Morphological Variation of Castor Bean (*Ricinus communis* L.) on Peatland Area in Kepulauan Meranti Riau Indonesia

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Abstract. Castor (*Ricinus communis* L.) has been reported as source of raw material for various products, including biofuel, cosmetic and pharmaceutical industries. This plant is known as an adaptive plant which perform well-growth and development in unfertile soil. We observed that castor plants grow and develop in Kepulauan Meranti, Riau Province, Indonesia where peatland mostly dominates. Objective of the study was to evaluate genetic diversity of castor bean germplasm in Kepulauan Meranti grown in fired-peatland area based on morphological characters. Sampled plants were tagged and parts of plant were photographed and characterized. Some plant organs such as leaves and fruits were taken for more identification. We observed 12 castor accessions showing distinctive phenotypes. Morphological characters that varied among genotypes were plant architecture; stem anthocyanin; stem wax; stem color; adaxial leaf surface; fruit wax; form of racemic; main seed coloration; secondary coloration of seed; and type of secondary coloration of seed. All genotypes showed prickle existence on fruit surface. The result indicates that castor germplasm in Kepulauan Meranti serve diverse genetic variability. Further studies including assessment based on agronomic, biochemical and molecular approaches are still required for supporting castor breeding program to develop new cultivars particularly that adaptive to peat soil area.

1. Introduction
Castor bean or castor oil plant (*Ricinus communis* L.) belongs to Euphorbiaceae family with diploid chromosome 2n = 2x = 20 [1]. Castor is an important source of renewable energy with a wide range utilization in industry, pharmaceutical and agricultural sectors [2][3]. This plant has been reported being tolerant to different types of soil and pH [4].

Kepulauan Meranti is an archipelago in Riau Province Indonesia predominantly by peatland area and prone to land and forest fire [5]. Peatland fires had been occurred since the 1980s and recurs almost every year. Peatland fire delivers notorious impacts including ecological and economic problems [6]. Indonesia government establish a specific program called 3R or Revegetation, Revitalitation, Rewetting to conserve peatland area [7]. Agroforestry system is one of forest management system to integrate crops and woody perennial for mitigating deforestation and natural resources management delivering to social, economic and ecological improvement [8] [9] [10]. For this reason, castor plant provides promising alternative for agroforestry commodity in Kepulauan Meranti region. This plant is likely suitable for revegetation fired land to restore soil fertility, prevent further fires and an alternative source of economic income for the local communities. Therefore, genetic diversity of castor germplasm is an important analysis to understand the width of genetic differences as a basic database for further various studies.
Currently, various techniques have been available to study plant genetic diversity. Morphological technique offers several advantages such as [11][12]. Understanding the diverse genetic background of the germplasm will serve database for the generating of new cultivars and future genetic improvement programme of castor, restoration of fired-peatland and fired-peat forest particularly in Riau Province [12] [13]. Objective of this study was to characterize genetic variability of castor plant germplasm in Kepulauan Meranti based on several phenotypic traits.

2. Materials and Method
This study was conducted from July to August 2020. The study population was at fired-peatland area in Tanjung Peranap, Kepulauan Meranti, Riau Province. This area is part of agroforestry fields managed by Forest Management Unit or Kesatuan Pengelolaan Hutan (KPH) Tebing Tinggi and Koperasi Peranap Agro Bertuah collaborating with PT. Meranti Energi Alam (MEA). We tagged and made documentation for sampled-plants by taking photographs and several plants organs for characterization. We morphologically characterized based on several descriptors as described by [14] [15][16].

3. Result and Discussion
Forest fire was occurred almost every year in the sampling location of this study (Figure 1). This post fired-land was then utilized for agroforestry area by KPH Tebing Tinggi and PT MEA. Since then, this area is free of land and forest fire, The areas are situated at 102° 29’ 11.462” E; 0° 53’ 46.488” N and 102° 29’ 20.147” E; 0° 51’ 54.745” N. Jarak kepyar is one of agroforestry commodities planted in this fired-peatland without soil modification treatment.

![Figure 1](image1.png)

**Figure 1.** Sampling sites of castor bean germplasm in Tanjung Peranap Kepulauan Meranti Riau Indonesia

Variation on anthocyanin pigmentation in the hypocotyl was found among castor germplasm in Kepulauan Meranti (Figure 2). This figure depicts two types of hypocotyl namely with and without pigmentation indicated by presence or absence of pinkish coloration. We observed that anthocyanin staining showed different intensity among plants. This results is similar to [17]. According to [17], low concentration of anthocyanin may lead to absence of strong pigmentation.
In addition, we also observed anthocyanin coloration and presence of wax layer of castor stem (Figure 3) which showed diversity among individual plants. According to [18] stem coloration is inherited in monogenic manner in that green colour is encoded by recessive alleles over dominant red pigmentation. This phenotype has been reported to be related to resistance to Fusarium wilt disease [18][19]. Thus, this castor population provides valuable genetic resources for further castor genetic improvement particularly to generate new cultivars resistant against wilt disease caused by Fusarium oxysporum f.sp. ricini.

