pyrite content at 0.26%, suggesting it is still suitable for purun bajang due to its dense population. Purun plants are often found in acid sulfate soils and open, flooded swamp areas. Suitable soil for purun growth includes clay or humus with a pH of 6.9-7.3, although purun can also thrive in acidic soils. Purun is specific to acid sulfate soils and is resistant to high soil acidity (pH 2.5-3.5), serving as an indicator of such soils. Pyrite (FeS_2) is found in tidal areas and is stable under reducing conditions. However, when groundwater levels drop and pyrite in the upper soil layers is exposed to aerobic conditions, oxidation occurs. This oxidation process produces sulfuric acid, leading to highly acidic soil conditions with pH levels ranging from 2-3. This occurs because the reaction of pyrite with oxygen (O_2) releases large amounts of sulfate ions (SO_4^{2-}) and hydrogen ions (H^+), drastically lowering the pH of the soil or water. This likely happens when water levels in the habitat drop or during soil sampling, causing pyrite in the soil to react and affect the soil and water pH.

According to peat swamp references, the highest pyrite content observed in the five purun bajang habitats is only 0.26%, well below the 0.75% threshold, indicating the absence of a pyrite layer. These swamps are considered potentially fertile and suitable for agriculture. The predominant soil type in these swamps is alluvial soil, formed by sedimentation from rainwater, river water, or seawater. Swamps without peat soil and with pyrite layers less than 50 cm deep are referred to as shallow sulfide alluvial soils, also known as potential acid sulfate soils (Widjaja, 1986; Cahyana & Destina, 2017; Fitzpatrick et al., 2008).

All habitats are open areas without shade, with purun populations ranging from sparse to very dense. Swamps, including tidal swamps and peat swamps, are areas with various specific plant species (Kurniadinata et al., 2024). Other vegetation dominating the purun bajang habitats includes Ferns (*Anchistea virginica*), Water spinach (*Ipomea aquatica*), Sedge grass (*Junfus effusus*), Yellow burr-head (*Limnocharis flava*), Torpedo grass (*Panicum repens*), Rusty mimosa (*Acacia pennata* (L.)), and Mimosa (*Mimosa pudica*).

Table 5. Physical and Biological Conditions of Natural Habitats of Purun Bajang

Habitat	Location Coordinates	Shade Plants	Soil pH	Water pH	Soil Pyrite Content	Water Level Height	Dominant Vegetation	Habitat
LP1	Lat -0.445366º Long 116.996119º	33.00	4.5	3.4	0.26	Without Shade	Very dense	Ferns (*Anchistea virginica*)
LP2	Lat -0.40613º Long 116.979718º	35.00	6	3.71	0.08	Without Shade	Moderately dense and spaced	Water spinach (*Ipomea aquatica*), Sedge grass (*Junfus effusus*), Yellow burr-head (*Limnocharis flava*)
LP3	Lat -0.427124º Long 116.989802º	30.25	5.8	5.6	0.09	Without Shade	Moderately dense and spaced	Ferns (*Anchistea virginica*), Water spinach (*Ipomea aquatica*)
LP4	Lat -0.407777º Long 116.970228º	36.00	6	4.05	0.06	Without Shade	Sparsely dense and spaced	Torpedo grass (*Panicum repens*)
LP5	Lat -0.409803º Long 116.97111º	26,80	6	4.9	0.09	Without Shade	Sparsely dense and spaced	Torpedo grass (*Panicum repens*), Rusty mimosa (*Acacia pennata* (L.)), Mimosa (*Mimosa pudica*)

Note: LP1 = Habitat 1, LP2 = Habitat 2, LP3 = Habitat 3, LP4 = Habitat 4, LP5 = Habitat 5

Conclusion

The agronomic characteristics of purun bajang influenced by soil pH differences in its natural habitat include the percentage of flowers per clump. The habitat with the highest soil pH of 5.6 has the lowest average flower percentage per clump at 43.40%. The highest average stem length (133.80 cm) and largest stem diameter (0.39 cm) were also found in the habitat with a pH of 5.6. If the utilization of purun bajang focuses more on using its stems, increasing the soil pH could be a consideration. The bio-physical characteristics of the natural habitat of purun bajang are flooded swamp areas with water levels between 26.8-36 cm, water pH of 4.5-6, soil pH of 3.4-5.6, pyrite content of 0.06%-0.26%, and open areas without shade.

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