Another leaf descriptor that we observed on castor bean germplasm in Kepulauan Meranti is curvature of adaxial surface of leaf blade. The study castor population comprised three classes namely flat, slightly concave and concave leaf blade. While shape of the raceme showed three types, i.e. conical, cylindrical, and globose (Figure 4). Flat leaf and conical shape of raceme have been reported to be dominant over concave type and cylindrical raceme, respectively according to [20].
This work determined number of genotypes mainly based on result of seed morphological observation (Figure 5). We identified 12 distinct castor genotypes and named them from Mea-1 to Mea-12. Variation on seed phenotypes were indicated by main seed coloration; secondary coloration of seed; and type of secondary coloration of seed (painted vs cracked).

Table 1 showed five descriptors (plant architecture, stem anthocyanin, presence of stem wax, stem coloration and type of adaxial leaf surface) that diverse among 12 castor germplasm. Table 2 depicts qualitative morphological traits of fruit (fruit wax) and seed (main seed coloration; secondary coloration of seed; type of secondary coloration) were varied among 12 castor germplasm. All castor bean germplasm in Tanjung Peranap produce fruit with prickle. However, size of prickle was visually varied in size. Presence of prickle of the fruit has been reported to be inherited partially dominant over non-spininess [20].

As explained above, castor plant germplasm grown in Tanjung Peranap Kepulauan Meranti exhibit genetic diversity revealed by several morphological traits. This genetic resources play an important role as genetically diverse sources for improving castor genotype through breeding programmes. Wide range of variation in castor plant identified in this study could be resulted from mode of reproduction in which outcrossing as a predominant mode in castor plant. Results of present study remain needs further investigation including evaluation based on agronomic, biochemical and molecular approaches. Genetic improvement on castor to develop new cultivars that adaptive to peat soil area will contribute to improvement several aspects including preventing region from fire-land, revitalizing peatland, and improving socio-economy of local communities.
Table 1. Diversity of qualitative morphological characters of plant and stem among various castor genotypes in Kepulauan Meranti Riau Indonesia

| Genotypes | Plant architecture | Stem anthocyanin | Stem wax | Stem coloration | Adaxial leaf surface |
|-----------|--------------------|------------------|----------|-----------------|---------------------|
| Mea-1     | Semi erect         | Absent           | Present  | Medium Green    | Concave             |
| Mea-2     | Semi erect         | Absent           | Present  | Medium Green    | Slightly Concave    |
| Mea-3     | Erect              | Present          | Absent   | Medium Green    | Flat                |
| Mea-4     | Erect              | Present          | Absent   | Medium Green    | Flat                |
| Mea-5     | Semi erect         | Present          | Absent   | Pinkish Green   | Flat                |
| Mea-6     | Erect              | Absent           | Present  | Medium Green    | Slightly Concave    |
| Mea-7     | Semi erect         | Absent           | Present  | Medium Green    | Concave             |
| Mea-8     | Semi erect         | Present          | Present  | Medium Green    | Slightly Concave    |
| Mea-9     | Erect              | Absent           | Present  | Medium Green    | Flat                |
| Mea-10    | Erect              | Absent           | Present  | Medium Green    | Slightly Concave    |
| Mea-11    | Semi erect         | Absent           | Absent   | Medium Green    | Slightly Concave    |
| Mea-12    | Erect              | Present          | Absent   | Green           | Flat                |

Table 2. Diversity of qualitative morphological characters of fruit and seed among various castor genotypes in Kepulauan Meranti Riau Indonesia

| Genotypes | Fruit wax | Presence of the prickles on the fruits | Main seed coloration | Secondary coloration of seed | Type of secondary coloration |
|-----------|-----------|---------------------------------------|----------------------|-------------------------------|-------------------------------|
| Mea-1     | Present   | Present                               | Light Brown          | Dark Brown                    | Cracked                       |
| Mea-2     | Present   | Present                               | Light Brown          | Black                         | Cracked                       |
| Mea-3     | Present   | Present                               | Dark Brown           | Light Brown                   | Painted                       |
| Mea-4     | Absent    | Present                               | Greyish              | Dark Brown                    | Painted                       |
| Mea-5     | Present   | Present                               | Dark Brown           | Greyish                       | Cracked                       |
| Mea-6     | Present   | Present                               | Greyish              | Dark Brown                    | Painted                       |
| Mea-7     | Present   | Present                               | Pinkish Brown        | Greyish                       | Cracked                       |
| Mea-8     | Present   | Present                               | Greyish              | Dark Brown                    | Cracked                       |
| Mea-9     | Present   | Present                               | Greyish              | Dark Brown                    | Cracked                       |
| Mea-10    | Present   | Present                               | Pinkish Brown        | White                         | Painted                       |
| Mea-11    | Present   | Present                               | Dark Brown           | White                         | Painted                       |
| Mea-12    | Present   | Present                               | Dark Brown           | Light Brown                   | Cracked                       |

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